MASSACHUSETTS BIOMEDICAL INITIATIVES: THE JOURNEY FROM INCUBATION TO SUCCESS

A Major Qualifying Project

Submitted to Massachusetts Biomedical Initiatives

And to the Faculty of the

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Authored By:

David Arnold

Amanda Leigh Eaton

Gina Roffo

Kayla Sousa

Project Advisors: Frank Hoy and Jerry Schaufeld

Project Sponsored By:
Kevin O'Sullivan, President and CEO
Massachusetts Biomedical Initiatives

Abstract

This project analyzed Massachusetts Biomedical Initiatives' (MBI) located in Worcester, MA, current operations against their Strategic Vision and provided suggestions for improvement in various aspects for their future strategic plan. A survey with questions regarding MBI's networking, mentoring, services offered, and facilities was administered to MBI's past, present, and prospective tenants. In addition, a linear programming model was created to optimize space allocation for new facilities. Based on the tenant responses and model, the team was able to recommend changes in the aforementioned focus areas of MBI's operations. The results came directly from MBI's tenant companies; therefore, these recommendations should improve both the experience of future tenants and the overall operation of MBI as an incubator if put into practice.

Acknowledgements

We would first like to thank our advisors and sponsor who continuously helped and supported us throughout our project. Our advisors, Professors Frank Hoy and Jerry Schaufeld were very supportive of our project from the beginning. They assisted us and provided feedback and encouragement when needed. The team also worked closely with our sponsor, Kevin O'Sullivan, who provided us with resources, insight, and guidance during the process of completing our project. We would like to sincerely thank Mr. O'Sullivan for providing us with the opportunity to work with him and the MBI team.

Additionally, we would like to thank the following people for assisting us in our project. Judy Cocaine, MBI Manager of Administration, was always very helpful in providing us with the information needed, especially in the area of MBI space allocation. All of the past, present, and prospective tenants of MBI who participated in our survey providing the data that made our project possible. Professor Amy Zeng continuously helped our group with the space allocation design component of the project. Finally, the team would like to thank Dean Rice, Professor Djamasbi, Professor Elmes, and Professor Loiacono for reviewing our questionnaire and providing advice and feedback, which allowed us to create a comprehensive questionnaire. We greatly appreciate all of the help we received during our project.

Executive Summary

Biomedical incubation companies, such as Massachusetts Biomedical Initiatives (MBI), are fairly new, and information on successful operations is still being developed. MBI has a Strategic Plan and a well-documented Scope of Services, which they use as a measure of their success in the industry. By incorporating quantifiable data, such as the data regarding success metrics provided by this project, biomedical incubation companies like MBI can continue to grow effectively and efficiently.

Through contact with Massachusetts Biomedical Initiatives (MBI) and Kevin O'Sullivan, CEO, the team began to fully understand MBI's future goals and their metrics for measuring their progress against those goals. After thoroughly reviewing MBI's Scope of Services, the group developed a survey to generate responses from a sample of MBI clientele including past, present, and prospective tenants. The results will be presented to MBI's Board of Directors, by Kevin O'Sullivan, CEO, in September of 2011. The presentation maps the results of the survey to the metrics on the Scope of Services.

Determining what questions would be included in the survey was a crucial part of the early development of the project. Therefore the first step in this process was defining what specific information the survey should gather. MBI's ultimate goal is to accept biomedical companies that have a high probability of continued operation upon leaving MBI that will increase the prolificacy of the biomedical industry in the Worcester-Boston corridor. Therefore, the main survey goal was to understand the successful and unsuccessful aspects of MBI operations. Through researching other successful biomedical incubation

companies, themes of positive practices became evident and these were used to model questions for the survey. Through background research of MBI and other successful biomedical incubation companies, a strong basis for the questions to be included in the survey was developed.

It is crucial to make a survey easy to understand and answer, yet it cannot be so simple and leading that it biases the response. For this reason, the survey was semi-structured, and was comprised of a few open response questions and some multiple-choice questions. MBI and Kevin O'Sullivan provided a list of tenants in four different categories: successful graduates, past tenants, current tenants, and prospective tenants. These categories provided a variety of interviewees who have had different experiences with MBI The survey was refined several times and 19 responses were gathered.

MBI was especially interested in the level of tenant satisfaction with current MBI services and facilities. The majority of respondents had heard about MBI through word of mouth or the MBI website. Nearly all respondents said obtaining information about the facility was very easy, and listed physical facility, shared services, and cost as major reasons they liked MBI. Respondents felt very strongly that MBI helped to enhance their business during their time as a tenant. Some respondents found that they felt the lab space was too far from the office space, or that the labs were not large enough to accommodate their growing businesses that were not large enough to be out on their own yet.

After evaluating the research, recommendations were made for MBI. The group believes MBI should address their Scope of Services by evaluating it more often and

incorporating a Strategic Plan on a Page (SOAP) method. Another suggestion for MBI is to implement a modified version of a mentoring program to help businesses with networking opportunities. Furthermore, some incubation companies felt that they would benefit from another form of mentoring such as defining their own success metrics. A large portion of the respondents who heard about MBI via their website were current or prospective tenants, showing the increasing role it is playing in their marketing strategy. The group feels strongly that MBI should continue to develop and update its website to keep potential tenants informed of what is happening and how to get keep in touch with them.

Overall, the analysis of survey results is important for MBI to understand and consider when making future changes to their operations. The group feels that the high response rate and quality of interviews merit considerable influence on MBI's success metrics. The research and survey results prove that MBI's performance strengths are far more significant than their weaknesses in aiding company development. By implementing the recommendations outlined in this paper, the group believes that MBI can further improve upon their already successful processes.

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Chapter 1: Introduction

The subject of this Major Qualifying Project (MQP) is life science incubation and the study of Massachusetts Biomedical Initiatives in particular. The background section outlines research on incubators in general and information to better understand the best (and worst) practices. Additional research was performed in the area of life science incubators to comprehend the difference between life science incubators and business incubators in general. Finally, MBI practices were compared to incubation and life science best practices to determine where MBI excelled and where improvements can be made.

A thorough evaluation of MBI's success metrics through their Scope of Services aided greatly in achieving the ultimate objectives of this project. The initial goal of this project was to determine the level of satisfaction the tenants of MBI have had within the incubator and evaluate the benefits MBI provides for their tenants and the places where MBI's services lack. To determine the satisfaction level of the tenants, the team began to identify where MBI's current Strategic Plan for tenants is adequate and conducive to future success. In addition, the team looked to gauge MBI's success in exemplifying the company's Scope of Services; to determine this we relied heavily on the survey responses from the current, past, and prospective tenants. An additional goal of the project was to determine if MBI's current facility layout is mutually successful for both MBI and their tenants. The main objectives of the project were conveyed through the final recommendations to MBI designed, if implemented, to improve their overall market strategy and future success.

Table 1. Goals for this Major Qualifying Project

Major Qualifying Project Goals
1. Study MBI's past and currently implemented market plan for prospective and current incubator tenants. 2. Gauge MBI's success in portraying the ideals of the company's Scope of Services in daily operations. 3. Determine if MBI's current facility layout is successful and offer potential improvements while simultaneously adhering to the requirements of WPI Design Component. 4. Offer MBI recommendations for an overall improved marketing strategy.

The needs of MBI and their Board of Directors were kept in perspective throughout gathering and analyzing data. The project team composed a PowerPoint presentation detailing the results of the surveys conducted with tenants of MBI, a linear programing model determining the optimal space allocation, and recommendations outlining improvements that MBI can implement. MBI will be reviewing and evaluating findings to determine if the recommendations are adequate for MBI. The recommendations can be applied in order to improve MBI's future Scope of Services and Strategic Plan. Additionally, this report can be used as a resource for future incubation companies, specifically those that are biomedical and biotechnology based.

Based on research, some key recommendations are in the areas of networking, business support, and space allocation. MBI should provide broader networking opportunities and increased operational and business support for tenants. In the area of

space allocation and flow, recommendations include optimizing open space, common space, and rentable space. Additionally, MBI can utilize the linear programing model in order to optimize future facility options.

Chapter 2: Literature Review

2.1 INCUBATOR DEFINITION

The term "incubator", when applied to business, is defined as an organization that provides developmental support for new business ventures. Incubator support can be provided through either "commercial space, management support, shared services" or a combination of all three (M-W Dictionary, 2011). "A business incubator's main goal is to produce successful firms that will leave the program financially viable and freestanding" (*National Business Incubator Association*, 2011). Incubator graduate companies have the potential to create new jobs, rejuvenate neighborhoods, commercialize new technologies, and strengthen local and national economies. Incubators have become more and more prevalent in modern business most likely caused by an increased awareness of the need for new technology. Current incubator ideals have progressed for over a century and change specifically according to the identity of each individual incubator.

Although there are several different subsets of incubation this project will focus on life science incubation. To fully understand the differentiation between incubators in general and biomedical incubators, it is important to have a good overview of incubators as background. The following chapter will begin by giving a brief history of incubation and an overview of the best practices of incubators before discussing life science incubators in particular.

2.2 EVOLUTION OF THE TRIPLE HELIX INCUBATOR MODEL

The principles of the modern definition of the incubator can be explained by examining the theories of the evolution of the incubator model. The triple helix model was proposed by Henry Etzkowitz, a well-known Professor of Business from Stanford University. Etzkowitz suggests that incubators and their development are interconnected with the fields of technology, industry, and academia in a triple helix relationship. Etzkowitz has penned nearly ten globally accepted books, over sixty articles, and four encyclopedia articles concerning incubators (*Etzkowitz Biography*, 2006). Etzkowitz's triple helix model will be used to describe the evolution of incubators for the purposes of this report.

The first step in the development of incubators, as stated in Etzkowitz's model, was called the "proto-incubator": an organization focused primarily on the creation and maturing of ideas. Research suggests Benjamin Franklin's "Invention Factory" supported bright entrepreneurs looking in developing "technological and business opportunities and solutions" (Etzkowitz, 2002).

The creation of early venture capital firms in the United States fueled the second major development in the evolution of the current incubator model. In 1946, the first venture capital firm, American Research and Development (ARD) was implemented in order to assist the early progressive stages of business development. ARD initially offered support and financing for the start-up of select businesses, initially referred to as "venture

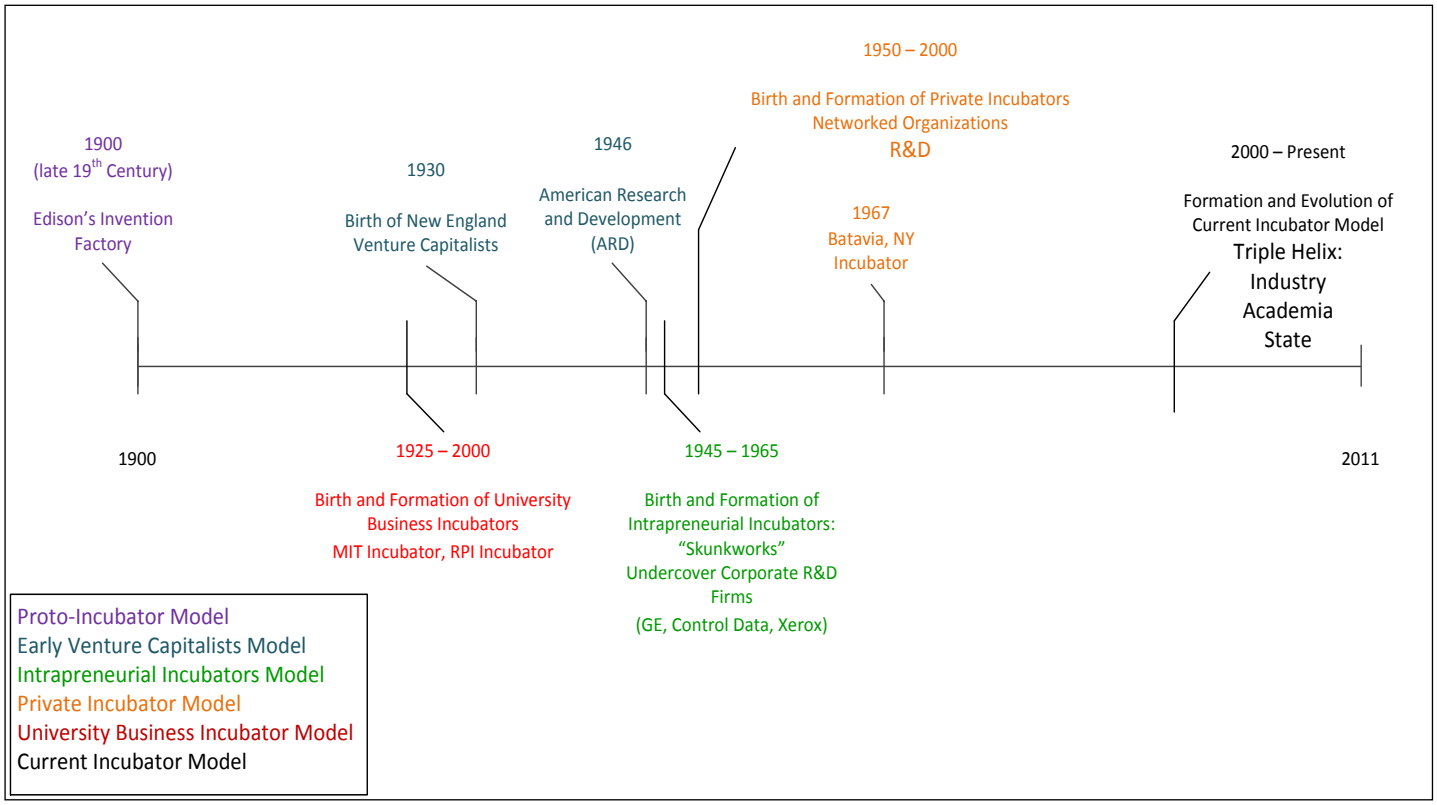
nurturing." As ARD matured, they reallocated financial support to the later stages of new technology development (Etzkowitz, 2002).

Intrapreneurial incubators marked the third step of incubator development and can be described as an internalization of research within an existing firm. To foster creativity and potentially increase profitability of their company, businesses started to differentiate space and money for the development of new technologies, commonly referred to as "skunkworks." General Electric started incubator facilities on site in hopes of creating new products (Etzkowitz, 2002). Many present companies, such as Google, use the idea of intrapreneurial incubation in their business models (Axelrod, 1992).

The fourth major development was the creation of the private incubator. Private incubators were essentially free-standing intrapreneurial incubators. Unassociated entrepreneurs noticed the success of business specific incubators and started initiating independent incubators. Private incubators supplied support to companies' business plans, topics of study, finances, and/or residences. Private incubators are often referred to as "networked incubators" because they rely heavily on the collaboration of all tenant companies to succeed (Etzkowitz, 2002).

The formation of university incubators marked the fifth step in the evolution of the triple helix incubator model. Stanford University and Rennselaer Polytechnic Institute encouraged their faculty and students to learn about the benefits of firm development and promote entrepreneurial principles. University incubators often facilitated student employment in research facilities and at affiliated companies (Etzkowitz, 2002).

A summary of the major events leading up to the current triple helix incubator model



is illustrated in the timeline below.

Figure 1. Brief Timeline for Evolution of Current Incubator Model

Adapted from (Etzkowitz, 2002) and (Etzkowitz, 2010)

The evolution of the triple helix incubator model culminated with the recognition of the contemporary incubator model. The current incubator model can be different for each individual facility, but generally adopts the following fundamentals: a selection process to identify the most promising option; exclusive space available for a regulated time; collective

services among incubation companies; and mentoring/networking opportunities for incubation companies (Etzkowitz, 2002). The norms and counter-norms of current incubator models are summarized below.

Table 2. Summary of Current Incubation Trends

(Page 212 from Etzkowitz, 2002)

Norms	***Counter-Norms***
Utilizing a **selection process** to encourage competition and to identify the firms with the most potential growth for the incubator.	Following the idea that "**entrepreneurs know best**" alleviates the need for a selection process as long as the entrepreneur has a sensible business plan and the incubator has space.
Centralized location eases the collaboration of all incubation companies and their ideals. This also allows for uncomplicated sharing of services.	**Virtual incubators** operate without a centralized location. Meetings are hosted to foster collaborative learning.
Hiring an **experienced entrepreneur as director** offers expertise in the business, financial, collaborative, and most important, the entrepreneurial efforts of the incubator.	Hiring an **academic as director** offers definite intellectual knowledge, but requires a fast learner who is usually mentored by an experienced entrepreneur.
High availability of business and technology experts to offer advice and support to the incubation entrepreneurs.	**Occasional consulting by experts** for specific projects when needed.

As current models of incubators continue to evolve, the balance between academia, industry, and government influences indubitably shifts (Etzkowitz, 2010). Etzkowitz classifies this as the triple helix model while other experts refer to this relationship as a "co-production" between business, developmental, and production facets of an incubator process (Rice et al., 1995). The most successful incubators find heavy guidance from academia, industry, and state influences. As the most prevalent state influence, location

plays a large role in the potential success of an incubator. Incubators located close to experts of business and technology, perhaps a university, are more likely to succeed than incubators located in the middle of small town (Etzkowitz, 2010). According to Etzkowitz, areas with high populations of business and technological developmental services (i.e. a city or near a university) are viewed as "thick" or "dense" whereas those areas with low populations are viewed as "thin" or "light." Ultimately, the ability for a specific incubator to succeed should determine the location. Life science incubators are often linked to or are in close proximity to universities because they rely on novel scientific research. Keeping facilities close to the university structure allows for incubation tenants to contact university personnel for technological support.

2.3 SUPPORT FOR INCUBATORS

Commonly known as the first U.S. business incubator, the Batavia Industrial Center opened in 1959, though the idea of providing support for incubators did not arise until the late 1970's. By 1980, approximately 12 business incubators were in use in the U.S. Throughout the 1980's the business incubation industry grew rapidly, and support for business incubators became more prevalent (*National Business Incubator Association*, 2011).

In the mid-1980's, the U.S. Small Business Administration (SBA) promoted incubator development. During this time, the SBA held a series of conferences and published newsletters and handbooks to publicize information about incubation. As a result, business incubator availability grew from approximately 20 openings nation-wide in 1984, to over 70 in 1987 (*Business Incubation, 2011*). An additional support system for incubators

came in 1982 when Pennsylvania developed the Ben Franklin Partnership Program. The program was focused on technology and manufacturing. Additionally, the "Entrepreneurial Development" section of the program concentrated on small business incubators. The program's support of business incubators also became a model for other states' support of business incubators early on (*Ben Franklin Technology Partners*, 2011). Another notable early supporter was Control Data Corporation whose founder William Norris developed two divisions of their company to support business incubators. An entrepreneurial center was created in Birmingham, Alabama and the Pueblo Business and Technology Center was formed in Pueblo, Colorado and still exists and supports business incubators today (Worthy, 2010).

More recently, communities all around the United States and the world have embraced and supported business incubation. As incubation became more popular, the industry recognized a need for information sharing and a centralized location for information. In 1985 business incubation leaders formed the National Business Incubation Association (NBIA). The new association was established to provide the training and tools necessary to assist start-up firms. Since its inception, the association's membership has grown from approximately 40 members in 1985 to over 1,900 members today (*National Business Incubator Association*, 2011).

The National Business Incubation Association (NBIA) is, "the world's leading organization advancing business incubation and entrepreneurship." NBIA serves over 1,900 members in over 60 nations providing information, education, encouragement and networking resources. NBIA's members include incubator managers, entrepreneurs, venture

capitalist, and anyone who has general interest in incubation. NBIA's mission is to: "advance the business creation process to increase entrepreneurial success and individual opportunity, strengthening communities worldwide." To accomplish their mission NBIA serves as a central location of information on incubator management and development issues. NBIA also participates in several activities that support member's professional development. In addition, NBIA's website provides valuable resources, as well as recognition of successful incubator companies throughout the world. For the past 25 years, NBIA has given awards to the most successful incubator companies in two categories, technology and nontechnology (*National Business Incubator Association*, 2011).

Life Science incubators can take advantage of the support offered by the NBIA. In addition, Massachusetts Biomedical Initiatives can utilize the resources and networking provided by the Massachusetts Association of Business Incubators (MABI). The MABI is a member of NBIA but gives Massachusetts's incubators a way to connect with other small business incubators in the area (*Massachusetts Association of Business Incubators,* 2008).

2.4 INCUBATION PROCESS

Incubation is a business process that supports and accelerates the development and success of start-up companies by providing them with a vast array of resources and services. Incubator management usually takes responsibility for developing the services that are provided by a specific incubator (Scillitoe et al., 2010). Once the services are decided upon, they are offered within the incubator and through its network of contacts. The overall goal of nearly all incubators is to produce successful companies that will leave or graduate from

the incubation facility as a financially stable and independent company (*National Business Incubator Association*, 2011).

The definition of an incubator includes the several forms of guidance and assistance provided to start-up companies. Incubators often provide mentoring/counseling, networking, training, space, and shared services (Rice, 1999). Space and shared services refer to the physical location and equipment provided by the incubator to the start-up companies. Space is usually leased to companies; some incubators offer flexible leases while others lease on a yearly basis. Of the three other services provided, Rice's study concluded that the least helpful business assistance programs provided were training programs (Rice, 1999).

Counseling within an incubator is unique because the incubator manager is on site with all of the incubator companies, which provides potential for a constant and comprehensive counseling relationship (Rice, 1999). Rice's study also discovered three different types of counseling that were present within his sample of incubators. The first type of counseling seen was "reactive and episodic." In this type of counseling, the start-up company requests help with a specific problem and is generally helped over a short amount of time. The second type of counseling is "proactive and episodic." This type of counseling requires that the incubator manager be proactive in counseling the start-up company, and is also generally over a short amount of time. The third type of counseling is "continual and proactive." "Continual and proactive" counseling efforts are ongoing and focus on developing the needs of incubator companies (Rice, 1992). The incubation managers in

Rice's study observed that continual and proactive counseling is the most effective (Rice, 1999).

Networking refers to connecting incubator companies to external resources and expertise, is also seen as an important resource within an incubator. Networking within incubators is facilitated by the incubator manager who serves as an intermediary between the start-up company and the sources of assistance. Networking, although helpful, may have shortcomings within incubators resulting from three contributing factors. First, outside networking experts may not be fully committed to making a connection with incubator companies. Second, incubator companies may not be ready or willing to take advantage of the networking opportunities that are available. Finally, incubator managers may not commit a sufficient amount of time and effort to facilitate the networking opportunities (Rice, 1999).

Although most incubators provide the same services, incubators vary in the way they deliver those services. Incubators also differ in their organizational structure and the types of companies they serve. Incubators may have differing goals, including providing employment, sparking economic growth, partnering with universities or corporations, etc. Despite the differences within incubators, incubator clients are developing new and innovative technologies helping toward the overall goal of incubators – to produce successful companies that will graduate from the incubation facility as a financially stable and independent company (*National Business Incubator Association*, 2011).

2.5 BEST (AND WORST) INCUBATION PRACTICES

According to NBIA, there are certain practices of incubators and their tenants that are more effective than others. The following section will review and evaluate NBIA's findings regarding these practices.

2.5.1 NBIA GUIDELINES OF SUCCESSFUL BUSINESS INCUBATION

NBIA realized a need for a set of industry guidelines to aid incubator managers better serve and support their start-up companies. In 1996, NBIA's Board of Directors developed such guidelines. Since the guidelines were developed, NBIA has conducted research each year to show whether or not companies that adhere to the guidelines were successful. NBIA's research has consistently shown that incubators that follow the guidelines typically outperform incubators that do not, measured by analyzing testimonials of NBIA members. The guidelines are accepted and applied around the United States and the world, regardless of the incubator's focus or goals (*National Business Incubator Association*, 2011).

NBIA also defines two core principles that characterize effective business incubation. Incubators must first aim to have a positive impact on the community where they are located. By helping and supporting start-up companies to succeed business incubators will have a positive impact on its community's economy. The business incubator must also, "be a dynamic model of sustainable, efficient business operation" (*National Business Incubator Association*, 2011). The most successful business incubators are committed to incorporating industry guidelines, which can be seen below (*National Business Incubator Association*, 2011).

Table 3. NBIA Guidelines for Best Incubation Practices

(National Business Incubator Association, 2011)

NBIA Guidelines for Best Practices
• Commit to the two core principles of business incubation • Obtain consensus on a mission that defines the incubator's role in the community and develop a Strategic Plan containing quantifiable objectives to achieve the program mission • Structure for financial sustainability by developing and implementing a realistic business plan • Recruit and appropriately compensate management capable of achieving the mission of the incubator and having the ability to help companies grow • Build an effective board of directors committed to the incubator's mission and to maximizing management's role in developing successful companies • Prioritize management time to place the greatest emphasis on client assistance, including proactive advising and guidance that results in company success and wealth creation • Develop an incubator facility, resources, methods and tools that contribute to the effective delivery of business assistance to client firms and that address the developmental needs of each company • Seek to integrate the incubator program and activities into the fabric of the community and its broader economic development goals and strategies

2.5.2 EXAMPLES OF BEST PRACTICES IN USE

Along with NBIA's guidelines for best practices listed above, they have also spent three years finding examples of how incubators are putting the guidelines to use. The examples provided in the book show the benefits that can come from applying specific guidelines (Adkins et al., 2010). It was important to our group to show specific examples of

some of the best practices presented above in use to justify that that best practices have a positive impact on the companies that use them.

First, the team will look at the development of a Strategic Plan. President and CEO of Northeast Indiana Innovation Center, Karl LaPan, has developed a process for creating a Strategic Plan. The process is called Strategic Plan on a Page (SOAP), which encourages the user to relate the strategic goals of their company to the company mission while focusing on the most important measurable outcomes. Once this is done, all of the information must be combined onto one sheet of paper. LaPan has reported that using this method has helped keep stakeholders informed about the company without providing them with unwanted details. In addition, LaPan ties his staff performance to the plan. LaPan goes on to say, "In our goals for each year, every person's key measurable goals are connected to one of the five key goals of the organization. It's great for building ownership, accountability and for simplifying thinking." Using his SOAP method, LaPan and his staff are able to focus not only on their day-to-day activities but on the big picture as well (Adkins et al., 2010).

Next, the team will look at Virginia Biosciences Development Center's (VBDC) client services. The clients of VBDC are matched with a group of experts nicknamed the "kitchen cabinet." At VBDC, the Executive Director, David Lohr, along with the company, comes up with a list of skill sets that the start-up will need. Once the needs are identified, Lohr then creates a list of 12 people who might be on the company's kitchen cabinet. The company reviews the list for final approval. From there, Lohr recruits eight people to the company's kitchen cabinet. Once the kitchen cabinet is assembled meetings are held including the cabinet and the company. VBDC has seen that their kitchen cabinet model

greatly benefits everyone involved. Specifically, the company receives a network of connections that they would not otherwise have met without the program. Lohr goes on to say, "When you bring that many bright people with the right perspectives together, you get great outcomes" (Adkins et al., 2010).

Another best practice is structuring for financial sustainability. A good example can be seen with the William M. Factory Small Business Incubator. This incubator prepares a five-year financial plan, which is approved by the incubator's board of directors. The financial plan is also updated each year and includes a summary of actual expenses for two or three years and projects out to expenses for five years. To accompany financial plans, the incubator has a business plan that is updated every two years. By projecting finances five years out, the incubator is able to prepare for future expenses. Tim Strege, the incubator's Executive Director says, "this approach also enables the incubator to calculate – as part of our building expansion plan – which costs can be held to smaller incremental amounts versus which costs will increase proportionately to size" as the incubator expands (Adkins et al., 2010).

The final example the team looked at is the facilities management of the Innovation Depot in Birmingham, AL.. The Innovation Depot was created by renovating a vacant Sears store, emphasizing features that encourage networking and collaboration among clients. Some of the features of the incubator include a café, shared meeting and boardrooms, large windows, and a "Main Street" hallway that extends through the entire building. By offering plenty of shared space, clients and staff alike are welcome to freely

discuss opportunities or contacts at their leisure. The incubator's open and shared space is said to create a feeling of "high energy" inside the facility (Adkins et al., 2010).

These specific examples of incubator best practices in action show that, when applied, the best practices can be very impactful. Additionally, it is clear that there are several different ways to adapt the best practices that NBIA provides and mold them to what will work best for your specific incubation facility. By following the NBIA best practices several incubators around the world have been able to run successful incubation facilities.

2.5.3 COMMON INCUBATION MISTAKES

In addition to providing studies regarding best practices, NBIA also provides members with research about the classic mistakes made by incubators. In one study in particular, NBIA looked at four troubled incubator programs, all which failed to follow the best practices referenced above. Specifically, the flaws found in these four incubators included: building-driven projects, the landlord mentality, a single source of funding, a narrow market, and the board not being on board (Colbert, 2007).

A building-driven project refers to an incubation facility being launched in a building simply because the space is vacant. However, it is important to remember that an incubator is not simply a space, but also provides services and help to clients. Facility size is another important consideration. Often times incubation facilities will be opened in buildings that are far too big or too small for their operation. Additionally, vacant buildings may require financial investments to bring the building up to code and maintain. An example of a

building-driven project can be seen in the Precision Valley Development Corporation incubation facility located in Springfield, VT. The incubator opened in the 1980's after a company closed and the building was left to the town of Springfield, VT. Soon the incubator realized that the 100 year old building was costing the company a great deal of money in maintenance. In addition to maintenance, the building was not built for modern business practices. For example, the truck loading docks did not fit modern day trucks because trucks in 1912, when the building was constructed, were much smaller. A valuable lesson can be learned from this example; look for a facility that will suit all of the incubators needs and do not rush into a building (Colbert, 2007).

The landlord mentality adopted by many incubators refers to the idea that young businesses are less able to pay rent and therefore incubators offer below-market or even no rent to help clients. When incubators offer below-market or no rent, other real estate developers may see the program as competition and therefore may not refer start-ups to the incubator. This is a small problem in relation to the risk it presents financially. If incubators rely solely on low rents, when the facility is not full they will no longer be able to pay their bills or debts, if they have any. This is exactly what happened to the New River Valley Competitiveness Center in Radford, VA. Because the facility could not afford to pay its bills when the facility was not full, they accepted clients that did not meet their admissions standards. The facility also had to borrow from local governments to remain open. It is important for all incubation facilities to realize that they cannot be run on rent alone (Colbert, 2007).

Single source funding is when the primary source of funding for an incubation facility comes from a source that is subject to renewal and therefore, out of the incubator manager's hands. A New England incubator, which could not be revealed, is a perfect example of the danger of single source funding. The incubation program was funded mainly by the county's economic development agency, which six years after the incubators starts; cut the subsidy by 60 percent. To keep the incubator open, management decided to use the $20,000 reserve fund. First, it is clear to see that relying on funding that is subject to renewal can be very dangerous. Additionally, it was pivotal that this specific incubator had a reserve fund, without which it would not have been able to remain open. From this example it is clear to see why NBIA recommends that all incubators have reserve funds (Colbert, 2007).

A narrowly focused market is a very simple concept referring to companies who focus on a very specific area of study, usually an area that is popular at the time. Having a narrowly focused incubator can be very unsafe because it is often unknown if the specific area will continue for an extended period of time or not. The community the incubator is in may also not support the specific industry well. The U-Start incubation facility in Schenectady, NY is a good example of a narrowly focused incubator. The U-Start incubator was started as a technology incubator. The problem with this was that the community that U-Start was in was not a very technologically advanced area and there was competition nearby at Rensselaer, which is a major research institution. In order to turn the U-Start incubator around the focus was widely broadened. Incubators should learn a lot about what type of community they should go to before starting a certain type of incubator. In addition, it is extremely important for incubators to know their market (Colbert, 2007).

When the Board of Directors is not on the same page as the incubation facility problems may arise. The Board of Directors should believe in the program they are representing and support it through good and bad times. A poor example of this can be seen when the board of a Southern incubator refused to support a capital campaign the incubator manager developed to raise money to keep the facility open. In this specific instance, the manager resigned and the program closed. However, a board can be rebuilt. NBIA suggests that getting the attention of the board is essential to incubator success. Once the manager has their attention it is important to keep them involved and interested in what is going on within the facility. It is clear that a dysfunctional board can be very harmful to an incubator but can also be repaired with hard work (Colbert, 2007).

Table 4. Common Incubation Mistakes and the Risks Associated with Them (Colbert, 2007)

Common Incubation Mistakes	Risks Associated with Mistakes
Building-Driven Projects	• Size of building is not right for the operation • Maintenance costs • Not up to appropriate codes • Amenities may not be up-to-date
The Landlord Mentality	• Less real-estate referrals • Financial risks
A Single Source of Funding	• Loss of funding • Financial risks
A Narrow Market	• Unknown if market will last • Loss of community support
The Board Not Being on Board	• No support for incubation mission • Can be harmful to many aspects of the incubator

2.5.4 COMMON TENANT MISTAKES

It is important for incubator managers to be aware of common mistakes in running incubators but it is almost equally important for incubator managers to know common mistakes made by tenants. If incubator managers are aware of common tenant mistakes, they will be able to help prevent their tenants from making the same mistakes. Client mistakes often include, "problems with ownership, funding, product development, management, and marketing" (Knopp, 2009). Much of Knopp's article was based on "Helping Early-Stage Entrepreneurs Avoid Common Mistakes," a session presented by Booker Schmidt at NBIA's 21st International Conference on Business Incubation.

The first mistake is having too many people in charge of the company. When there is more than one person who owns the business, decisions typically have to be made by a consensus. If the owners of the company cannot come to a decision the company may have to take the problem to court where a mediator may make the decision. To alleviate this problem, it is believed that giving one person the majority ownership and making them responsible for decisions of the company is best in the start-up phase of a company (Knopp, 2009).

Another common mistake is having a company with only one person. Booker Schmidt, a lawyer and incubator manager for over 30 years, believes "it takes a talented team to make a company a success." Schmidt continues by saying that for members of the team to be most motivated to make a difference in the company, they should have a stake in

the business. When team members have a stake in the company, they have more incentive to help the firm grow (Knopp, 2009).

Many companies also enter incubators under-capitalized. One of the biggest reasons start-up companies fail is because they lack funding. Start-up companies often underestimate the amount of time and money it will take for the company to reach positive cash flow. Schmidt explains that companies that use the "two-times or three-times philosophy" have a much better chance of success. The philosophy means that companies plan for two or three times the length of time and amount of money that is estimated. Although companies may not always need two or three times the amount of money that is estimated it is very beneficial to have when unexpected events or setbacks take place (Knopp, 2009).

The next mistakes include relying on verbal commitments and securing funding indiscriminately. First, start-ups should know that verbal commitments are not binding and that they should not rely on these commitments as final. Additionally, start-up companies should be sure they know where their funding is coming from and any "strings attached" before they accept the funding. Schmidt advises companies to find out as much information about an investor before accepting any funding. He goes on to say that if a company can find information about the last five investments made by the investor, they will have a good idea about what type of investor they are, and what they can expect from the partnership (Knopp, 2009).

Scientists and engineers in start-ups often make the mistake of assuming that everyone will buy their new product without investigating market need first. It has been seen

several times in the past where companies invest exhaustive amounts of time and money in new products that investors are not interested in investing in. Schmidt associates this process with companies that chase every opportunity that presents itself. He advises that companies should go through all of the opportunities they have come up with and only pursue the ones that help the start-up reach their goals and objectives (Knopp, 2009).

Start-ups should also be careful not to make plans based on early success. Expansion can be dangerous for start-ups if the firm increases spending or manufacturing based solely on early success. Companies should be aware of their market at all times and should make decisions based on the market. Schmidt recommends that companies base growth on real customer demand. Additionally, start-ups should not be too optimistic. Companies should be sure to measure how well they are doing and know not to be optimistic when it is clear that the company is not doing well. Relating to the common mistake of optimism Schmidt advises that companies, "keep their options open to keep their companies alive" (Knopp, 2009).

Table 5. Common Tenant Mistakes and Risks Associated with Them (Knopp, 2009)

Common Tenant Mistakes	Risks Associated with Tenant Mistakes
Problems with Ownership	• Too many owners = difficult to make decisions • One owner = lack of a multi-skilled team
Lack of Funding/Underestimating Funding Needs	• Search for additional funding • Spend personal money • Company failure
Product Development	• Consumers may not want to buy the product • If development takes more time than planned, more money is needed
Management	• Plans based on early success may lead to over-spending or expanding too soon which can cause company failure

2.6 LIFE SCIENCES INCUBATORS

Massachusetts Biomedical Initiatives (MBI) is a biotechnology incubator; thus, it is important to understand and differentiate biotechnology and life science incubators in comparison to other incubators. Commonly, the incubation industry views biotechnology and life science incubators as a sector of technology incubators (James, 2001). To better understand the biotechnology sector of incubation, NBIA contacted eight biotechnology

incubator managers to learn what distinguishes these incubators and to determine which practices make biotechnology incubators successful.

In general, life science incubator managers have said that getting biotechnology start-ups to launch takes much longer than other industries. A major factor that accounts for the longer start-up time is the need to address regulatory issues. Regulatory issues can include conducting clinical trials and getting U.S. Food and Drug Administration (FDA) approval. For these reasons, biotechnology start-ups often stay in incubation facilities for approximately two to three years in comparison to twelve month stays of other technology incubator clients. The current start-up time of tenants is estimated at two to three years, which is a vast improvement from the approximated ten years that biotechnology incubator tenants stayed in the late 1980's (James, 2001).

Life science incubator managers also state that most life science incubators are attached to universities or other research institutions. Patricia Snider, manager of BioVentures Development Partners in Cincinnati says it is hard to set up a successful life sciences incubator "if you don't have a strong life sciences research school already in the area." The correlation between life science incubators and universities or other research institutions indicates that a strong research base draws biotechnology start-ups to biotechnology incubators. The president of Cincinnati's nonprofit BIO/START, Carol Frankenstein, agrees that having a strong research base is key. Frankenstein's BIO/START gets its research base from two research institutions nearby: the University of Cincinnati and Children's Hospital Research Foundation (James, 2001).

Like in any other incubation facility, capital is extremely important to the business success of an incubator. However, Snider reveals that venture capitalists are less likely to invest in life sciences. In Ohio, of the $4 billion in venture capital, only 6 percent of funds are assigned for life science start-ups. Additionally, life science incubators' spending cycles differ from the spending cycles of other technology incubators. MBI's past President and CEO, Pamela Hochman Norton, explains the spending cycle: "At first you're spending little, staffing up and starting on a bench to prove what you have. Then you ramp up spending in orders of magnitude, especially clinical trials." She goes on to explain that it is very important that investors are familiar with the spending cycle of biotechnology incubators because if they are not, "then [that investor] will be concerned when a company asks for $1 million one year and $10 million the next year" (James, 2001).

Life science incubation facilities also require specialized needs that are not required by other incubation facilities. Life science incubators must keep the community up to date on their progress. Since there are several controversial issues that fall into the life sciences, the community will want to be sure that the companies are safe to the environment around them. Life science incubator clients may need intangible services like access to nearby academic experts. The infrastructure of life science incubators may require wet lab space and specialized equipment. Often, life science incubators will need to use external facilities such as university animal testing facilities or hospitals. For this reason, it is extremely important for life science incubators to form strong alliances with hospitals, schools, and other research institutions to provide clients access to the equipment they need (James, 2001).

In addition to focusing on their incubation facility, life science incubator managers must also focus on several factors that identify life science industry success. NBIA reported that a life sciences task force study conducted by Patricia Snider and Carol Frankenstein developed "Keys to Life Science Industry Success" for companies to compare how they rank in terms of these factors as seen below (James, 2001). Ranking incubator facilities' strengths and weaknesses based on the Keys to Life Science Industry Success provides a better idea as to what life science incubators are doing well and what they should improve within their facility to continue success. The Keys to Life Science Industry Success can also be used to compare incubator facilities to those of other regions in order to adopt best practices and again, become more successful. These factors are summarized below.

Table 6. Keys of Life Science Industry Success (James 2001)

Key	Explanation
Cutting Edge Research	• Producing innovations around which entrepreneurs can build technology companies • Achieving critical mass in this area requires a solid life science research base
Access to Capital	• Including seed and venture funds that support life science companies at all stages of their development • Life sciences companies can have difficulty attracting funds because of their lengthy time line and unusual fundraising curve
Effective Technology Commercialization	• Getting university and other public research from the laboratory to the marketplace • Checking out amount of licensing revenue, number of companies formed around university technologies and other variables
Skilled Workforce	• Becomes an issue as companies expand and graduate incubators • Specialized companies may have to recruit national
Access to Transportation	• Having access to nearby hubs for business activities including shipping products and bringing in venture capitalists
Industry Infrastructure	• Having the ability to access professional services, such as patent and clinical trial firms
Entrepreneurial Culture	• People willing to take on the risk of starting and working for a company at a stage when there's a lot of risk and no money • People with business acumen to work with them
Quality of Life	• Comes into play when companies recruit people to a community • Cultural attractions, sunny beaches and other amenities can make a difference when recruits are in high demand

2.7 UNIVERSITY INCUBATORS

It is useful and relevant to examine university-based incubators because of MBI's proximity to WPI and their share in WPI's Life Sciences and Bioengineering Center, Gateway Park. In the early 1980's, the Bayh-Dole Act gave universities the right to claim the innovations created by their students and faculty members (Kalis, 2000). Universities began to experiment with sharing technology with firms already established in the market and partnering with existing corporations. Technology labeled "too new" was not ideal for corporations with already strong brand recognition to waste resources learning and producing before the technology had been proven marketable. Upon recognizing this unsuccessful coordination, decision-making parties at many U.S. universities created venture forums for ideas born of their community members. It was not long before these forums grew into university incubators. This specific type of incubator has a much larger focus on research and collaboration than other general business and/or technology incubators (Kalis, 2000).

University-based incubation does encounter some difficulties that are, for the most part, unique to their incubation type. Universities are full of students and faculty that are often driven by research, rather than entrepreneurship and business sense. The inconsistent effort, in terms of business sense, can create a low rate of successful companies leaving university incubators. Another, perhaps larger, issue for university incubators is that the general nature of education requires an open sharing of information. In business, and more

specifically technology-based business, intellectual property and nondisclosure is important to success (Kalis, 2000).

Today, many universities find a way to make an incubator work as a part of their institution. Finding the correct balance between research and entrepreneurship is important to ensure that a university incubator is graduating start-up companies with a high potential for success. "Benchmarking Best Practices for University-Industry Technology Transfer," a study done by the Southern Technology Council, detailed the most effective means of "bridging the gap between academia and entrepreneurship" (Kalis, 2000). Their empirical findings are summarized in the table below with examples of a university-followed or generally observed policy that illustrates each practice (Tornatzky, 2001).

Table 7. Best Practices for University-Industry Technology Transfer (Tornatzky, 2001, Kalis, 2000)

Practice	Explanation	Example
Know Your Economy	Have an understanding of the strengths and weaknesses of the university's regional economy	Ohio State University's (OSU) Endeavor Center has an active "Virtual Incubation" service that allows start-ups linked to the OSU to obtain their business services virtually, allowing them to move out of the Columbus area where the technology industry is slow moving.
Start at the Top	Commit fully to the mission of technology commercialization and make that commitment known publicly as a university standard	Louisiana State University (LSU) created upper level university positions with specific focus on technology and economic development. LSU also mentions economic growth in their mission statement and has exemplified this mission in the community through the LSU Small Business Incubator.
Make it a Policy	Initiate policies for university personnel that allow for the flexibility to attend to external business ventures	A policy where a university faculty or incubator staff member could easily enter a sabbatical period to take an active role in launching a new technology company.
Incubate	Generate a university-sponsored incubator or actively pursue creating a strong university bond with an existing incubator	See Section 2.6.1 For a Full Outline of Rensselear Polytechnic Institute's Exemplification of this Practice.

Capitalize	Help entrepreneurs find gap funding whenever possible through any applicable institutional or state-level programs	The University of Chicago's ARCH Development Corporation accepts equity in university-based start-ups in exchange for various investing activities and uses returns on stock to replenish the ARCH investment capital for more start-ups.
Create Infrastructure	Allow non-university tenants to use campus facilities and lab space for an agreeable price	The University of Wisconsin provides a searchable database that matches facilities with business needs. This allows small companies in need of facilities to automatically view the cost per university department for the on-campus spaces they are looking to use.
Promote an Organizational Culture	Sponsor informal incentives and workshops for entrepreneurial ventures	Universities across the United States use monetary incentives to support the growth of interest in entrepreneurship and technology.
Minimize Bureaucracy	Maximize flexibility in operations to maximize new-company generation	Ohio State University created a new position 'Assistant Vice President of Technology Partnerships' whose main goal is to coordinate technology partnerships.

2.8 INCUBATOR CASE STUDIES

To better understand incubation and best practices, the group reviewed well-known incubation case studies. These case studies provided us with knowledge about incubation and how utilizing best practices can enhance an incubation facility. Some of the best practices highlighted in the case studies below include: connection to universities, business support, opportunities for expansion, connections for funding, and various networking programs.

2.8.1 RENSSELAER POLYTECHNIC INSTITUTE INCUBATOR

The incubator at RPI is now called Rensselaer Technology Park and is the nation's oldest incubator linked directly to a university, having been initially founded in 1980 as the RPI Incubator. After the incubator's first 20 years, more than 80% of its graduate companies were still in operation. The Technology Park is now comprised of 23 buildings and as of 2009, had over 70 tenant companies, which continue to grow steadily. Although university incubators are challenged by a huge inflow of ideas lacking a direct concern for market need and intellectual property concerns, RPI's incubator proves that these incubators do have the ability to be successful (Tornatzky, 2001).

As the RPI incubator grew through the early 1980's, the university began to reach out to their community to create a strong network of personnel with interest and competency in driving the successful creation of start-up companies. Through this measure, the RPI Incubator saw such great success that the RPI Board decided to expand their incubator into a technology park: the Rensselaer Technology Park. This is the facility that is still in operation today; it still includes incubation units directly linked to the university in addition to rentable non-incubation space for companies, a children's science museum, and most importantly, RPI's Severino Center for Technological Entrepreneurship (SCTE). The SCTE further enhanced RPI's ability to facilitate university-industry technology transfer by offering students educational and employment opportunities to advance their knowledge and interest in entrepreneurship (*Rennselaer Polytechnic Institute*, 2011).

The RPI Incubator has achieved a great level of success by sticking to its main mission established in the 1980's at the incubator's founding: "to transfer the technology of the university to the marketplace." RPI's incubation policy was also heavily and positively influenced by former RPI President George Low, who believed that the key to successful incubation was a strong link between education, business, and government. The RPI incubator provides this link by employing students in its tenant companies as business interns. This teaches the students important entrepreneurial skills like how to write a business plan and create a market analysis (Kalis, 2000). The main contributions to RPI's incubator success are summarized in the table below.

Table 8. Contributions to RPI's Incubator Success (Kalis, 2000)

Contributions to RPI's Incubator Success
• Connected to a University • Clear Strategic Vision and Mission • Partially Government Funded • Business Support Offered • High Level of University-Industry Technology Transfer • Allowed for Expansion Beyond the University

2.8.2 CAMBRIDGE INNOVATION CENTER (CIC)

The Cambridge Innovation Center is located in Kendall Square in Cambridge, MA, with direct access to the MIT Campus. CIC has been in operation since 1999 and in that

time has raised over $865 million in venture capital. The incubator is not linked with the university, but houses many MIT students and graduates in its facility. The majority of the CIC's tenants are start-up companies in the technology and life sciences fields, though a few tenants are venture capitalists and business service firms. The tenants of the CIC find that the mix of technology-based companies and business-based companies creates a strong dynamic for collaboration and mutual growth (*Cambridge Innovation Center*, 2011). The main contributions to CIC's success are summarized in the table below.

Table 9. Contributions to CIC's Success (*Cambridge Innovation Center*, 2011)

Contributions to CIC's Success
• In Close Proximity to a University (Although not affiliated) • Strong Venture Capital Connections • Strong Networking and Collaboration

2.8.3 SAN JOSE BIOCENTER

The San Jose BioCenter is one example of an emerging successful incubator, opening in 2004 and winning NBIA's Randall M. Whaley incubator of the year award in 2009 in the technology category (*National Business Incubator Association*, 2011). The San Jose BioCenter was founded by San Jose State University research foundation as well as the city of San Jose. The collaboration with local universities seems to be one constant in successful incubator companies. Incorporating students' ideas and research allows an incubator to

introduce new ideas to their facility, permits students and faculty an opportunity to start their businesses, and remunerates the initial costs for any expensive lab equipment. San Jose Bio Center currently has 40 incubator clients and 36,500 square feet of lab and office space for their companies. In just five years, the incubator has produced 14 graduate companies and plans to expand their lab space by an additional 36,500 square feet. Additionally, the San Jose BioCenter has created over 800 jobs and raised more than $1 billion in capital directly from the life science and clean technology companies from their incubator (*San Jose BioCenter*, 2011).

The success of the incubated companies can be directly attributed to the unique services the San Jose BioCenter (SJBC) provides. In addition to the traditional lab space offered by incubators based around technology, the SJBC offers business support, reception and office services and various other optional services. The business support provided is a critical resource needed to grow any small business, says Dr. Abi Abiorabi, president and CEO of GIRUS Life Sciences Inc. Abiorabi's company is a recent graduate of the SJBC. In addition to an online business portal that includes a mentor database with experts from over 50 different industries, SJBC provides media exposure, and introductions to venture capitalists and angel investors. These introductions often times are directly linked to a company's graduation from the incubation stages if they successfully find an investor. SJBC also provides monthly seminars with experts on starting a business with relevant topics critical for companies in the drug and development process. This is not a complete list of the business services SJBC provides but it does begin to show the comprehensive approach they

take to building successful companies through their incubator (*San Jose BioCenter*, 2011). The main contributions to SJBC's success are summarized in the table below.

Table 10. Contributions to SJBC's Success (SJBC)

Contributions to SJBC's Success
• Connection to a University • Business Support • Office Services • Optional Services (allowing companies to choose what suits their needs) • Mentor Database • Media Exposure • Networking opportunities with Venture Capitalists and Angel Investors • Monthly Seminars with Experts

2.8.4 MONTPELLIER BUSINESS AND INNOVATION CENTER

The Montpellier Business and Innovation center in Montpellier, France, was one of the first technology based incubation companies in Europe. Upon the inception of the incubation center in 1987, the incubator was confronted with obstacles. At that time, the region had little industrial experience with incubator companies and little corporate culture in the area. However, the incubator also encountered advantages that would eventually lead to the success of the Montpellier Business and Innovation Center. Its central location near seven universities in Mediterranean region and, local government funding are examples of these advantages. The proximity to local universities has shown to be a key factor in a

successful incubation company because of the ideas that are transferred from the classroom to a real life technological environment (*National Business Incubator Association*, 2011).

The Montpellier Business and Innovation center currently has 95,000 square feet of lab and office space housing 61 pre-incubation projects, 64 start-ups and 6 developing companies. This breakdown of companies shows one of the subtle differences in the incubation process between the Montpellier Business and Innovation Center and other incubators. Montpellier Business and Innovation Center has diversified their lab and office space to more specifically meet the needs of individual start-up companies. They provide 18 parks for use by business, scientific, industrial, or technology companies. The incubator also affords 2 start-up incubator facilities that are equipped with biotech labs and are located in direct proximity to universities and research centers, which allow access of their resources. Temporary workshops that can be rented out for just a short period of time and have service villages that are located in reduced tax zones are another offering. This variance of office and lab space in various locations of Montpellier allows for a unique customization for each start-up business. While the breakdown of pre-incubation, start-up, and developing companies is unique to Montpellier's Business and Innovation Center, there are many similarities between their incubation process and that of other successful incubators. Often successful incubation centers are centrally located near universities, receive or have received funding through the local government, provide professional business advice, and introductions to potential investors (*Montpellier*, 2011). The main contributions to Montpellier's success are summarized in the table below.

Table 11. Contributions to Montpellier's Success

Contributions to Montpellier's Success
• Connection to Universities • Diversified Lab and Office Space • Partially Government Funded • Offer Short Term Leases • Allows for Customization of Start-Up Businesses

2.9 MASSACHUSETTS BIOMEDICAL INITIATIVES

A Board of Trustees founded Massachusetts Biomedical Initiatives in 1985 for the purpose of accelerating life science development in Western Massachusetts. This effort was converted from the Massachusetts Biotechnology Research Institute (MBRI) which was founded a year earlier with a similar goal. MBI has been very successful in obtaining funding from both public and private technology driven companies. In the past years they have opened three major incubation centers in Worcester, Massachusetts that have launched over 50 companies (*Massachusetts Biomedical Initiatives*, 2011).

2.9.1 CURRENT COMPANY SUMMARY

A recent Major Qualifying Project (MQP) from Worcester Polytechnic Institute completed a comparative analysis of MBI's Operations against National Life Science Incubator Operations. MBI owns and operates three incubator locations (Barber Avenue, Biotech Three, and Gateway Park). Only 14% of incubator facilities nationally have three or

more locations (*National Business Incubator Association*, 2011). The WPI study also found that MBI graduates companies in about 30 months, four months shorter than the national average of 34 months. In addition, graduate companies from MBI are 16% more likely to be operating independently five years after graduating than graduates of other incubation facilities (Boudreu et al., 2010).

The location at Barber Avenue is named MBIdeas and includes many laboratories of all sizes, office space, a conference room, and kitchen spaces. There is also available shared equipment for the use of tenant companies. Biotech Three is a one million square foot facility and is highly recognized as a successful facility in the national scope of biotechnology centers. This center operates as a key transfer for technology from academic research to commercial applications. This facility is located across the street from the University of Massachusetts Medical School and teaching hospital. Biotech Three houses MBI's Tissue Culture and Product Manufacturing (GMP) Facility. MBI's incubator location at Gateway Park works in tandem with Worcester Polytechnic Institute's (WPI) Bioengineering Department. MBI operates on the first level of WPI's Life Sciences building and offers a similar environment to the other two incubators.

2.9.2 COMPANY GOALS

Massachusetts Biomedical Initiatives provides much information about the missions and goals of their company. The mission of Massachusetts Biomedical Initiatives is to aid the growth of the biomedical industry in Massachusetts. MBI strives towards commercializing biomedical research and development conducted in the Central

Massachusetts region. In striving to meet their overall goals, MBI has compiled a comprehensive list of objectives that they will work towards in the coming years, which they call their Scope of Services. A full version of MBI's Scope of Services can be seen in Appendix A. Over time, MBI reviews their progress relating to their Scope of Services and every few years a new Scope of Services is created with updates and new goals.

MBI's current Scope of Services includes over 20 goals listed under five major themes. The five themes are as follows: to continue to actively facilitate success, to re-evaluate incubator locations, to selectively broaden the cluster, to respond to changing industry dynamics, and to assess impact and outcomes. Each goal or objective has tactics associated with it and metrics to measure progress with. The goals also have a priority rating, assigned 'owner' or people who are in charge of the specific goal, and a status. The Scope of Services sheet is an easy way for MBI to keep track of and review their progress over time. For the purpose of this report, three of the five themes will be further analyzed: to actively facilitate success, to re-evaluate incubator locations, and to assess impact and outcomes.

The first objective listed in MBI's Scope of Services is "identify and attract entrepreneurial scientists and emerging companies, keeping existing criteria for incubation" (Appendix A). In order to meet this goal, MBI plans to track all of the inquiries they receive on a monthly basis from prospective tenants looking to join MBI. MBI will also focus on regions where biomedical companies can be recruited to Massachusetts and particularly, Worcester. Finally, MBI plans to launch a web-based marketing plan to recruit companies. Another MBI goal is to increase efforts to heighten awareness of MBI and its reputation.

MBI plans to reach this goal by continuing to build upon the established relationships they have with biomedical, life science, and incubator companies and resources. By attracting and accepting new companies to MBI, the company will ensure its financial stability.

MBI's next goal is to mentor start-up firms and provide opportunities for partnerships. There are several areas MBI would like to cover with mentoring its tenants. First, MBI plans to interview each tenant upon entrance, every six – 12 months, and when they exit to see what type of support they need at different times during their stay at MBI. Additionally, MBI plans to provide tenants with advice on how to develop business and scientific plans and provide workshops pertaining to funding and writing grants. A related goal is to offer affordable incubator facilities, support for companies, and expansion/relocation advice. In order to accomplish its third goal, MBI will be seeking a possible transition out of Biotech 3 when the lease is up in December, 2011, to a more effective space. MBI also plans to accommodate tenant expansion and help tenants transfer out of MBI as best they can.

MBI also plans to work to build a brand for MBI. In order to create a company brand, MBI plans to promote company success stories and increase the visibility MBI currently has. MBI's next goal is to create and maintain connections to resources. In creating and maintaining resources, MBI strives to conceive innovative resources not currently available. MBI relies on marketing through resources in order to promote its brand. MBI would like to ensure ongoing financial viability as well.

Another goal of MBI is to consider adding affordable incubator space. When adding affordable incubator space MBI will be concerned with location, cost/benefit analysis, and of course availability. When MBI reviews current incubator locations the company performs a cost/benefit analysis to determine if lower cost lab space is available. The final goal in the theme of re-evaluating incubator locations is to investigate funding options for MBI. When investigating funding, MBI will focus on three main areas including university support, endowment, and state and federal funds.

The final theme is to assess impacts and outcomes of MBI's implemented practices. MBI relies on learning from past and current tenants in order to prosper. The first goal in this section is to better understand the factors that result in companies becoming successful graduates. MBI researches the causes behind prospective companies that never made it to incubation and follows up with unsuccessful graduate tenants to determine if MBI could have done anything differently to help the company. The next goal in this section is to, "document and provide evidence for the region's strong track record of collaboration." In order to do this, MBI plans to publicize collaborative partnerships. Finally, MBI has a goal of renewing connections with the National Business Incubator Association (NBIA). By reconnecting with the NBIA, MBI will be able to assess their incubator against other life science incubators in the U.S. and attend the Incubator Manager's conference and meetings that the NBIA offers (*MBI Scope of Services*, Appendix A).

MBI feels that they will be able to become a better incubation facility for their tenants through facilitating the goals listed in their Scope of Services. MBI also feels the Scope of

Services helps to keep the company on track for the continued development of the company and their tenants.

2.9.3 IMPACT OF BIOMEDICAL INDUSTRY IN MASSACHUSETTS

One of MBI's main goals is to enable the growth of the biomedical industry in Massachusetts. A 2008 Major Qualifying Project from Worcester Polytechnic Institute studied the impact on the economy of this industry in Massachusetts to further support MBI's mission. The project compared the growth in the industry between 2004 and 2008 and predicted numbers for 2012. The project group found that especially in Central Massachusetts (the 59 cities and towns of Worcester County) the industry is experiencing huge amounts of growth. Between 2004 and 2008, the economic impact of the industry on the region, and the number of people employed in the industry more than doubled, with fast growth predicted between 2008 and 2012. These figures suggest that Worcester County is industrially profitable currently (Ngo et al., 2008).

2.10 INCUBATOR SPACE ALLOCATION

As the incubator industry continues to grow, companies must efficiently allocate their facility space in order to be the most successful. Making sure that incubated organizations have the best layout will help determine their overall satisfaction level and usually increase productivity. The following chapter will describe the elements of successful space division.

2.10.1 SPACE ALLOCATION TECHNIQUES

Optimizing open space, encouraging collaborative efforts, and optimizing space around tenant behaviors can improve the overall flow of the facility in addition to effective space allocation and efficient facility flow. Every company will have independent views on the importance of and amount of required rentable, common, and shared space in their facility. Incubators that operate under a common research idea, like MBI, would benefit from using both common and shared space whereas others may not. It is crucial to maintain a balance between independent and shared space for a successful environment while allotting facility area. Outlined below are three various techniques for allocating space effectively.

In recent years, Massachusetts General Hospital has developed a research space management group to help allocate space on their facilities most effectively. The space distribution method was based off of four key decision components: "program quality, mission-relatedness, demonstrated need, and availability of sponsored research support" (MGH). The most important step in determining effective space allotment is to calculate

utilization densities of all parties. Utilization density is a measure of how efficiently an incubated organization will operate in and succeed from the allotted facility space and is determined based on the number of employees, suggested space estimates and expected costs (MGH). The group runs by the idea that no space is permanent and research facilities should be able to move space around on a whim.

For some companies, utilization density may depend on other factors such as expected annual profit. In a study by Libecap et al., a space allocation method is described which relies on net profit margins from previous fiscal years to determine utilization density. For example, incubated companies that receive high profit margins are offered more space or access to different space in the incubator facility as a pseudo reward. Using space allocation as a reward increases overall productivity by introducing a friendly level of competition. Incubated companies feel as though they need to do better in order to keep their space and studies find that these companies usually do increase profitability of the entire incubator facility when using this utilization density method (Libecap et al., 2008).

A third option in designing an effective facility layout is to create a mathematical model based on the desired allocation of space and the average annual profit. Mathematical models made through spreadsheets provide the most effective analysis of business situations (Powell et al., 2006). Average annual profit of a facility can be calculated by subtracting the rental cost of the overall facility from the revenue gained by renting out lab space, office space or cubicles, and shared space. Spreadsheet models have the ability to show the effect of a changing variable, such as allocated space percentage, on annual profit.

The group chose to look deeper into a linear programming model for the type of mathematical model. While the applications of mathematical models are infinite, there are four major varieties of linear programming models: allocation, covering, blending, and network models. Allocation models optimize (usually maximize) an objective function based on less-than capacity constraints. Covering models minimize an objective function based on greater-than coverage constraints. Blending models optimize an objective function subject to a combination of less-than capacity constraints and greater-than coverage constraints. Finally, a network model is the most complex mathematical model. A networked model relies on a series of interconnected nodes and arcs to denote flow patterns to analyze the objective function (Powell et al., 2006). For the purposes of this project, the group will focus on an allocation based linear programming model in order to determine the optimal space distribution for MBI.

A linear programming model focused on allocation optimizes a specific objective function by changing decision variables according to predetermined constraints and assumptions. Before a linear model could be implemented, the model conditions had to be defined. In the case of optimizing profit, the linear programming objective function would be to maximize profits. Decision variables include variable parameter values that effect the optimization of the objective function such as percentage of allocated space. Constraints involve problem specific values that control the results of the objective function. An example of a constraint would be a defined range for allocated percentages (Powell).

Table 12. Assumptions of Linear Programming Models (psu.edu)

Linear Programming Assumptions
• The objective function and corresponding constraints follow a linear model. • The model has divisibility in terms of decision variable values. • The results of the model have a given amount of certainty. • The model works off an available and accurate data pool.

All linear programming models follow four main assumptions, which are summarized in the table above. The first assumption requires the model to be linear. Model linearity indicates that the resulting objective function values are proportional to constraint values. Furthermore, linearity suggests that objective function values and constraints are additive and changing a single constraint will have no effect on another constraint. The second assumption specifies that the values for decision variables are divisible and can be fractional amounts. Models that require integer values for decision variables utilize a technique known as Integer Programming. The third assumption entails that the model has a definitive amount of certainty. Thus, the implemented model should produce results very similar to the values actually observed. Finally, the last assumption requires accurate enough data in a large enough amount to substantiate the model (psu.edu).

Microsoft Excel provides many useful tools for linear programming analysis that the project group will use in order to optimize the space allocation for MBI facilities. Features such as the Scenario Manager and the CHOOSE function allow Excel to examine the

annual profit over a range of allocation percentages. This will be useful to show MBI the change in profit if they allocate ten more percent lab spaces and detract five percent cubicle space. Excel also includes a *Risk Solver* software package that will show variable ranges for decision variables and corresponding objective function values. Additionally, Excel offers a built data tool called *Solver* that will perform a linear programming analysis to optimize an objective function based on decision variables and established constraints (Powell et al., 2006). *Solver* will be very useful in reporting the optimal percentages of allocated space for MBI.

In order to optimally allocate space, the project group needs to utilize a specific distribution model. The model relied on current MBI facility layouts, the behavior and operations of tenants, the perceived success of the current layout as determined from tenant survey responses, and MBI developed constraints regarding acceptable allocation percentages. This information will provide an optimal space allocation to be used by MBI in future facility division.

2.10.2 CURRENT SPACE ALLOCATION AT MBI

MBI provided the project group with metrics of the current space allocation at the three Worcester, MA locations. The confidential document details the percentage of every building that is allocated to rentable area, common area, shared area, lab space and office and cubicle space. On average, MBI offers slightly over half of the facility as rentable space. Common areas result in about one fifth of the available space whereas building common space is only around one tenth. Shared space also makes up one tenth of space on average.

The three MBI facilities average about half lab space and one seventh offices and cubicles. (See Appendix B for more Detailed Information).

Chapter 3: Methodology

3.1 CHOOSING A PROJECT

Defining a topic of study was the first step of this Major Qualifying Project. The project group had a few distinct options. In order to effectively pick the most productive topic, the group investigated various methods for making multiple criteria decisions. A successful decision making process is cultivated from many different factors (Fan et al., 2010). Research suggests that the best approach to multiple criteria decision-making is to evaluate all potential outcomes both quantitatively and qualitatively before choosing an ultimate selection (Fan et al., 2010). Ultimately, the topic option that received the best over score in the decision matrix became the topic selection.

Decision making processes that are first cultivated with a list of specific objectives and a clear understanding of the risk associated with the decision are often the most successful (Sánchez-Silva, 2005). The group developed a list of criteria for successful projects and then evaluated each topic option based on these criteria. The four main criteria were very general and meant to quickly differentiate the topic options between those of academic and personal importance and those which would not be well suited for the project group. The project group agreed on personal interest level, prior research and resources available, personal background in topic area, and project potential as the four main criteria. The project group also created a scoring mechanism for each criterion, which simply put was a scale of one to five (see table below).

Table 13. Scoring Descriptions for Decision Matrix

Score	1	2	3	4	5
Explanation	Doesn't Meet Expectations Whatsoever	Doesn't Meet Expectations	Almost Meets Expectations	Meets Expectations	Will Exceed Expectations

Topic selection is not a decision that the project group felt required much mathematical risk analysis; however, the project did evaluate the risks accompanying each prospective outcome. After developing a list of necessary project standards, the project group worked together to compile a list of questions to help gauge the associated risk of each topic option and further gauge the capacity of each topic option. Questions included: can the project group identify a specific need for this project; were similar projects completed in the past; will the work done on the project have a direct impact; is the project group capable of completing this project; are experts in the topic area available for support with this topic; and will the project group benefit from this topic. From these questions, the project group associated their personal risk in the topic; the group was able to decide which project would be most beneficial to both a sponsor and the group.

After compiling much research on successful decision-making processes, the project group decided that the best way to effectively choose a final topic area was to rank all options based on the group developed criteria and questions in the form of a decision matrix. Work done in a previous MQP was very helpful in developing the project group's

decision-making process. Quoted below is a section of Lynch's MQP that describes his self-created decision making process:

> "Using the MOpA tool consists of three main steps. The first step is the systematic evaluation of each opportunity to be analyzed. This is done through the Single Opportunity Questionnaire (SOQ). The outcome of the SOQ is a series of weighted scores for each opportunity. The second step of the tool uses the analysis tool to compare the opportunities using a set of weighted and non-weighted scales. The final part of the tool allows for user input which adjusts how the opportunities are compared, then identifies the most potentially successful opportunities (1 - 3 opportunities)" (Lynch, 2010).

The project group relied on Lynch's process to help create the decision matrix. Each of the five topic options was rated on the group's developed criteria and risk analysis question set. The project group qualitatively approached the topic decision-making process in the development of criteria and the risk association questions. The group quantitatively approached the topic decision-making process by scoring each topic option. Furthermore, the group weighted the criteria and questions on a scale of zero to three where zero represented no importance and three represented extreme importance. After the topic options were evaluated numerically with the assigned weighted scores, it was very easy for the group to make a decision. The highest score on the decision matrix became the ultimate topic selection (Lynch, 2010). Appendix C shows the progression of ranking MQP options.

Research explains that the most complete decision making processes are those, which use mathematical risk analysis to prove what is, and what is not a successful decision (Santoso et al., 2010). The project group felt that the use of risk equations would serve no purpose in the decision making process. For this reason, the project did not use any mathematical risk equations.

The project group developed an in depth decision making process based on the research of many scholars as well as another WPI MQP. Utilizing both a qualitative and quantitative approach allowed the project group to confidently choose a project topic that was both intellectually challenging and personally interesting; involved little perceived risk; and would benefit both the project group and its potential sponsor. The project group is confident that its decision making process was successful.

3.2 INTERVIEW PROCESS

3.2.1 DEVELOPING A QUESTIONNAIRE

The first step in developing the questionnaire was to define its goal (Gillham, 2000). Ideally, Massachusetts Biomedical Initiatives (MBI) wants to accept biomedical companies into their facilities that will graduate and be successful. What MBI provides to these incubator companies has a lot to do with their success. Through the analysis the goal is to be able to see what MBI does well, what MBI could improve upon and what, specifically, companies are looking for in MBI. By surveying past, present, and potential tenants of MBI,

the team believes will have a complete set of data to support suggestions of what to keep the same and what to focus on improving.

Generally, incubators provide mentoring/coaching/advising, networking (i.e., connecting the entrepreneurs to external resources and expertise), training (e.g., marketing; accounting; fundraising; quality control; HR practices; and so forth), space, and shared services (Rice, 1999). These are the five key areas the survey is structured around. There are questions in the survey pertaining to each of these five generally provided tools. The group's hope was that by surveying past, present, and potential tenants with questions from each category, area(s) where MBI excels and which need improvement would become apparent.

Questionnaires can range from unstructured to structured, as seen in the figure below. The team decided that developing a semi-structured questionnaire would best suit our needs. The semi-structured questionnaire will consist of both questions that have specific answers for respondents to choose from as well as open ended questions for respondents to give answers in their own words. Our team felt that having a semi-structured questionnaire would allow us to obtain more information than a structured questionnaire while keeping the questionnaire fairly short in length of time. Thus, a semi-structured questionnaire was developed with both scaled response and open response questions (Gillham, 2000).

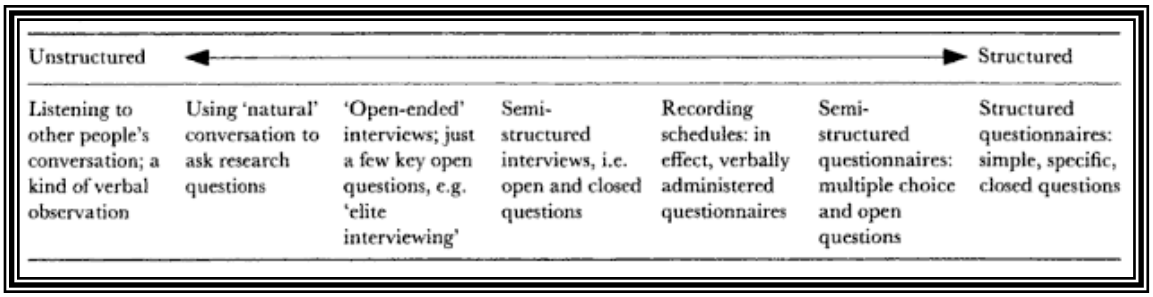


Figure 2. Questionnaire Structure (Page 3 from Gillham, 2000)

Once the preliminary questionnaire was created, the next step was to test it (Gillham, 2000). Our team decided to test the survey both among academic resources (professors) and fellow students. The purpose of testing the survey was to make sure the questions were understandable, to reach project goals by question responses, and to further develop our questions and goal. The group was able to test our survey among four interdisciplinary professors and students. From this review it was clear that the questionnaire should be separated into two questionnaires, one for current and past tenants and one for prospective tenants who could not answer several of the questions asked to the current and past tenants. Based on other feedback received from the survey test, the team was able to change any questions that needed clarification and further develop the survey. The surveys were tested one final time when all of the necessary revisions had been made. Both the prospective tenant questionnaire and the questionnaire for current and past tenants can be seen in Appendix D.

3.2.2 CONDUCTING INTERVIEWS

Originally, the team had planned to conduct the questionnaires in person with each of the tenants, however, due to time constraints, it was decided that phone interviews would be the best option. First, the team contacted each of the 26 incubator tenants via e-mail to ask for their participation with the questionnaire and provided them with the questionnaire to review. Once the team had sent the e-mails, we called each company in order to set up a 15-minute time slot to review their answers to the questionnaire. Additional e-mails were sent from MBI's President and CEO, Kevin O'Sullivan, in order to gain support for our survey. The team repeated the process of e-mailing, calling, setting up interview times, and conducting interviews until a sufficient amount of data was collected. Thank you notes were also sent to all respondents for their participation in the questionnaire.

When physically conducting the questionnaires over the phone, the team decided that two of members should be present at each interview: one to speak with the respondent on the phone and one to take notes on respondent's answers. Once each phone call was completed, the two surveyors reviewed the notes and added where they felt it was necessary. Having two surveyors present allowed for the maximum amount of information to be retained during each questionnaire.

3.2.3 COLLECTING AND ORGANIZING DATA

Collecting interview results was easy due to the planning efforts of the team. Before interviewing began, the team created a tracking sheet to notate the dates of interviewing and scheduled response calls (Appendix E). In addition, the team also manufactured an Excel

document that could easily be filled with interview responses (Appendix F). The method was very successful. The Excel tracking document included a master information sheet, whose information was summarized in auto-updating Pivot Charts for each question. Each Pivot Chart illustrated the frequency of responses from all participants. Furthermore, the Pivot Charts tallied responses based on the type of responder: current tenant, prospective tenant, past tenant, and successful graduate.

3.2.4 PREPARING MBI PRESENTATION

When compiling the data for the presentation to the MBI Board of Directors, the team originally based it on the graphs we had created in Excel and showed how each question related to MBI's Scope of Services. Once the first draft of this presentation was completed, it was reviewed with the project sponsor, MBI President and CEO, Kevin O'Sullivan. When reviewing the presentation, it was clear that the graphs were too complicated. Thus, results were simplified into percentages of respondents or frequency of respondents and listed conclusions along with the data. The correlation to the Scope of Services remained in the presentation to show how our results supported the goals and tasks. The final presentation was presented to the MBI Board of Directors in September, 2011, and can be seen in Appendix G.

3.3 ALLOCATING SPACE

A variety of factors influence effective space allocation model: user preferences, the physical layout of the facility, and most importantly the cost. In order to determine the most efficient spatial layout for MBI facilities, the project group used interview questions to gauge

the satisfaction with the current layout. This way, the project group could determine if changing the space allocation was necessary or not.

Profit potential is a huge determinant in almost all business decisions, thus the project group decided it would be beneficial to utilize a linear programming model via Microsoft Excel to determine ways to allocate space in order to create the most optimal profit margins. The model, contained in an Excel document, contained all the current information detailing the space allocation of the three facilities and the rental rates and costs accompanying each of those facilities. The project group used this information to create formulaic relationships between the various cells to ensure that the mathematical associations would hold true despite changing cell values.

The first step in creating a linear programming model is to define the model space. Describing the model space includes determining objective function, designating decision variables, formulating MBI driven constraints, and verifying model assumptions. The project group defined the model space and inputted current allocation data into an Excel file. The spreadsheet file is used to perform linear programming analysis utilizing built-in Excel features such as *Risk Solver* and *Solver*.

The project group used *Risk Solver* software to assign sensitivity parameters in terms of the percentages of rentable space (lab and office), shared space, and common space. The project group defined acceptable parameter ranges for the decision variable values, which is listed in the table below. Assigning parameter ranges and utilizing *Risk Solver Sensitivity Analysis* provides a sensitivity analysis showing the effects of small incremental change in

parameters on the resulting objective function values, in this term profit (Powell et al., 2006). The end user is able to view a graph and a chart, which summarizes the results of changing the input parameters.

Table 14. Acceptable Decision Variable Ranges

Description	Minimum Value	Maximum Value	Base Case Average Value
Total Rentable Area	55%	100%	62%
Lab Space	40%	80%	50%
Office Space	5%	25%	13%
Shared Space	5%	25%	13%
Common Area	10%	30%	18%
Building Common Area	5%	25%	10%

The project group used the given MBI space allocation in order to perform an Excel *Solver* analysis to determine optimal space allocation model. The spreadsheet was designed to illustrate the resulting objective function value as well as decision variable and constraint value. The *Solver* add-in tool was then used to determine optimized profit. The objective function was maximized by changing values of the decision values subject to MBI drive constraints. The results are further described in the following chapter. The project group

was able to determine broad conclusions about increasing profit based on space allocation techniques.

Chapter 4: Results

4.1 INTERVIEW RESULTS

Using the above methodology, a total of 26 current tenants, prospective tenants, past tenants, and successful graduates were contacted with a goal of obtaining 20 completed surveys. Through the group's efforts, we were able to complete 19 surveys, which provided an adequate spread of data to work with. It is important to note that not all questions were answered by all respondents. This is because some participants could not answer certain questions. The response demographic included six current tenants, four successful graduate tenants, four past tenants, and five prospective tenants as shown in the graph below. Past tenants were separated into two categories: successful graduates, meaning they have graduated from MBI and have been operating on their own for at least five years; and past tenants, who have graduated from MBI but their company is no longer in business.

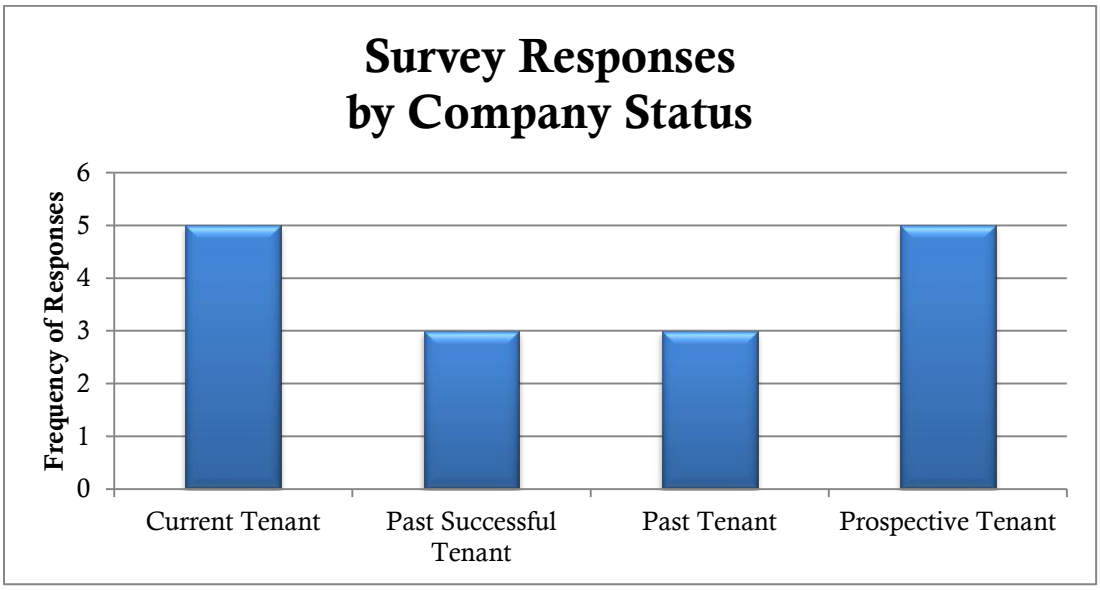


Figure 3. Survey Responses by Company Status

The project team collected data for the length of stay for each survey respondent (current tenants, past tenants, and successful graduates only). The average length of stay overall is approximately 37 months. Current tenants averaged a length of 26 months, past successful graduates averaged a length of 75 months, and past tenants averaged a length of 18 months as shown in the graph below. This data shows that successful graduates stay longer lengths of time within the incubator than companies who stay for shorter amounts of time.

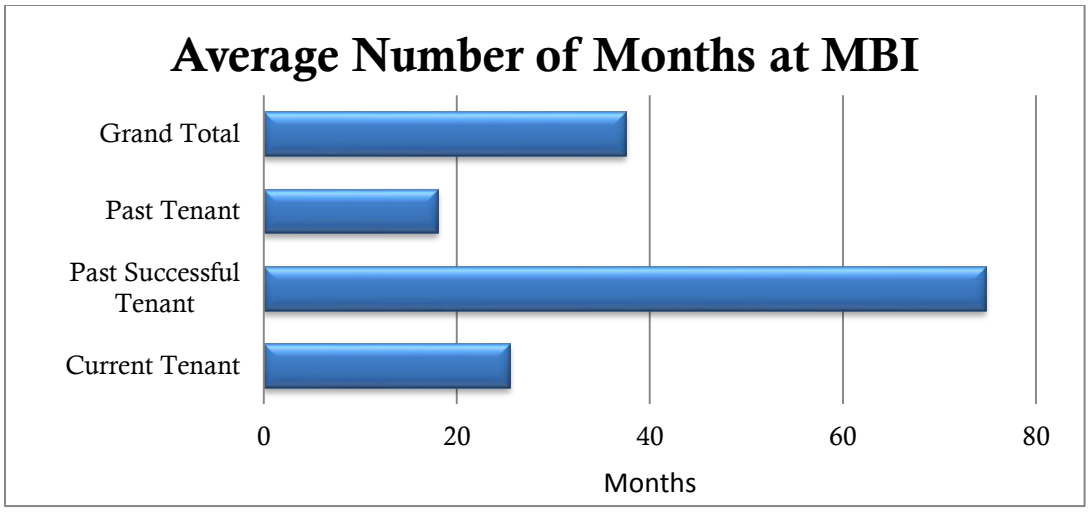


Figure 4. Average Number of Months at MBI

Next, the team inquired about how each respondent had heard about MBI. Three options of Website, Word of Mouth, and Affiliated MBI Company Recommendation were given in addition to a choice to provide a unique answer. It was seen that approximately 6% of respondents heard about MBI through an affiliated MBI company recommendation, 25% of respondents heard about MBI through word of mouth, 25% of respondents heard about MBI through their website, and 44% of respondents heard about MBI through 'Other' sources as seen in the graph below. From the respondents that answered 'Other' there was no common theme seen. With most respondents answering that they heard about MBI through either their website or word of mouth this shows that MBI is doing a good job at getting their name out in the biomedical community. Additionally, it was seen that more current and prospective tenants heard about MBI through their website which suggests that their website is becoming more important in recent times.

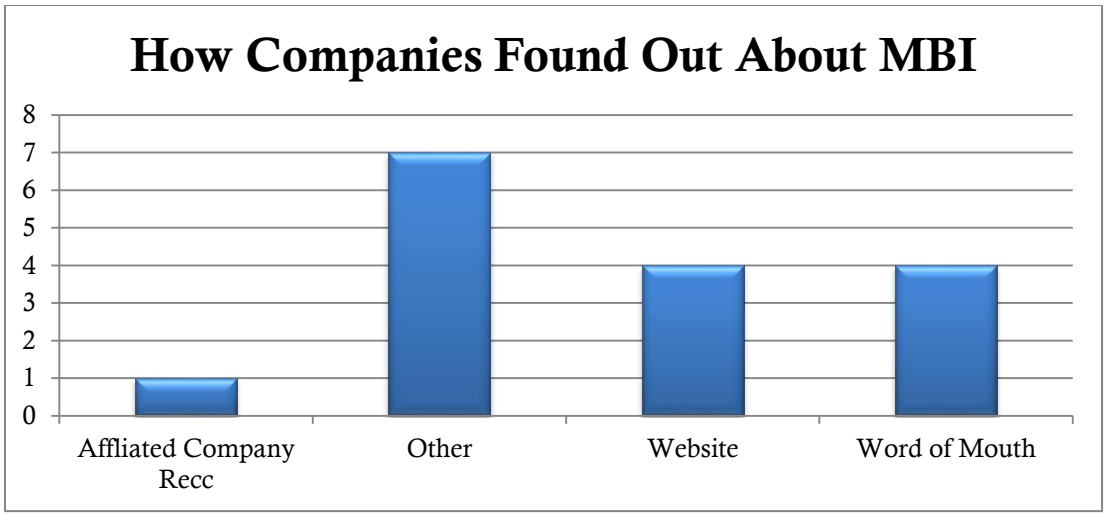


Figure 5. How Companies Found Out About MBI

Data was also collected regarding how responsive MBI is to requests for information about joining their facility. Responsiveness was defined as timeliness in processing requests for information about the incubator and its facilities. Responsiveness also includes effectively answering questions and efficiently offering information regarding the facilities, rent, and space. In addition, prospective tenants are also offered tours of the facilities, which were greatly appreciated by the survey respondents. The results show that MBI is very responsive to tenant requests as confirmed by 100% of respondents. Respondents were also asked to rate the ease of obtaining information from MBI on a scale of one to five, one being Very Difficult and five being Very Easy. 13 respondents answered that it was very easy and three respondents answered that it was somewhat easy to obtain information from MBI as seen in the graph below.

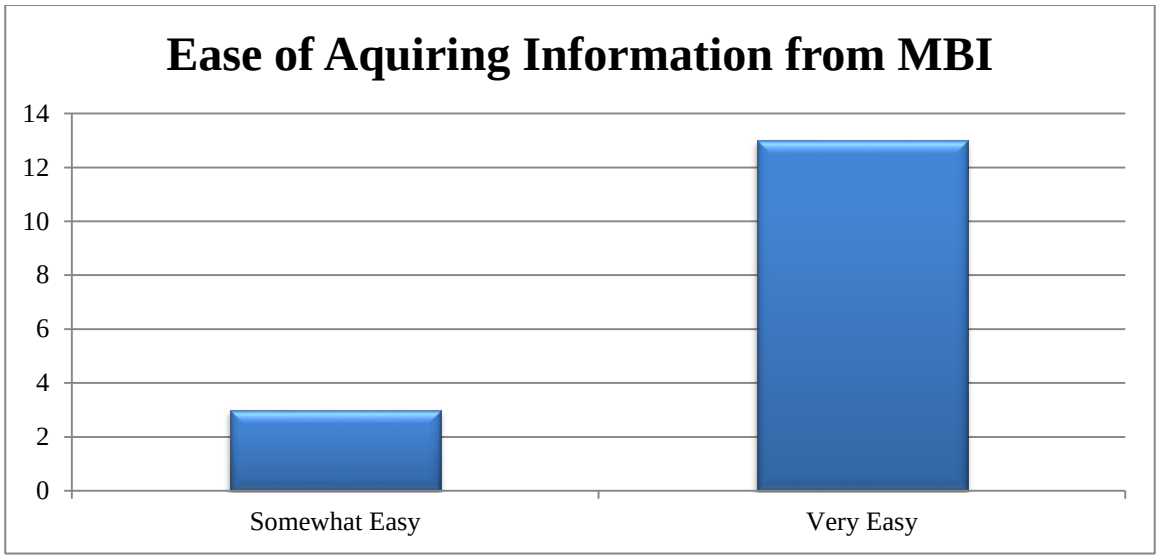


Figure 6. Ease of Acquiring Information from MBI

In addition, respondents were questioned about whether or not anything was discouraging about joining MBI's facility; in other words, were there any reasons that would have caused them to look into other real estate options. 56% of respondents answered that there were no discouraging factors about MBI. Among the 44 % respondents that answered there were discouraging factors common answers included the location of the facilities and the cost of the rented lab and office space. Although a high percentage found a limiting factor in joining MBI many of the respondents found these factors were insignificant in comparison to the benefits provided by MBI.

Respondents were then asked what specific needs or factors originally attracted them to MBI. The team found that there were several common needs that attracted tenants to MBI. First, the ready-to-move-in space was very attractive to many respondents. The price of the available space was also mentioned numerous times as a positive influence to join

MBI. Another popular response was the need for equipment and having shared equipment available that companies did not need to purchase individually. Additionally, it seemed that MBI's excellent responsiveness to tenant requests motivated prospective tenants to want to join facilities. There were several specific needs collected from respondents that did not show any trend as well.

Current tenants, past tenants, and successful graduates were asked once in MBI's facility what did they like best about their accommodations. Accommodations were defined as the physical facility, shared services, cost, etc. From this question it was seen that respondents appreciated the professional environment that was provided by MBI. Other common answers included the cost of the facility and the shared services provided. Current tenants, past tenants, and successful graduates were also asked if there were any accommodations they felt MBI lacked. Most respondents said that there were no accommodations that MBI lacked. Among the respondents that answered yes, common accommodations that were mentioned included lack of support in the area of operations and a lack of conference rooms and shared space within the facilities.

Next, current tenants, past tenants, and successful graduates were asked to rate MBI's services and support system on a scale of one to five, one being completely inadequate and five being excellent. 11 respondents answered that the support system was excellent, two answered that the support system was adequate and one answered that the support system was somewhat inadequate as seen in the graph below. The results suggest that MBI's current support system is well liked by tenants.

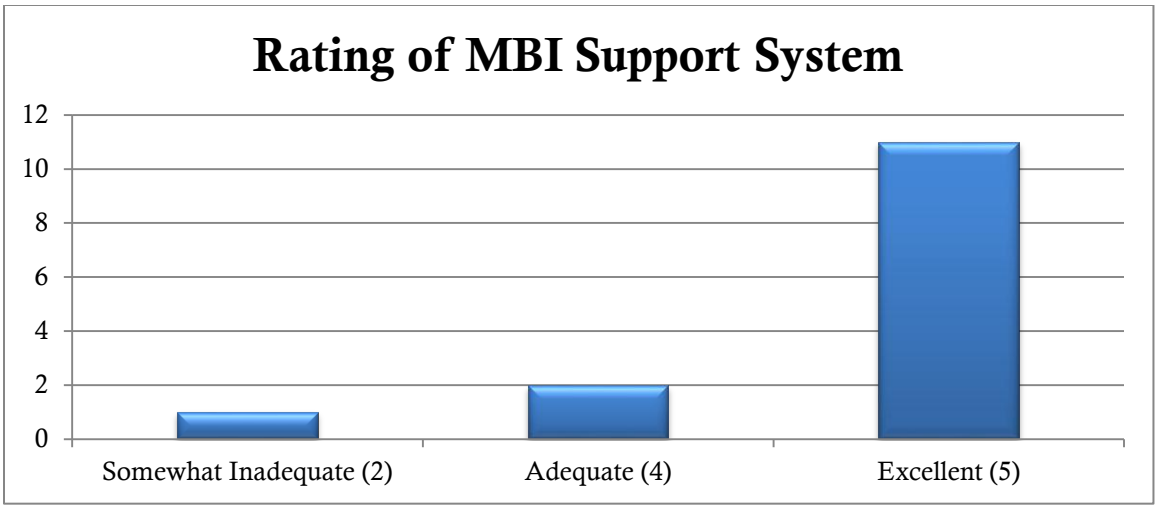


Figure 7. Rating of MBI's Support System

Further, all tenants were asked about MBI's facilities layouts. Respondents were asked to rate their satisfaction with the layout of MBI's facilities on a scale of one to five, one being Completely Unsatisfied and five being Completely Satisfied. Six respondents answered that they were completely satisfied, 12 respondents answered that they were satisfied, and one respondent answered that they were neutral about the layout of MBI's facilities as seen in the graph below. The mix of responses shows that most tenants are at least somewhat satisfied with the layout of MBI's facilities. Respondents were also asked to explain any positive and negative aspects about the lab, office, and shared equipment layout of MBI's facilities. Many respondents commented that the facilities at Gateway Park and One Innovation Drive were much nicer and preferred to the location at Barber Avenue. The few respondents who provided negative aspects also felt that the office space was too far from the lab space in many instances. Several respondents also noted that their company had outgrown MBI but were not yet able to move out on their own and wished MBI

provided larger lab spaces. Finally, some respondents noted that shared equipment comes with problems of including when each company is able to use the equipment and cleaning the equipment.

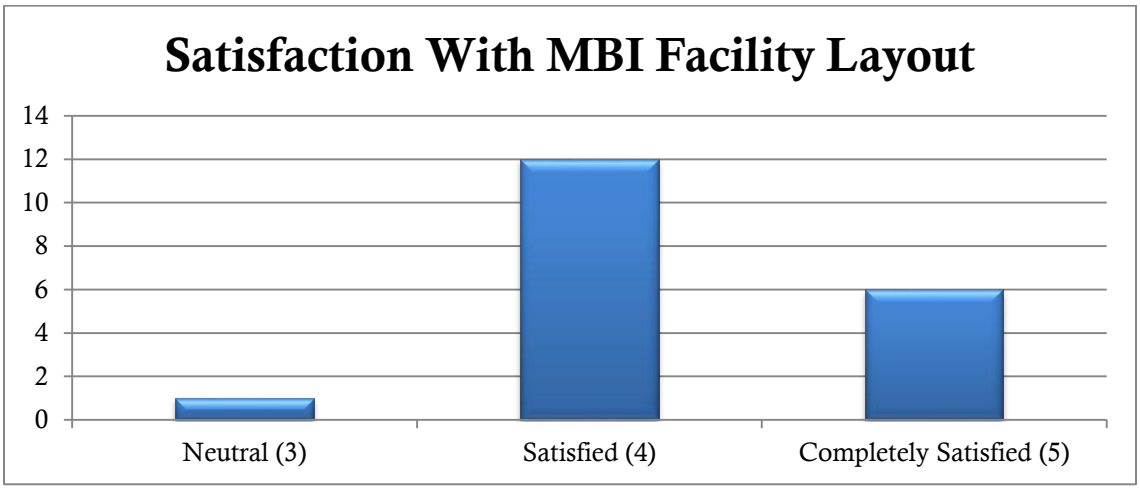


Figure 8. Satisfaction with MBI Facility Layout

Current tenants, past tenants, and successful graduates were asked whether or not MBI saved or cost their company start-up time and to estimate how much. This question proved very difficult to answer for many of the respondents. Some commented that they would not have been able to start at all of they hadn't had the opportunity to join MBI. Others were established companies that needed new space to move into and MBI provided that space which allowed them minimal closing time for relocation. Overall, companies saved an average estimate of three – six months of start-up time and no companies stated that MBI cost start-up time.

Next, current tenants, past tenants, and successful graduates were asked to rate the amount that MBI helped to enhance and grow their business on a scale of one to five, one

being Depreciation to Business and five being a Substantial Enhancement to Business. Six respondents stated that MBI substantially enhanced their business, five respondents answered that MBI moderately enhanced their business, and two respondents answered that MBI had very little enhancements in their business as seen in the graph below. Although no respondents answered that MBI was detrimental to their business, several companies stated that there were little to moderate enhancements to their companies. This information leads us to believe that overall MBI's tenants have been very happy with the incubator and the enhancements MBI has had on their company.

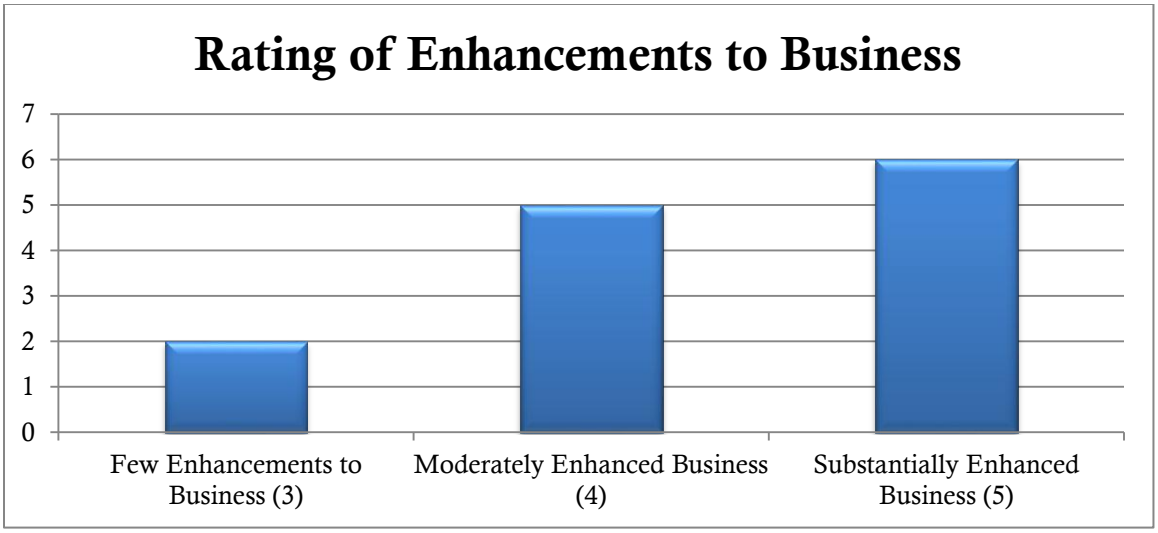


Figure 9. Rating of Enhancements to Business

The team also inquired from current tenants, past tenants, and successful graduates about their company-desired success metrics, how they created these metrics, if MBI had anything to do with the development of these metrics, and how the companies were performing compared to the success metrics that were developed. Success metrics varied among the companies from financial increases to staff increases as well as several other

metrics. Respondents were consistent in the fact that they all created their success metrics themselves and stated that MBI did not aid them in developing these metrics. Additionally, how the company was performing in relation to their success metrics varied from company to company.

Current tenants, past tenants, and successful graduates were then asked to rate the overall success of MBI and their facility in relation to their own operation on a scale of one to five, one being Extremely Unsuccessful and five being Very Successful. In rating the overall success of MBI, seven respondents answered very successful, five respondents answered somewhat successful, and two respondents answered neither unsuccessful nor successful as seen in the graph below. No respondents answered that they found MBI unsuccessful.

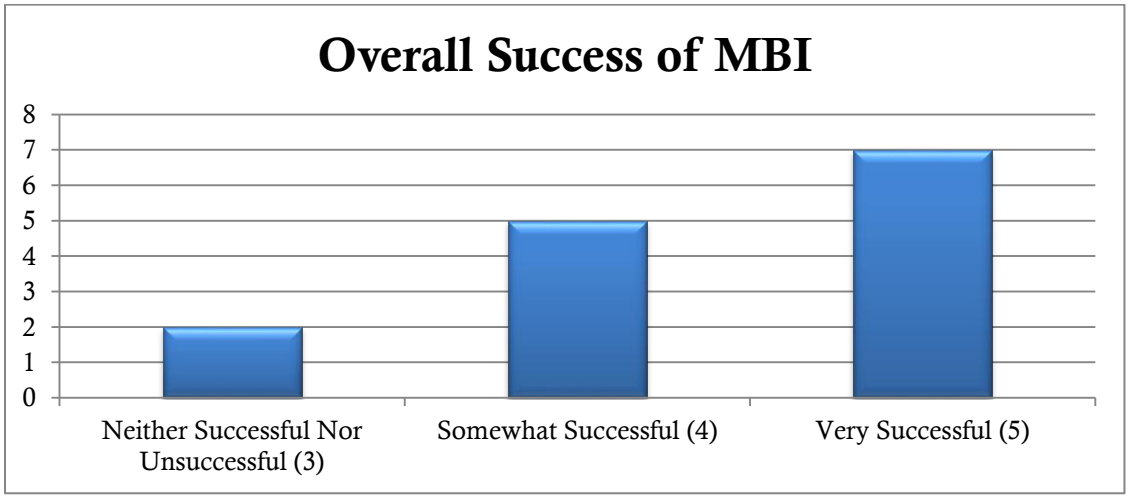


Figure 10. Overall Success of MBI

Finally, the team asked all respondents to share any suggestions for improvements they have for MBI and any additional comments. The most common suggestions for MBI

were to have more common areas and conference rooms for tenants. Many tenants also suggested having more networking opportunities both with other incubator companies within the facilities and with entrepreneurs. Other additional comments stated that respondents have or had a good relationship with MBI during their stay and that their experience with MBI has been positive.

4.2 SPACE ALLOCATION RESULTS

The three existing MBI facilities are, in fact, successfully allocated based on research suggestions and feedback from prior and existing tenants. As explained in the previous section, the majority of survey respondents agreed that they were either satisfied (four out of five) or extremely satisfied (five out of five) with the current layout of the three existing facilities. Respondent suggestions for improvement came from a desire to have a shared services handler or a clearer schedule of how to use the shared space.

To mathematically allocate facility space the most effectively, the project group completed an initial optimization model based on financial figures. The linear programming model revealed the most effective percentages of lab and office space to rent based on rental costs for MBI and selling costs to the tenants. These financial figures are, in fact, confidential and could not be shared with the team. Therefore, the group used increased figures from a 2008 MQP studying the financial viability of MBI as estimated benchmark figures to model economic inflation as per the advice of our advisor (Ngo et al., 2008). Nevertheless, the document is set up to reflect the annual average profit based on the average costs of renting the overall facility space and the average revenue from renting lab

space, office space or cubicles, open space, and common space. The model suggests that the most important factor in space allocation is cost. The project group's model has been populated with estimated figures in order to prove current success of the facilities and offer support for the future.

The first step in allocating space was to properly define the model space based on survey results, MBI concerns, and background literature. The objective function for this model is to maximize annual profit. It is more accurate to describe this as an optimization model rather than a maximization model due to the given constraints. The decision variables which change to reflect change in profit in this model are the allocated percentages of rentable, common, and shared space in each facility. Constraints for this model include the acceptable variable ranges as defined in Table 14 and the sum of all allocated percentages must sum to 100%. The results can be summarized in the table below.

Table 15. Linear Programming Model Space Definition

	Title	**Description**
Objective Function	*OPTIMIZE* Total Expected Profit	Total Profit of MBI based on the theoretical values entered in Cost and Revenue calculations. Total Profit = Expected Revenue – Expected Cost.

Decision Variables	Total Rentable Area	The amount of allocated rentable area.
	Total Common Area	The amount of allocated common area.
	Total Shared Area	The amount of allocated shared area.
Input Parameters	Expected Revenue	The amount of revenue collected by MBI for the year. This includes specific rental costs for rentable space and shared space.
	Expected Cost	The amount of money spent by MBI annually to maintain facilities.
	Acceptable Variable Ranges	The maximum and minimum allocation percentages for rentable, common, and shared space within a facility.
Constraints	Percentage of Allocated Rentable Area	The optimal total amount of allocated rentable area must be between a user-defined minimum and maximum percentages.
	Percentage of Allocated Common Area	The optimal total amount of allocated common area must be between a user-defined minimum and maximum percentages.
	Percentage of Allocated Shared Area	The optimal total amount of allocated shared area must be between a user-defined minimum and maximum percentages.
	Sum of All Allocated Percentages	The sum of all percentages for a given facility must be equal to 100%.

It was important for the project group to verify the assumptions of linear programming before performing linear programming model analysis. The first assumption of model linearity is confirmed by testing changes in the decision variables in the developed

spreadsheet. Changing the value of allocated rentable space alters the resulting profit value without changing other decision variable values. The second assumption of decision variable divisibility is proved because the resulting decision variable amounts are in terms of percentage, not an integer. The third assumption of model certainty is tested in the 2008 MQP analyzing the financial viability of MBI (Ngo et al., 2008). MBI is thriving and in the event that the company seeks new facility locations, this model can be used to predict the optimal space allocation. Finally, the fourth assumption of available data is covered by the aforementioned MQP as well as company provided information about facility design. Furthermore, there exists much literature regarding linear programming as well as space allocation models that can be used in the model.

The model was first analyzed to see the effects of sensitivity analysis in terms of annual profit. Results from the sensitivity analysis suggest that adding more rentable space will create the greatest profit margins. This makes sense because rentable space is the main income source for MBI. Increasing revenue will ultimately increase profit margins. The sensitivity analysis is useful in showing the numerical effect of incremental changes in the percentages of rentable, common, and shared space in the MBI facility. *Risk Solver* software plotted a graph, which summarize these changes in net profit. The results are viewable in Appendix B.

Additional modeling was completed in order to determine the best allocation of space based on given constraints and utilizing Excel's *Solver* Platform. The defined model space is included in previous table. The purpose of *Solver* is to define optimal percentages for total allocated rentable and shared space as to maximize profit while staying within defined

constraint ranges. The constraints were entered into the *Solver* Add-In and the model was optimized. The full results are viewable in Appendix B.

For this model, Solver resulted in a space allocation plan very similar to the current model. The project group optimized the allocation for current facilities as well as the average allocation for use in future facility obtainment. *Solver* optimized profit by allocating 64% rentable space to Barber Ave and 62% for Biotech 3 and Gateway respectfully. The amount of shared space was optimized at 13%, 7%, and 8% for Barber Ave, Biotech 3, and Gateway respectfully. The average resulting values for the decision variables are the optimal values for future MBI facilities. The optimal average percentages are as follows: 71% rentable space, 10% common space, and 19% shared space. The summarized results of the space allocation model are shown in the table below and are further displayed in Appendix B.

Table 16. Summarized *Solver* Results for Optimized Space Allocation

	Rentable Space	**Common Space**	**Shared Space**
Current MBI Facility Average	63%	In: 18% Out: 14%	10%
Optimal Range	60-80 %	5-25%	5-20%
Optimal Average	71%	10%	19%

Designing a facility layout that can withstand constant tenant change is a difficult task. As the research proposes, an effective layout is handpicked for those utilizing it and MBI will have to review and implement any facility changes in their environment with their current tenants. A full list of recommendations can be found in the next chapter of the report.

4.3 MBI VS. BEST PRACTICES

Once the team had strong background information regarding incubation best practices and MBI it was extremely important for us to compare how MBI's compare to incubation best practices. By comparing MBI's practices to incubation best practices the group was able to see where MBI follows best practices, where they do not, and where MBI's practices could be improved. The team was able to see that MBI follows nearly all of the best practices. The two guidelines that MBI does not fully follow are prioritizing management time to place the greatest emphasis on client assistance, including proactive advising and guidance that results in company success and wealth creation and develop an incubator facility, resources, methods, and tools that contribute to the effective delivery of business assistance to client firms and that address the developmental needs of each company. The comparison of NBIA Guidelines for Best Incubation Practices and MBI practices can be seen in the table below.

Table 17. NBIA Guidelines for Best Incubation Practices vs. MBI Practices

(*National Business Incubator Association*, 2011), (*Massachusetts Biomedical Initiatives*, 2011)

NBIA Guidelines for Best Practices	MBI Comparison
• Commit to the two core principles of business incubation.	• MBI is committed to the two core principles of business incubation that NBIA defines.
• Obtain consensus on a mission that defines the incubator's role in the community and develop a Strategic Plan containing quantifiable objectives to achieve the program mission.	• MBI has a mission and Strategic Plan that is updated every three years. The Strategic Plan is also accompanied by a Scope of Services that states objectives, tactics, and metrics to aid in accomplishing the mission.
• Structure for financial sustainability by developing and implementing a realistic business plan.	• MBI has a structure for financial sustainability that was reviewed in a previous MQP in 2008. Additionally, MBI has a detailed business plan.
• Recruit and appropriately compensate management capable of achieving the mission of the incubator and having the ability to help companies grow.	• MBI recruits and has recruited a highly talented staff with significant experience in their particular position.
• Build an effective board of directors committed to the incubator's mission and to maximizing management's role in developing successful companies.	• MBI has built a very strong board of directors. MBI's board meets regularly and is committed to MBI's mission.
• Prioritize management time to place the greatest emphasis on client assistance, including proactive advising and guidance that results in company success and wealth creation.	• Client assistance is a main priority of MBI. In recent years MBI has hired a facilities manager to help clients with physical facility issues. Advising and guidance are also offered at MBI, but limited.
• Develop an incubator facility, resources, methods and tools that contribute to the effective delivery of business assistance to client firms and that address the developmental needs of each company.	• MBI has been successful in creating three incubation facilities including several shared services. However, MBI does lack in business assistance that is offered to clients.
• Seek to integrate the incubator program and activities into the fabric of the community and its broader economic development goals and strategies.	• MBI is well connected to the community surrounding its facilities and is well respected in the community.

Since MBI is a biomedical incubator, the team also compared MBI practices to the keys to success in the life science industry. Again, MBI follows almost all of the life science industry best practices with a couple of exceptions. First, MBI does not help incubation clients obtain capital. Second, MBI does not help companies with commercialization of their products, which is a large difficulty among start-up companies. Finally, although MBI offers several professional services, not all services that clients want and need are provided. The comparison of MBI practices to life science industry best practices can be seen in the table below.

Table 18. Keys of Life Science Industry Success

(James 2001), (*Massachusetts Biomedical Initiatives*, 2011)

Key	Explanation	MBI Comparison
Cutting Edge Research	• Producing innovations around which entrepreneurs can build technology companies • Achieving critical mass in this area requires a solid life science research base	• MBI is very successful in being a center for cutting edge research • MBI's connection to the WPI Venture Forum has aided in cutting edge research at MBI • MBI's Biocomputing Center also acts as a catalyst for collaborative research

Access to Capital	• Including seed and venture funds that support life science companies at all stages of their development • Life sciences companies can have difficulty attracting funds because of their lengthy time line and unusual fundraising curve	• MBI as an incubator has been very successful in obtaining capital • MBI does not, however, help their clients obtain capital investments for their companies
Effective Technology Commercialization	• Getting university and other public research from the laboratory to the marketplace • Checking out amount of licensing revenue, number of companies formed around university technologies and other variables	• MBI does not help companies commercialize their products
Skilled Workforce	• Becomes an issue as companies expand and graduate incubators • Specialized companies may have to recruit national	• MBI has a very skilled workforce including employees with years of experience in their field
Access to Transportation	• Having access to nearby hubs for business activities including shipping products and bringing in venture capitalists	• MBI's location in "the corridor" from Worcester to Boston provides excellent access to transportation
Industry Infrastructure	• Having the ability to access professional services, such as patent and clinical trial firms	• MBI's many connections provide clients with the opportunity to access many of the professional services they need • Not all services that companies need are provided

Entrepreneurial Culture	• People willing to take on the risk of starting and working for a company at a stage when there's a lot of risk and no money • People with business acumen to work with them	• MBI is filled with start-up companies that are willing to take a risk for their companies
Quality of Life	• Comes into play when companies recruit people to a community • Cultural attractions, sunny beaches and other amenities can make a difference when recruits are in high demand	• Although Worcester is not in a tropical environment, the location is very desirable for biomedical companies because of the close proximity to Boston

Overall, MBI follows many incubator and life science industry best practices. The main practices that are not followed by MBI include client advising/guidance, business services, commercialization, and assisting companies in obtaining capital.

Chapter 5: Recommendations

After thoroughly researching incubation best practices and receiving feedback from tenant questionnaires, the group was able to compare MBI's current performance to industry best practices. By identifying strengths and weaknesses of MBI's incubator, the team was able to make several recommendations to improve services provided as well as space allocation. In addition, the team was able to relate recommendations to MBI's Strategic Plan and Scope of Services to ensure our recommendations related to high priorities on MBI's Scope of Services.

The first recommendation for MBI addresses their Strategic Plan and Scope of Services. One of the NBIA guidelines for best practices is to, "develop a Strategic Plan containing quantifiable objectives to achieve the program mission" (*National Business Incubator Association*, 2011). Although MBI already has and will continue to update the Strategic Vision's Scope of Services every few years, the documents are very long and tedious. When reviewing industry best practices in action, the group found a new way to develop a Strategic Plan called Strategic Plan on a Page (SOAP). As discussed in the literature review, the SOAP method forces companies who use the method to only put the most important strategic goals on a single sheet of paper (Adkins et al., 2010). The team suggests that MBI keep the Strategic Vision and Scope of Services that they have now, which usually runs approximately three years, but also use the SOAP method on a year-to-year or even biannual basis to ensure they are focusing on the most important goals first. The team believes this method will allow MBI's staff to focus on the goals they need to

accomplish on a short-term basis which, in turn, will allow MBI to progress more efficiently. Additionally, this method allows MBI's staff to easily refer to their goals for the year by looking at one sheet of paper, rather than going through the lengthy documents that are available now. Finally, MBI will be able to update their Board of Directors easily using this method by addressing progress that is being made in areas that are important to the incubator at the time. Although this recommendation does not fall under MBI's Scope of Services, the importance of updating the Strategic Plan's Scope of Services has been expressed by President and CEO of MBI, Kevin O'Sullivan, many times.

Both research and tenant questionnaire responses have shown the importance of client services in incubator programs. MBI's Scope of Services also ranks two related goals as 'high' importance. These goals include: mentor start-up firms, and provide partnership opportunities and offer support for incubated companies. Since several sources show the importance of client services, the team has many recommendations for MBI in this area.

The first recommendation in the area of services provided to tenants again comes from the best practices of NBIA seen in action. As stated earlier, an incubator facility that pairs each tenant with eight connections to people who will be able to help them while they are in the incubator. The facility uses eight connections to different people to ensure a broad range of services and insight are provided to the start-up. Although this specific program would be difficult to provide to each company, the group would like to suggest a modified version of the program. First, it is apparent from discussions with Kevin O'Sullivan, President and CEO of MBI, that not all companies are interested in the networking opportunities provided by incubators. Thus, the team first suggests that when MBI tenants

are interviewed when they first move into the facility, they are asked whether or not they are interested in networking opportunities and if so, specifically what kinds of networking and help they are interested in. Directly asking tenants what types of networking opportunities they are looking for will allow MBI to provide networking opportunities the tenants want. The team also believes that this would allow MBI to bring in a variety of different networking opportunities.

In addition to asking what types of networking tenants require as they move in, the team feels it would be very beneficial for MBI to keep an open forum for suggestions of networking opportunities that companies would like to see throughout their stay at MBI. It was very clear to the team that over time, tenants' needs will change and they may need help with different aspects of their company. Asking graduate companies what networking opportunities they would have liked to see would be beneficial for MBI. During interviews with graduate tenants it was clear that they now have more insight of what would have benefited their company that current tenants do not have. By continuously asking the tenants what they are looking for in networking opportunities, MBI will be able to better serve their tenants and provide the networking that they want and need.

A specific recommendation for the services provided by MBI stems from a question asked about tenants' success metrics and how they were formed. Each tenant that participated in the questionnaire noted that MBI did not help them create their company's success metrics. A discussion with Kevin O'Sullivan provided some insight on this topic. Mr. O'Sullivan stated that help with business plans and success metrics was once a part of MBI's incubation program, but they decided not to continue with it because they found they

were wasting their time with companies who were not successful. Further, MBI does not know the market for each specific company which makes it difficult to help with success metrics. Although MBI has not had success with providing this service in the past, the group believes it is an area that should be re-visited based on the survey results. Though having a staff member specifically helping tenants with success metrics did not work for MBI, the group believes having a bi-annual or annual expert (mentor) on the topic come in to MBI and present on business strategy and creating success metrics would benefit their tenants greatly. The team also believes this program would be well attended because several of the questionnaire participants asked for more support in this area.

The next recommendation for MBI directly relates to their Scope of Services objective of identifying and attracting entrepreneurial scientists and emerging companies. Through our questionnaire, the team has found that MBI's website is becoming more important in attracting prospective tenants. For this reason, the team suggests that MBI focus on their website and keeping it up to date. Specifically, MBI should highlight the areas in which they exceed industry averages. MBI may also want to draw attention to the factors that attracted tenants to MBI that were collected in the survey. Additionally, MBI may want to work with an online marketing agency to ensure that MBI is appearing high on search engine lists when specific words are being searched. It is also very important that MBI remains a member of the Massachusetts Association of Business Incubators (MABI) as they appear on the MABI website with a link to MBI's website and contact information. Focusing on their website will allow MBI to work towards accomplishing a goal that is

ranked as 'high' on their priority list of attracting entrepreneurial scientists and emerging companies.

In terms of facility design, the group recommends that MBI continue to utilize the observed space allocation in current facilities. The current allocation is successful as proved by the literature review and the opinions of current and prospective tenants. Based on the results from the *Solver* optimization, the ideal amount of rentable space is between 60% - 80%. The group understands that it would be difficult, if not impossible, to redistribute the current allocations for the three existing facilities. Luckily for MBI, the three facilities allocate this optimal amount of rentable space currently. In the event that MBI seek an additional facility location, the company should look for a facility where the amount of rentable space is maximized around 71%.

To improve facility flow at the existing locations, MBI should consider maximizing open space, allocating more rentable space, and highlighting specific travel paths around the facility. This means creating additional storage in shared space, introducing wall shelving instead of tables or counter space, and increasing cooperative activity among tenants. Increasing space to move will increase the potential for collaboration among the tenants utilizing the space. In addition to increasing productivity, these suggestions should create a more organized flow to the facility in general. The *Solver* optimization set the allocation of common space at 10% and the shared space at 19%. The optimization model suggests that optimizing rentable space while allocating more shared space than common space is profitable. In relation to incubation best practices, this will also enhance business by increasing partnership and productivity among tenants.

MBI could improve flow around the three facilities by teaching tenants the most efficient travel paths around the space. The project group noticed that tours of the facility often left hallways cramped and doorways crowded. If MBI were to post facility layout designs with highlighted travel paths to and from highly congested areas (bathroom, shared kitchen space, shared lab space), it would increase the speed at which people moved around and decrease the potential corridor collisions that may happen. Furthermore, these paths should indicate the correct areas to enter and leave each room so that tenants can avoid cramming between labs.

Finally, the project group recommends that MBI utilize the provided linear programming model to forecast annual profit based on the amounts of space allocated in the future. By entering a few input parameters into the model, a user will be able to determine profit. The user of the model can experiment by changing the percentage of rentable space, shared space, and overall space of a facility. This model will be useful in the event that MBI is looking to acquire another or an alternative facility for the business.

By identifying strengths and weaknesses of MBI's incubator, the team was able to make several recommendations to improve services provided as well as facility space allocation and flow. Making recommendations for MBI that are high on their priority list, the team is confident that these changes would improve MBI as an incubator. Finally, the group believes that these changes would result in MBI's tenants being more satisfied with their stay at MBI and overall allow MBI to remain a successful incubation program.

Chapter 6: Conclusions

Initial goals of the project are as follows: study MBI's current strategic plan, gauge the success of MBI in portraying goals of their Scope of Services, examine and analyze MBI's facility layout, and offer recommendations for overall improvements to MBI. The group was able to accomplish the first three goals through an interview process involving past, present, and prospective tenants of MBI facilities along with a linear programming model. The analysis of these results led the group to create a series of recommendations which were presented to MBI for eventual implementation pending a review from the MBI Board of Directors.

The survey results from MBI's tenants are a very important tool for MBI to understand their tenants' satisfaction. MBI has never surveyed their past, current, and prospective tenants in this way; thus, the project group's surveys were an attempt to collect a non-biased evaluation of MBI. It is important to note that the survey included questions regarding each of the areas incubators often provide services in including mentoring/counseling, networking, training, space, and shared services (Rice, 1999). By including questions in each of these areas, the project team was able to see which areas MBI excelled in and which areas need improvement.

It is crucial to recognize that the survey is only as good as the data provided by the participating tenants and the number of responses received. The team accomplished a high response rate of approximately 73% by working closely with MBI and specifically, Kevin O'Sullivan. Although the team obtained a high response rate, it became clear to us that not

all respondents were capable of answering all questions within the survey. The data also relied on how much information participants were willing to share when answering open response questions; some respondents provided detailed and lengthy answers while others provided one word answers to the same question. Another limitation of the survey data was the outliers that were documented in our data. These outliers skewed the data and can be attributed, in part, to the number of responses in each category of tenant; prospective, current, past, and successful past. Although the survey response rate overall was high, the number of respondents in each category only ranges from four – six tenants, which is very few; allowing for data to be skewed when analyzing categories separately.

In addition to the survey, the literature review, specifically the section about life science incubators, helped outline industry best practices. These industry best practices allowed the team to create recommendations based on the areas that needed improvement that were discovered using the survey. Although the team made several recommendations for MBI, it is clear from the survey that tenants are content with their experiences at MBI. This suggests that MBI's strengths outweigh their weaknesses and that strengths affect their operation much more than weaknesses.

The team feels that additional validation of the results, achieved by surveying more MBI tenants would enhance the correlations between the survey results and recommendations. Conducting the surveys face-to-face would have resulted in more in depth answers to the questions and therefore, stronger data. To explicitly prove that the recommendations will result in more satisfied tenants, the recommendations would have to be put into effect by MBI and a survey, similar to the one given in the project, would need to

be conducted and examined a few years after the recommendations were put into effect in order to see if companies were more satisfied.

Another limitation of the group's work was the analysis of space allocation. Determining optimal facility flow relied on theoretical figures and practices. In order to get the most accurate results, MBI should utilize the provided Excel based linear programming model to obtain precise percentages for the allocation of rentable and shared space. Furthermore, the group understands that MBI will probably not be able to alter the current allocation at their existing facilities to offer more rentable space. The group merely offered suggestions as to what will yield the most significant profit for the company. MBI might use this analysis and the Excel tool to help decide future facilities for the company.

It is important for MBI to realize that the linear programming model is subject to many constraints. Economically, this model relies on inflated figures from a previously completed 2008 MQP studying MBI. The model will change drastically if any financial fluctuations change the expected revenue and cost values for the company. MBI should make sure to check figures included in the model before utilizing it as these figures are bound to change. Similarly, extreme changes in the regional location will alter the model. The financial figures are based on a MQP studying the financial viability of MBI in the MetroWest area of Massachusetts (Ngo et al., 2008). This means that if MBI were to secure facility locations outside of this region, the model would not be accurate.

Space allocation depends totally on tenant behaviors and operations to be the most successful. Changes within the tenants' social, political, and ethical paradigm will greatly

affect the model. For example, some tenants may not be comfortable with sharing space, so a facility may need to minimize shared space versus the model choice of maximizing shared space. Tenants could be politically or ethically opposed to certain lab procedures, so space would need to be allocated around these constraints to please the tenants. In these cases, the model would not be applicable as it does not account for such issues.

In a life science incubator, health and safety concerns play a large role in the location of specified lab equipment. Changes in health and safety codes may prevent the allocation of certain shared space in relation to non-lab space. These changes may deter the model results from being implemented in the event that they do not satisfy new codes.

The viability of life science incubators is very good in today's economy. This suggests foreseeable profit increasing for companies such as MBI. Greater profit margins advocate for the sustainability of the industry. With increased allies for revenue, MBI could place less significance on the amount of allocated rentable space. This would change the constraints of the linear programming model and alter the results of the model. The model should be reworked in the instance of great economic change.

Overall, the designed linear programming model will be successful for the current MBI market. A reassessment of decision variables and constraints is recommended before use of the model and especially prior to model implementation. While many environmental constraints exist, the model can and should be applied to current MBI facility layout. The provided linear programming model helps to optimize profits with decision variables

allocating percentages of rentable, common, and shared space, and subject to predefined variable ranges.

Developing recommendations for MBI to improve their company and better satisfy their tenants has been a very rewarding experience for the group. The recommendations made to MBI have real potential to boost MBI's already successful performance in the world of incubation. The group succeeded in completing this project by accomplishing predetermined goals as outlined in the Introduction Chapter. We believe the research and survey results have truly allowed the group to make an impact on Massachusetts Biomedical Initiatives both by helping staff understand the current satisfaction of tenants and techniques to increase satisfaction over time.

Chapter 7: Reflection on Industrial Engineering Design

The following chapter details the design component of this Major Qualifying Project as related to the study of Industrial Engineering (IE). The chapter will outline the designed space allocation model and discusses potential environmental and implemental constraints. Much of the material discussed in the following chapter repeats material presented earlier in the report. The purpose of this chapter is to explain the methodology, results, and analysis of the proposed linear programming model in order to show sufficient completion for the WPI IE design component.

7.1 DESIGN IDENTIFICATION AND PROCESS DESIGN

To fulfill the design component of my Major Qualifying Project for Industrial Engineering, I developed a linear programming model to determine the optimal space allocation for Massachusetts Biomedical Initiatives (MBI) facilities. My project group worked with Kevin O'Sullivan, the President and CEO of MBI, to analyze the strategic vision of the company and the success of the company's Scope of Services as perceived by prospective tenants, current tenants, past tenants, and successful graduate companies. A main area of focus was determining the tenant paradigm concerning current facility layout and providing an optimized space allocation model for potential implementation in future acquired facilities.

The main objective was to optimize space allocation in order to maximize profit and respond to tenant needs. The first step in allocating space was to properly define the model

space based on survey results, MBI concerns, and background literature. The objective function for this model is to maximize annual profit. It is more accurate to describe this as an optimization model rather than a maximization model due to the given constraints. The decision variables which change to reflect change in profit in this model are the allocated percentages of rentable, common, and shared space in each facility. Constraints for this model include the acceptable variable ranges as defined in the table below and the sum of all allocated percentages must sum to 100%. The results can be summarized in the second table below.

Previously Cited as Table 194. Acceptable Decision Variable Ranges

Description	Minimum Value	Maximum Value	Base Case Average Value
Total Rentable Area	55%	100%	62%
Lab Space	40%	80%	50%
Office Space	5%	25%	13%
Shared Space	5%	25%	13%
Common Area	10%	30%	18%
Building Common Area	5%	25%	10%

Previously Cited as Table 1520. Linear Programming Model Space Definition

	Title	Description
Objective Function	*OPTIMIZE* Total Expected Profit	Total Profit of MBI based on the theoretical values entered in Cost and Revenue calculations.
Decision Variables	Total Rentable Area	The amount of allocated rentable area.
	Total Common Area	The amount of allocated common area.
	Total Shared Area	The amount of allocated shared area.
Constraints	Percentage of Allocated Rentable Area	The optimal total amount of allocated rentable area must be between a user-defined minimum and maximum percentages.
	Percentage of Allocated Common Area	The optimal total amount of allocated common area must be between a user-defined minimum and maximum percentages.
	Percentage of Allocated Shared Area	The optimal total amount of allocated shared area must be between a user-defined minimum and maximum percentages.
	Sum of All Allocated Percentages	The sum of all percentages for a given facility must be equal to 100%.

It was important for the project group to verify the assumptions of linear programming before performing linear programming model analysis. The first assumption of model linearity is confirmed by testing changes in the decision variables in the developed

spreadsheet. Changing the value of allocated rentable space alters the resulting profit value without changing other decision variable values. The second assumption of decision variable divisibility is proved because the resulting decision variable amounts are in terms of percentage, not an integer. The third assumption of model certainty is tested in the 2008 MQP analyzing the financial viability of MBI. MBI is thriving and in the event that the company seeks new facility locations, this model can be used to predict the optimal space allocation. Finally, the fourth assumption of available data is covered by the aforementioned MQP as well as company provided information about facility design. Furthermore, there exists much literature regarding linear programming as well as space allocation models that can be used in the model.

The model was first analyzed to see the effects of sensitivity analysis in terms of annual profit potential. Results from the sensitivity analysis suggest that adding more rentable space will create the greatest profit margins. This makes sense because rentable space is the main income source for MBI. Increasing revenue will ultimately increase profit margins. The sensitivity analysis is useful in showing the numerical effect of incremental changes in the percentages of rentable, common, and shared space in the MBI facility. *Risk Solver* software plotted a graph, which summarize these changes in net profit.

Additional modeling was completed in order to determine the best allocation of space based on given constraints and utilizing Excel's *Solver* Platform. The defined model space is included in previous table. The purpose of *Solver* is to define optimal percentages for total allocated rentable and shared space as to maximize profit while staying within defined

constraint ranges. The constraints were entered into the *Solver* Add-In and the model was optimized.

For this model, Solver resulted in a space allocation plan very similar to the current model. The project group optimized the allocation for current facilities as well as the average allocation for use in future facility obtainment. *Solver* optimized profit by allocating 64% rentable space to Barber Ave and 62% for Biotech 3 and Gateway respectfully. The amount of shared space was optimized at 13%, 7%, and 8% for Barber Ave, Biotech 3, and Gateway respectfully. The average resulting values for the decision variables are the optimal values for future MBI facilities. The optimal average percentages are as follows: 71% rentable space, 10% common space, and 19% shared space. The summarized results of the space allocation model are shown in the table below.

Previously Cited as Table 16. Summarized *Solver* Results for Optimized Space Allocation

	Rentable Space	**Common Space**	**Shared Space**
Current MBI Facility Average	63%	In: 18% Out: 14%	10%
Optimal Range	60-80 %	5-25%	5-20%
Optimal Average	71%	10%	19%

Designing a facility layout that can withstand constant tenant change is a difficult task. As the research proposes, an effective layout is handpicked for those utilizing it and MBI will have to review and implement any facility changes in their environment with their current tenants. MBI will be responsible for testing this model in their facility setting. Furthermore, the company will be asked to evaluate the model based on the actual profit margins observed when following the optimized allocation.

In terms of facility design, the group recommends that MBI continue utilizing the observed space allocation in current facilities. The current allocation is successful as proved by the literature review and the opinions of current and prospective tenants. Based on the results from the *Solver* optimization, the ideal amount of rentable space is between 60% - 80%. The group understands that it would be difficult, if not impossible, to redistribute the current allocations for the three existing facilities. Luckily for MBI, the three facilities allocate this optimal amount of rentable space currently. In the event that MBI seek an additional facility location, the company should look for a facility where the amount of rentable space is maximized around 71%.

To improve facility flow at the existing locations, MBI might consider maximizing open, collaborative space. This means creating additional storage in shared space, introducing wall shelving instead of tables or counter space, and increasing cooperative activity among tenants. In addition to increasing productivity, this will create a more organized flow to the facility in general. The *Solver* optimization set the allocation of common space at 10% and the shared space at 19%. The optimization model suggests that allocating more shared space than common space is profitable. In relation to incubation best

practices, this will also enhance business by increasing partnership and productivity among tenants.

Potential improvement areas for MBI's facility flow include maximizing open space, allocating more rentable space, and highlighting specific travel paths around the facility. MBI should focus and making sure shared space is managed correctly, scheduled for use if necessary, and cleaned on a regular basis. Through this, MBI should make sure to use wall space, cabinets, and shelving to keep everything up and away from the center of the room. Increasing space to move will increase the potential for collaboration among the tenants utilizing the space.

MBI could improve flow around the three facilities by teaching tenants the most efficient travel paths around the space. The project group noticed that tours of the facility often left hallways cramped and doorways crowded. If MBI were to post facility layout designs with highlighted travel paths to and from highly congested areas (bathroom, shared kitchen space, shared lab space), it would increase the speed at which people moved around and decrease the potential corridor collisions that may happen. Furthermore, these paths should indicate the correct areas to enter and leave each room so that tenants can avoid cramming between labs.

Finally, the project group recommends that MBI utilize the provided linear programming model to forecast annual profit based on the amounts of space allocated in the future. By entering a few input parameters into the model, a user will be able to determine profit. The user of the model can experiment by changing the percentage of rentable space,

shared space, and overall space of a facility. This model will be useful in the event that MBI is looking to acquire another or an alternative facility for the business.

7.2 POTENTIAL ALTERNATIVES AND MODEL CONSTRAINTS

Maximizing open space, encouraging collaborative efforts, optimizing space around tenant behaviors can improve the overall flow of the facility in addition to effective space allocation and efficient facility flow. Every company will have independent views on the importance of and amount of required rentable, common, and shared space in their facility. Incubators that operate under a common research idea, like MBI, would benefit from using both common and shared space whereas others may not. It is crucial to maintain a balance between independent and shared space for a successful environment while allotting facility area. Outlined below are three various techniques for allocating space effectively.

In recent years, Massachusetts General Hospital has developed a research space management group to help allocate space on their facilities most effectively. The space distribution method was based off of four key decision components: "program quality, mission-relatedness, demonstrated need, and availability of sponsored research support" (MGH). The most important step in determining effective space allotment is to calculate utilization densities of all parties. Utilization density is a measure of how efficiently an incubated organization will operate in and succeed from the allotted facility space and is determined based on the number of employees, suggested space estimates and expected

costs (MGH). The group runs by the idea that no space is permanent and research facilities should be able to move space around on a whim.

For some companies, utilization density may depend on other factors such as expected annual profit. In a study by Libecap et al., a space allocation method is described which relies on net profit margins from previous fiscal years to determine utilization density. For example, incubated companies that receive high profit margins are offered more space or access to different space in the incubator facility as a pseudo reward. Using space allocation as a reward increases overall productivity by introducing a friendly level of competition. Incubated companies feel as though they need to do better in order to keep their space and studies find that these companies usually do increase profitability of the entire incubator facility when using this utilization density method (Libecap et al.).

A third option in designing an effective facility layout is to create a mathematical model based on the desired allocation of space and the average annual profit. Mathematical models made through spreadsheets provide the most effective analysis of business situations (Powell). Average annual profit of a facility can be calculated by subtracting the rental cost of the overall facility from the revenue gained by renting out lab space, office space or cubicles, and shared space. Spreadsheet models have the ability to show the effect of a changing variable, such as allocated space percentage, on annual profit.

The group chose to look deeper into a linear programming model for the type of mathematical model. While the applications of mathematical models are infinite, there are four major varieties of linear programming models: allocation, covering, blending, and

network models. Allocation models optimize (usually maximize) an objective function based on less-than capacity constraints. Covering models minimize an objective function based on greater-than coverage constraints. Blending models optimize an objective function subject to a combination of less-than capacity constraints and greater-than coverage constraints. Finally, a network model is the most complex mathematical model. A networked model relies on a series of interconnected nodes and arcs to denote flow patterns to analyze the objective function (Powell). For the purposes of this project, the group will focus on an allocation based linear programming model.

A linear programming model focused on allocation optimizes a specific objective function by changing decision variables according to predetermined constraints and assumptions. Before a linear model could be implemented, the model conditions had to be defined. In the case of optimizing profit, the linear programming objective function would be to maximize profits. Decision variables include variable parameter values that effect the optimization of the objective function such as percentage of allocated space. Constraints involve problem specific values that control the results of the objective function. An example of a constraint would be a defined range for allocated percentages (Powell).

All linear programming models follow four main assumptions. The first assumption requires the model to be linear. Model linearity indicates that the resulting objective function values are proportional to constraint values. Furthermore, linearity suggests that objective function values and constraints are additive and changing a single constraint will have no effect on another constraint. The second assumption specifies that the values for decision variables are divisible and can be fractional amounts. Models that require integer

values for decision variables utilize a technique known as Integer Programming. The third assumption entails that the model has a definitive amount of certainty. Thus, the implemented model should produce results very similar to the values actually observed. Finally, the last assumption requires accurate enough data in a large enough amount to substantiate the model (psu.edu).

Microsoft Excel provides many useful tools for linear programming analysis that the project group will use in order to optimize the space allocation for MBI facilities. Features such as the Scenario Manager and the CHOOSE function allow Excel to examine the annual profit over a range of allocation percentages. This will be useful to show MBI the change in profit if they allocate ten more percent lab spaces and detract five percent cubicle space. Excel also includes a *Risk Solver* software package that will show variable ranges for decision variables and corresponding objective function values. Additionally, Excel offers a built data tool called *Solver* that will perform a linear programming analysis to optimize an objective function based on decision variables and established constraints (Powell). *Solver* will be very useful in reporting the optimal percentages of allocated space for MBI.

In order to optimally allocate space, the project group needs to utilize a specific distribution model. The model relied on current MBI facility layouts, the behavior and operations of tenants, the perceived success of the current layout as determined from tenant survey responses, and MBI developed constraints regarding acceptable allocation percentages. This information will provide an optimal space allocation to be used by MBI in future facility division.

The linear programming model is subject to many constraints. Economically, this model relies on inflated d from a previously completed 2008 MQP studying MBI. These figures are estimates. The model will change drastically if any financial fluctuations change the revenue and cost values for the company. MBI should make sure to check figures included in the model before utilizing it as these figures are bound to change. Similarly, extreme changes in location will alter the model. The financial figures are based on a MQP studying the financial viability of MBI in the MetroWest area of Massachusetts. This means that if MBI were to secure facility locations outside of this region, the model would not be accurate.

Space allocation depends totally on tenant behaviors and operations to be the most successful. Changes within the tenants' social, political, and ethical paradigm will greatly affect the model. For example, some tenants may not be comfortable with sharing space, so a facility may need to minimize shared space versus the model choice of maximizing shared space. Tenants could be politically or ethically opposed to certain lab procedures, so space would need to be allocated around these constraints to please the tenants. In these cases, the model would not be applicable as it does not exactly address these issues.

In a life science incubator, health and safety concerns play a large role in the location of specified lab equipment. Changes in health and safety codes may prevent the allocation of certain shared space in relation to non-lab space. These changes may deter the model results from being implemented in the event that they do not satisfy new codes.

The viability of life science incubators is very good in today's economy suggesting foreseeable profit increasing for companies such as MBI. Greater profit margins advocate for the sustainability of the industry. With increased allies for revenue, MBI could place less significance on the amount of allocated rentable space. This would change the constraints of the linear programming model and alter the results of the model. The model should be reworked in the instance of great economic change.

Overall, the designed linear programming model will be successful for the current MBI market. A reassessment of decision variables and constraints is recommended before use of the model and especially prior to model implementation. While many environmental constraints exist, the model can and should be applied to current MBI facility layout. The provided linear programming model helps to optimize profits with decision variables allocating percentages of rentable, common, and shared space, and subject to predefined variable ranges.

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Appendices

APPENDIX A: MBI SCOPE OF SERVICES

Massachusetts Biotechnology Initiatives

Strategic Vision Plan (2011-2014)

Scope of Services, March 29, 2011

(Draft for Review)

Theme	Objective	Tactics	Metrics	Priority	Owner	Status
1. Continue to Actively Facilitate Success	A. Identify and attract entrepreneurial scientists and emerging companies, keeping existing criteria for incubation	a. Target academic/science/ commercial institutions to identify scientists doing research & development with potential life science company and job development relevance to MBI. Track inquiries on a monthly basis from the following sources: (i) Phone inquiries (ii) Email inquiries (iii) Web site hits	• Document inquiries and establish a spreadsheet & trend charts. • Document life science companies established both within MBI incubator as well as outside with MBI assistance. • Document number of life science jobs created	I	MBI Staff (Admin & Operations)	Yearly statistic documented ongoing.
		b. Identify regions from which biomedical companies are leaving or can be recruited to Massachusetts & Worcester	• Establish database and outreach to contacts • Annual increase in inquiries = 5% per year	I	MBI Staff (Admin & Operations)	Yearly statistics documented ongoing.
		c. Institute a Web Site based Marketing Plan (i) Disseminate information about MBI through personal and professional groups, contacts, publications & MBI web page to recruit potential biomedical entrepreneurs	• Marketing plan under review to reflect possible growth of new facility(s) sites.	I	MBI Staff (Admin)	Survey and study underway.

	B. Mentor start-up firms, and provide partnership opportunities	a. Emphasize opportunities for developing new resources & providing services to existing companies as well as help in bringing new products to market (i) All tenants in the incubator should be interviewed in accordance with the following schedule: 1. Entrance 2. Every 6-12 months 3. Exit	• Measure tenant satisfaction = Tenant's view MBI staff and facilities as responsive and caring.	I	MBI Staff (Admin, Facilities, Operations, Health & Safety)	Interviews completed, important feedback extracted & recorded in database. Report of findings underway.
		b. Offer advice to entrepreneurs as to how to develop sound business & scientific plans; provide advice in ensuring proper balance of expertise in both science & business.	• Build upon prospect tenant recruitment listings.	I	MBI Staff (Admin)	Referrals ongoing. to consultant based expertise such as MassDevelopment, WPI Venture Forum, etc.
		c. Offer workshops on identifying potential sources of funding and writing grants	• Workshop(s) design and offer in partnership with outside resource institutions.	I	MBI Staff (Admin, Operations)	Ongoing yearly list compiled with workshop collaborators and co-sponsors.
		d. Offer assistance in identification recruitment of technical staff	• Measure number of referrals, interviews and hires	I	MBI Staff (Admin)	Ongoing.yearly list compiled
	C. Offer affordable incubator facilities, support for incubated companies, and expansion/ relocation advice	a. Provide new physical resources at Gateway Park. Explore possible transition out of Biotech 3 facility. Develop additional partnerships for rentable wet lab space.	• Space provided (# square feet) • # of tenant companies • # of tenant graduates • Document demand for wet lab space	I	MBI Staff (Admin, Facilities, Operations)	Ongoing due diligence study of all regional affordable and available lab space to meet MBI growing need.
		b. Accommodate tenant expansion, move out, and occupancy into new wet lab facilities and operations.	• Support provided vs. number of tenant leases.	I	MBI Staff (Admin, Operations, Facilities, H&S)	Support systems established with ongoing advice to mature tenant companies labs expansion needs.

		c. Provide necessary permits that ensure compliance with health and safety regulations	• Number of Health & Safety permits issued as a prerequisite of occupancy • Number of Health & Safety updates/reviews & reports issued	I	MBI Staff (Admin, H&S)	Health & Safety permitting/licensing/advice and training ongoing as part of MBI tenancy.
		d. Provide referrals to appropriate regulatory agencies for development of new products	• Number of referrals vs. new products developed	II	MBI Staff (Admin)	Attendance at MassBio & MassMEDIC related regulatory meetings.
	D. Increase efforts to enhance awareness of MBI and its reputation, domestically and internationally	a. Continue building upon established partnerships with MassBio, Mass Life Sciences Center, Bio, MassMEDIC, NBIA, etc.	• Number of companies attracted outside MA & USA	I	MBI Staff (Admin)	Attend partner meetings, symposiums, and conferences where appropriate.
	E. Work to build the MBI brand throughout the life sciences corridor	i. Enhance and promote company success stories	• Track media coverage & company progress & news reports	I	MBI Staff (Admin)	Ongoing Complied and shared with Board of Trustees.
		i. Heighten function and visibility as a convener	• Document and promote affiliated partnerships	I	MBI Staff (Admin)	Ongoing Complied and shared with Board of Trustees.
	F. Create and sustain personal and institutional connections to critical resources	a. Cooperate with but do not duplicate existing efforts such as the WPI Venture Forum, MassBio, Mass Life Sciences Center Services and Programs.	• Offer MBI support, referral assistance, and active involvement where needed	II	MBI Staff (Admin)	Ongoing team effort. Documented relationships in good standing.

		b. Maintain links to key academic, government, and industry leaders	• Maintain ongoing & updated key contacts list	I	MBI Staff (Admin)	Key community contact leadership list established with ongoing communications linkages.
		c. Play a supporting role with existing tech transfer operations within the network	• Continue to support existing tech transfer operations such as WPI, UMass, Tufts, Clark University, etc.	II	MBI Staff (Admin)	Referrals ongoing.
		d. Advocate for MBI and life sciences industry as necessary, in media, community, and government settings.	• Provide relevant information on MBI and tenant companies to media outlets on a regular basis	I	MBI Staff (Admin)	Serve as ongoing life science media "ombudsman"
		e. Consider active partnerships with companies pursuing external grants, also offering referrals and consultation on grant processes (e.g. SBIR)	• Advertise & co-sponsor related workshops for tenant companies	I	MBI Staff (Admin)	Ongoing promotion documented.
	G. Ensure ongoing financial viability of MBI	a. Increase rentals where possible based upon regional market trends and occupancy rates	• Gross dollar per square foot analysis of three incubator facilities as Business Units. • Maintain increased percent of occupancy • Decrease percent of time a lab is unoccupied • Rental increases of 2.5% per year where possible	I	MBI Staff (Admin, Finance, Facilities)	Highly proficient based on 2010 % of occupancy rates and turnover time.
		b. Equity in client companies	• 1% Equity established (where feasible)	I	MBI Staff (Admin & Finance)	Ongoing
		c. Other Income: Service fees, etc.	• % of outside income increase • Establish service fee based system	I	MBI Staff (Admin, Finance, Facilities)	Service and rental fee schedule review underway.

Theme	Objective	Tactics	Metrics	Priority	Owner	Status
2. Re-Evaluate Incubator Locations	A. Assess cost/benefit of laboperational activity in the City of Worcester	a. Seek out all lower cost lab space availability within city	• Survey city & regional lab rental, CAM, and occupancy rates	I	MBI Staff (Admin, Facilities)	Underway.
	B. Consider adding affordable incubator space	a. Explore possible university and other affiliations (UMass Medical School, Tufts Veterinary School, Clark University, WBDC, etc.)	• List available properties, time frames & availability	I	MBI Staff (Admin, Operations, Facilities)	Discussions underway.
		b. Evaluate the 495 belt for real estate opportunities	• Survey city & regional lab rental, CAM and occupancy rates	II	MBI Staff (Admin & Operations)	Survey underway.
		c. Determine availability and desirability of space for science-related labs, offices, and light manufacturing	• Survey city & regional lab rental and CAM rates	I	MBI Staff (Admin & Operations)	Survey underway.
		d. Assess proximity to corporate resources (pharmaceutical and medical device companies)	• Establish life science (pharma recruitment) working group	I	MBI Staff (Admin, Board of Trustees)	Discussions and membership considerations underway.
		e. Maintain relationships with potential future partners state-wide, particularly to the west	• Continue discussions with PVLSI, NSTC, UMass Boston, etc.	I	MBI Staff (Admin)	Continue to explore. Financial considerations a major hindrance.
	C. Investigate funding options	a. Determine availability of university and other possible supported space subsidies	• Document solicited partnerships and outcome report	I	MBI Staff (Admin)	Discussions underway.
		b. Review endowment expenditure policy, to determine if it should be used to invest in growth and/or support ongoing incubator facility operations	• Investment & Audit Committee review	I	MBI Staff (Admin, Invest/Audit & Executive Committees)	Regular committee meeting agenda discussions.

		c. Seek state and federal funds (i) Increase advocacy for state funding, keeping in mind the current fiscal climate. (ii) Investigate innovative funding arrangements in other states, countries.	• Explore public and private funding collaborations	I	MBI Staff (Admin)	Continued advocacy underway.

Theme	Objective	Tactics	Metrics	Priority	Owner	Status
3. Selectively Broaden the Cluster	A. Explore involvement in new technologies (bio-fuels as one example) that have a kinship to existing biomedical laboratory incubation operations and/or to health care mission.	a. Be cognizant of new expertise and connections needed for new technologies; plan to attain such knowledge	• Support and participate where appropriate in local & statewide efforts such as Institute for Energy Sustainability	I	MBI Staff (Admin & Operations)	Presentations made and discussions ongoing.
		b. Determine what percentage of MBI efforts to be spent on new technologies vs. existing biomedical	• Document time frame of existing biomedical incubator support system	II	MBI Staff (Admin, Operations, MBI Executive Com., Board of Trustees)	Presentations made and discussions ongoing.
	B. Further pursue initiatives related to E-health outcomes	a. Computing resources and data mining/information management	• Explore partnerships in E-Health • Offer outsource bioinformatics services	I	MBI Staff (Admin & Operations)	Feasibility study underway.
	C. Assess extent to which hospitals in the	a. Further establishment of Hospital Resource Collaborations with MBI	• List key hospital resources and pertinent personnel support	I	MBI Staff (Admin & Operations)	Ongoing discussions.

	biomedical cluster may require non-lab support and/or services					

Theme	Objective	Tactics	Metrics	Priority	Owner	Status
4. Respond to Changing Industry Dynamics	A. Investigate expansion into energy and environmental technologies, in conjunction with ongoing local efforts like the Institute for Energy and Sustainability	a. Market research on local, regional and statewide efforts	• National research accumulated. Statewide cluster efforts established. Document need in Central Massachusetts.	II	MBI Staff (Admin, Operations, MBI Executive Com, Board of Trustees)	Outcome unsure at the present.
		b. Create list of comparable biomedical incubators (i) State (ii) University (iii) Private	• Database establish with comparable data vs. MBI operations	II	MBI Staff (Admin & Operations)	Comparative review study with NBIA affiliated membership incubators completed.
		c. Develop biomedical working group to share and support innovative incubator facility ideas	• Working group establishment with ongoing recommendations to the Board	II	MBI Staff (Admin & Operations, Executive Com., Board of Trustees)	Discussions underway.
	B. Increase outreach and create regular opportunities to connect with newest sources of innovation	a. Focus on large pharmaceutical firms	• Establish Life Science Pharma Recruitment Working Group	I	MBI Staff (Admin, Board of Trustees)	Discussions underway.
		b. Consider relationships with hospitals and disease foundations	• Search out possible affiliations	I	MBI Staff (Admin)	Exploring at the present.

	C. Establish stronger linkages with venture capital (VC)	a. Match prospective companies with specific VC fund opportunities	• Connect MBI tenant companies with VC funding opportunities where feasible.	I	MBI Staff (Admin)	Underway.
		b. Increase VC awareness of industry activity beyond Boston/Cambridge	• Continue outreach efforts to educate VC community to MBI tenant companies.	I	MBI Staff (Admin)	Underway.
	D. Continue to monitor global developments	a. In terms of supply of scientists, ideas, and incubation and CRO sites and demand for new product testing, business service provision, markets for new products	• Highlight MBI company expertise for service and new product development outsourcing.	I	MBI Staff (Admin & Operations)	Ongoing.
		b. Strengthen local sourcing awareness and opportunities (in contrast to outsourcing)	• Highlight MBI company expertise for service and new product development outsourcing.	I	MBI Staff (Admin & Operations)	Ongoing.
	E. Modify incubation model, explicitly offering:	a. Shared services as well as shared space, responding to virtual incubation	• Document via web site and email	I	MBI Staff (Admin, Operations, Facilities)	Review underway
		b. Partial incubation, and virtual service-provision (e.g. current clients there for two months only)	• Review current 1 year tenant occupancy requirement	II	MBI Staff (Admin, Operations, Facilities)	Smaller lease terms established where feasible.
		c. To do this, supportive services should be catalogued and made available to existing and future companies	• Increase awareness of shared services offerings	II	MBI Staff (Admin, Operations, Facilities)	Underway via web site.

	F. Enhance industry awareness that MBI companies are increasingly service/contract research companies (i.e. less product-oriented) and develop this service profile	a. Publicize wide array of MBI company service/contract research offerings	• Increase awareness of shared services offerings	I	MBI Staff (Admin)	Underway via web site.
	G. Investigate models for enhancing the management/business expertise in the life sciences	a. Create opportunities for active business mentoring	• Document specific needs and specific requests.	II	MBI Staff (Admin)	Ongoing.
		b. Leverage the knowledge of the stable of entrepreneurs MBI has assisted over past 20 years	• Continue to expand networking opportunities for past, present and future incubator entrepreneurs	II	MBI Staff (Admin)	Collaboration with appropriate network opportunities ongoing.
		c. Enhance connections to the Small Business Development Center (SBDC)	• Broadly promote and refer to client companies	I	MBI Staff (Admin)	Ongoing client company SBDC communication.
		d. Continue to encourage Small Business Innovative Research (SBIR) funding	• Broadly promote and refer to client companies	I	MBI Staff (Admin)	Ongoing client referrals.

Theme	Objective	Tactics	Metrics	Priority	Oer	Status
5. Asses Impact and Outcomes	A. Better understand the factors that result in firms becoming "winners"	a. Research the outcomes/whereabouts of the 85% of prospect companies that never make it to incubation	• Survey MBI prospect list	II	MBI Staff (Admin)	WPI/MQP project underway
		a. Follow up with unsuccessful post-incubation companies (i) Determine their next steps and learn if MBI could have done anything differently (ii) Assist in recycling assets, cataloguing material and equipment available to new entrants	• Survey MBI prospect list • Document yearly asset list for prospect and existing companies.	I	MBI Staff (Admin, Facilities)	WPI/MQP project underway.
	B. Document and provide evidence for the region's strong track record of collaboration	1) Research and publicize established collaborative partnership(s)	• Build ongoing listing of established collaborations	I	MBI Staff (Admin)	Ongoing.
	C. Renew connections to the National Incubator Association and assess MBI in light of other life sciences incubators in the US.	1) Attend Incubator Manager's conferences and meetings where appropriate	• Select at regular meeting(s) which most benefits MBI operations	II	MBI Staff (Admin)	Ongoing.

APPENDIX B: SPACE ALLOCATION FOR MBI FACILITIES

CURRENT ALLOCATION

Summary of Current Allocation

	Facility	Rentable Area		MBI Common Area		Building Common Area		Shared Area	
	sq. ft.	*sq. ft.*	*%*	*sq. ft.*	*%*	*sq. ft.*	*%*	*sq. ft.*	*%*
Barber Ave	8000	5,120	64%	1,825	23%	n/a	n/a	1,050	13%
Biotech 3	9314	5,961	64%	1,468	16%	1,232	15%	689	7%
Gateway	7518	4,511	60%	1,247	17%	1,154	13%	637	8%
Average	8,277	5,197	63%	1,513	19%	1,193	14%	792	9%
Total	24,832	15,592		4,540		2,386		2,377	

Summary of Current Allocation of Rentable Area

	Total Rentable Area *sq. ft.*	Rentable Area			
		# Labs	*%*	*# Offices / Cubicles*	*%*
Barber Ave	5,125	13	55%	10	12%
Biotech 3	5,925	9	45%	15	19%
Gateway	4,511	14	51%	10	9%
Average	5,187	12	50%	12	13%
Total	15,561	36		35	

PROFIT ESTIMATORS

Summary of Expected Revenue Parameters

	Rentable Area *(per sq. ft.)*			Shared Area	Total Revenue	*2007 Estimates*
	Total	*Labs*	*Offices / Cubes*	***(per sq.ft)***		
Barber Ave	$40.00	$40.00	$40.00	$0.00	**$204,800.00**	*$172,864.00*
Biotech 3	$55.00	$55.00	$55.00	$15.00	**$338,191.34**	*$291,729.00*
Gateway	$45.00	$45.00	$45.00	$15.00	**$212,537.62**	*$115,178.00*
Average	$46.67	$46.67	$46.67	$10.00	**$251,842.99**	*$193,257.00*
Total	$140.00	$140.00	$140.00	$30.00	**$755,528.96**	*$579,771.00*
Minimum %	*55%*	*40%*	*5%*	*5%*		
Maximum %	*95%*	*80%*	*25%*	*25%*		

Summary of Expected Cost Parameters

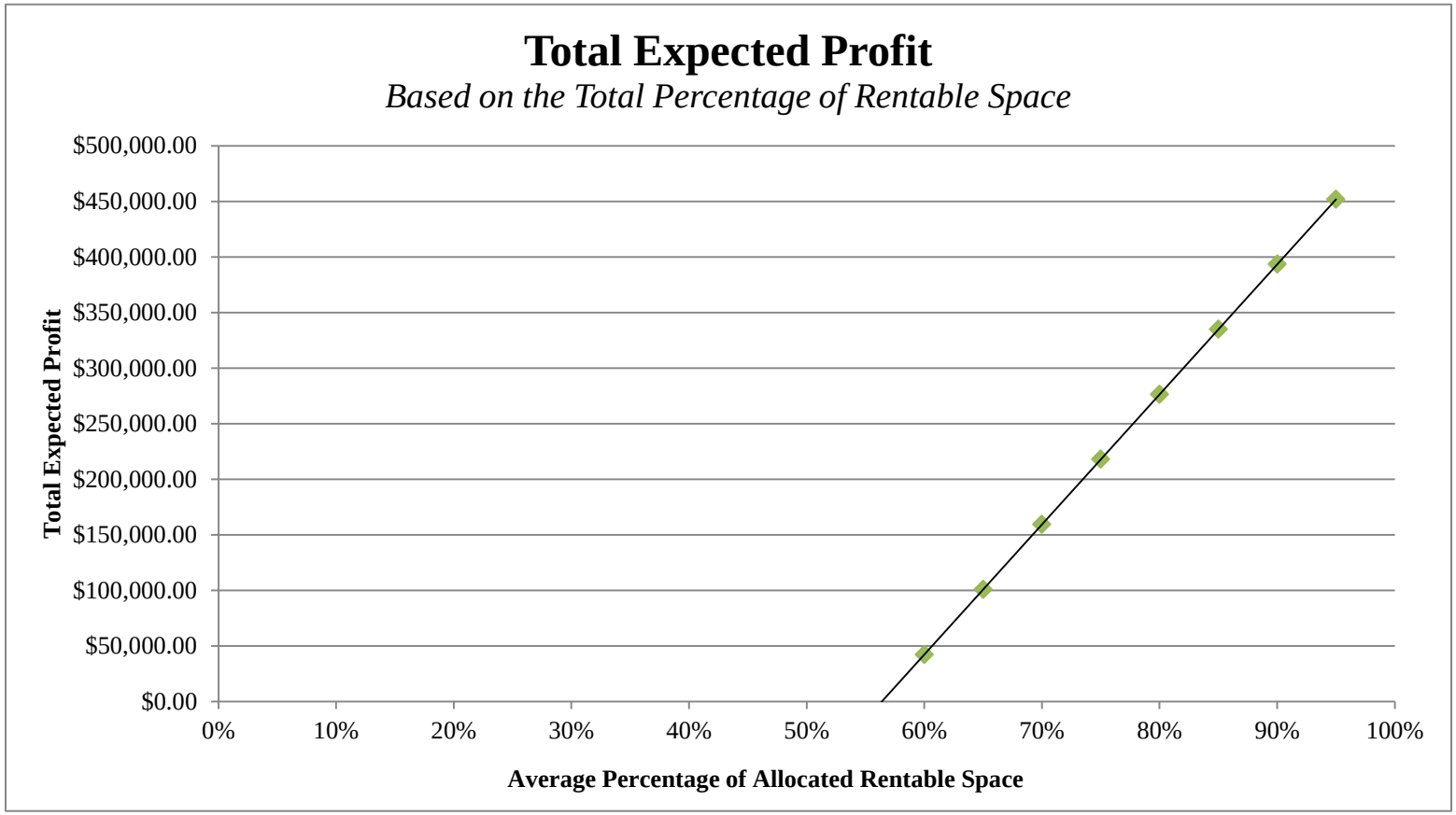
	Total Operating Costs	*2007 Estimates*
Barber Ave	**$180,000.00**	*$163,559.00*
Biotech 3	**$300,000.00**	*$290,531.00*
Gateway	**$200,000.00**	*$186,799.00*
Average	**$226,666.67**	*$213,629.67*
Total	**$680,000.00**	*$640,889.00*

Summary of Expected Profit

	Expected Profits
Barber Ave	**$24,800.00**
Biotech 3	**$38,191.34**
Gateway	**$12,537.62**
Average	**$25,176.32**
Total	**$75,528.96**

RISK SOLVER SENSITIVITY ANALYSIS

Sensitivity Analysis Resulting Graph



OPTIMIZED ALLOCATION

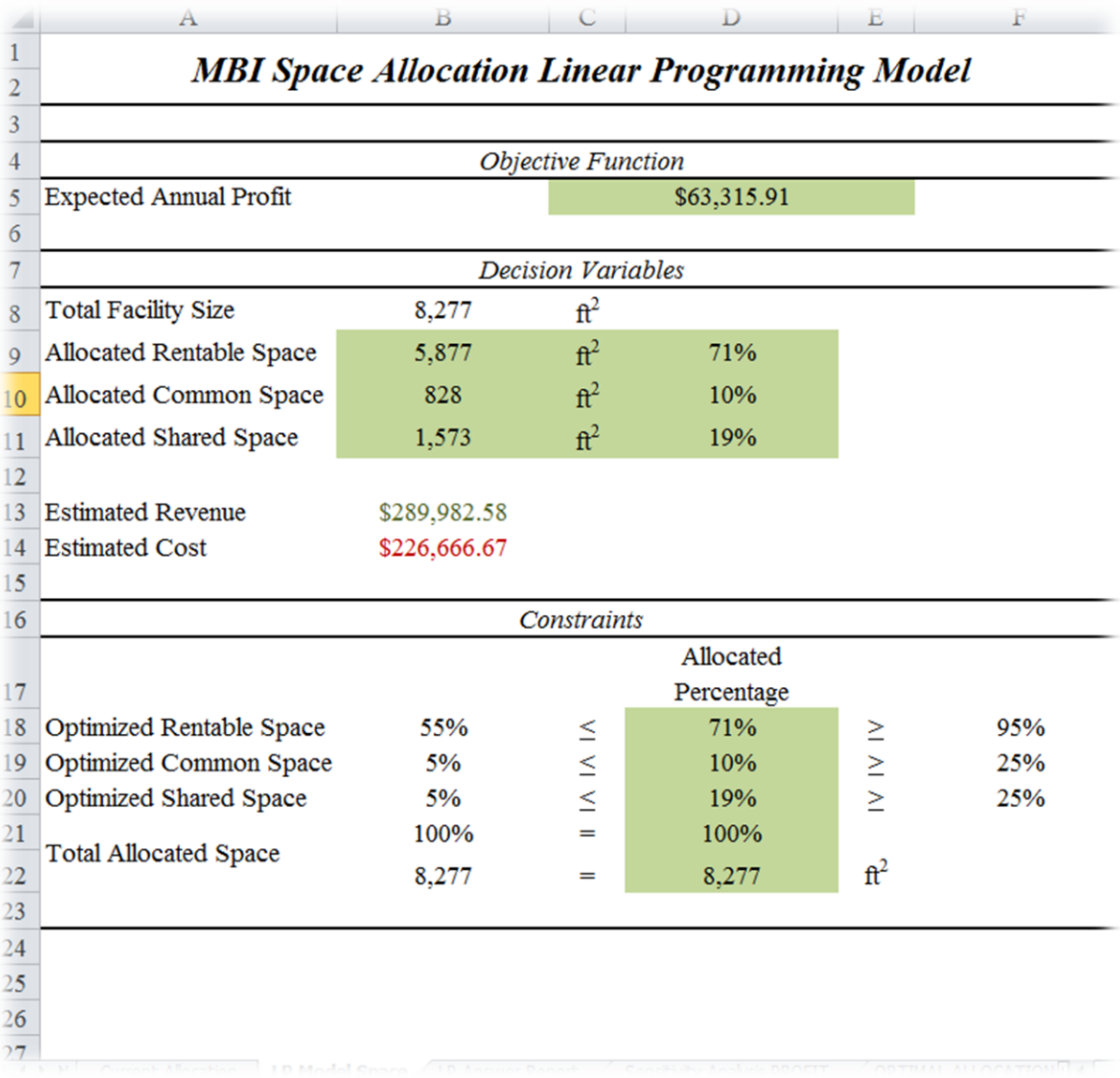
Summary of Optimized Allocation

	Facility	Rentable Area		MBI Common Area		Building Common Area		Shared Area	
	sq. ft.	*sq. ft.*	*%*	*sq. ft.*	*%*	*sq. ft.*	*%*	*sq. ft.*	*%*
Barber Ave	8000	5,125	64%	1,825	23%	n/a	n/a	1,050	13%
Biotech 3	9314	5,806	62%	1,468	16%	1,232	15%	689	7%
Gateway	7518	4,657	62%	1,247	17%	1,154	13%	637	8%
Average	8,277	5,196	63%	1,513	19%	1,193	14%	792	9 %
Total	24,832	15,588		4,540		2,386		2,377	

Summary of Optimized Allocation of Rentable Area

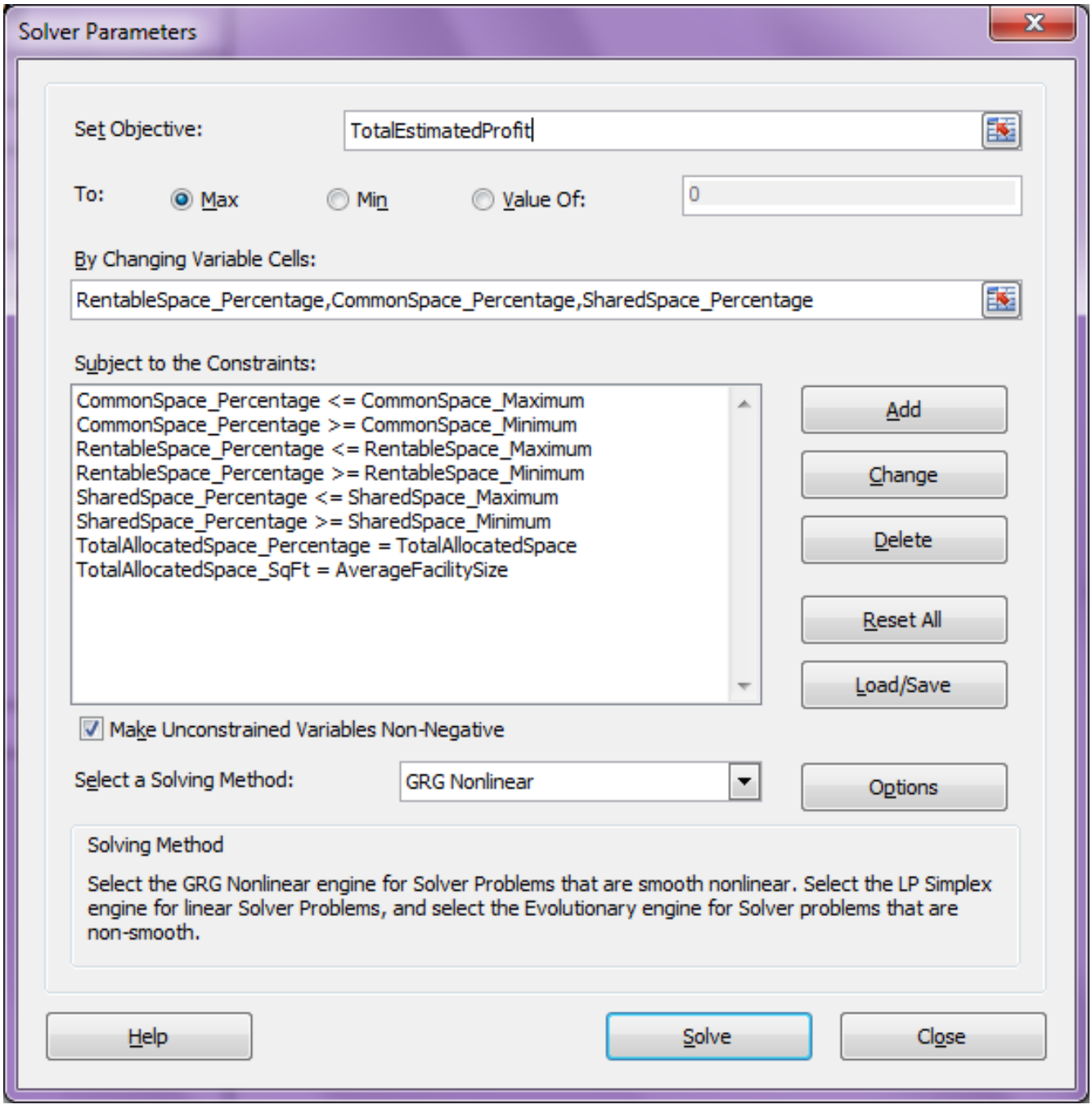
	Total Rentable Area *sq. ft.*	Rentable Area			
		# Labs	*%*	*# Offices / Cubicles*	*%*
Barber Ave	5,125	13	55%	10	12%
Biotech 3	5,925	9	45%	15	19%
Gateway	4,511	14	51%	10	9%
Average	5,187	12	50%	12	13%
Total	15,561	36		35	

Screenshot of Excel Spreadsheet



	A	B	C	D	E	F
1						
2	***MBI Space Allocation Linear Programming Model***					
3						
4	*Objective Function*					
5	Expected Annual Profit			$63,315.91		
6						
7	*Decision Variables*					
8	Total Facility Size	8,277	ft^2			
9	Allocated Rentable Space	5,877	ft^2	71%		
10	Allocated Common Space	828	ft^2	10%		
11	Allocated Shared Space	1,573	ft^2	19%		
12						
13	Estimated Revenue	$289,982.58				
14	Estimated Cost	$226,666.67				
15						
16	*Constraints*					
17				Allocated Percentage		
18	Optimized Rentable Space	55%	≤	71%	≥	95%
19	Optimized Common Space	5%	≤	10%	≥	25%
20	Optimized Shared Space	5%	≤	19%	≥	25%
21	Total Allocated Space	100%	=	100%		
22		8,277	=	8,277	ft^2	
23						
24						
25						
26						
27						

Screenshot of *Solver* Add-In



Screenshot of *Solver* Answer Report for Optimized Model

Microsoft Excel 14.0 Answer Report
Worksheet: [MQP Space Allocation with Sample Data.xlsx]
Report Created: 4/10/2011 11:17:31 AM
Result: Solver found a solution. All Constraints and optimality conditions are satisfied.
Solver Engine
Engine: GRG Nonlinear
Solution Time: 0.951 Seconds.
Solver Options
Max Time Unlimited, Iterations Unlimited, Precision 0.000001, Use Automatic Scaling
Convergence 0.0001, Population Size 100, Random Seed 0, Derivatives Forward, Require Bounds
Max Subproblems Unlimited, Max Integer Sols Unlimited, Integer Tolerance 1%, Assume NonNegative

Objective Cell (Min)

Cell	Name	Original Value	Final Value
C5	TotalEstimatedProfit	$0.00	$63,315.91

Variable Cells

Cell	Name	Original Value	Final Value	Integer
D9	RentableSpace_Percentage	0	71%	Integer
D10	CommonSpace_Percentage	0	10%	Integer
D11	SharedSpace_Percentage	0	19%	Integer

Constraints

Cell	Name	Cell Value	Formula	Status	Slack
B18	RentableSpace_Minimum	55%	B18=>D9	Not Binding	1
F18	RentableSpace_Maximum	95%	D9=>F18	Binding	0
B19	CommonSpace_Minimum	5%	B19=>D10	Not Binding	1
F19	CommonSpace_Maximum	25%	D10=>F19	Binding	0
B20	SharedSpace_Minimum	5%	B20=>D11	Not Binding	1
F20	SharedSpace_Maximum	25%	D11=>F20	Binding	0
D21	TotalAllocatedSpace_Percentage	100%	D21=B21	Binding	0

Current Allocation | LP Model Space | LP Answer Report | Sensitivity Analysis PROFIT | OPTIMAL ALLOCATION

APPENDIX C: MQP DECISION MATRICES

From research and Lynch's MQP, the original Decision Matrix that was created can be seen below followed by a copy of the scoring descriptions shown in Chapter 3 of this report.

	Option #1: Market Research Study	**Option #2**: Start-Up Market Analysis	**Option #3**: Industry Analysis Database	**Option #5**: Drug Delivery	**Option #6**: Stem Cell Delivery
Criteria #1: Interest Level	5	4	4	4	3
Criteria #2: Prior Research / Resources	5	5	4	5	5
Criteria #3: Personal Background	4	4	3	3	3
Criteria #4: Project Potential	5	5	4	4	4
Can we identify a specific need for the project?	5	5	5	5	5
Have similar projects been completed in the past?	5	5	4	5	3
Will our project have a direct impact?	5	5	3	4	4
Are we capable of completing this project?	5	5	5	5	5
Do we have experts willing to help us complete this project?	5	5	3	3	3
Who benefits from this project?	5	5	2	4	4
Total Score	**49**	**48**	**36**	**42**	**39**

Score	1	2	3	4	5
Explanation	Doesn't Meet Expectations Whatsoever	Doesn't Meet Expectations	Almost Meets Expectations	Meets Expectations	Will Exceed Expectations

Once the Decision Matrix was created, the group 'weighed' our questions 0-3, 0 having little importance and 3 having high importance. Once each question is rated, each questions is multiplied by the rate for that question's score in the Decision Matrix. Once again, this gave the group a better understanding of which project to pursue. The matrix including the multiplier is below.

	Rate of Importance (0-3)	**Option #1**: Market Research Study	**Option #2**: Start-Up Market Analysis	**Option #3**: Industry Analysis Database	**Option #5**: Drug Delivery	**Option #6**: Stem Cell Delivery
Criteria #1: Interest Level	**3**	5	4	4	4	3
Criteria #2: Prior Research / Resources	**3**	5	5	4	5	5
Criteria #3: Personal Background	**2**	4	4	3	3	3
Criteria #4: Project Potential	**3**	5	5	4	4	4
Can we identify a specific need for the project?	**0**	5	5	5	5	5
Have similar projects been completed in the past?	**2**	5	5	4	5	3
Will our project have a direct impact?	**3**	5	5	3	4	4
Are we capable of completing this project?	**0**	5	5	5	5	5
Do we have experts willing to help us complete this project?	**3**	5	5	3	3	3
Who benefits from this project?	**3**	5	5	2	4	4
Total Score		**108**	**105**	**74**	**88**	**81**

The third and final stage of Lynch's MQP is the adjustable tool parameters. This stage allows users to adjust the value importance of categories that they believed are most important. This step also allows for thresholds to be set in order to determine if an opportunity will be

unsuccessful and thus given a score of 0. During this step we decided that our personal interest in the topic was exceptionally important and granted interest a rate of 4 instead of 3. Below we show how this changed the final decision matrix.

	Rate of Importance (0-3)	**Option #1**: Market Research Study	**Option #2**: Start-Up Market Analysis	**Option #3**: Industry Analysis Database	**Option #5**: Drug Delivery	**Option #6**: Stem Cell Delivery
Criteria #1: Interest Level	4	5	4	4	4	3
Criteria #2: Prior Research / Resources	3	5	5	4	5	5
Criteria #3: Personal Background	2	4	4	3	3	3
Criteria #4: Project Potential	3	5	5	4	4	4
Can we identify a specific need for the project?	0	5	5	5	5	5
Have similar projects been completed in the past?	2	5	5	4	5	3
Will our project have a direct impact?	3	5	5	3	4	4
Are we capable of completing this project?	0	5	5	5	5	5
Do we have experts willing to help us complete this project?	3	5	5	3	3	3
Who benefits from this project?	3	5	5	2	4	4
Total Score		**113**	**112**	**78**	**92**	**84**

APPENDIX D: MBI TENANT SURVEYS

PROSPECTIVE TENANT SURVEY

Massachusetts Biomedical Initiatives
Incubator Survey

Created By	Kayla Sousa	**Revision Date**	February 10, 2011
Revised By	Dave Arnold, Amanda Eaton, Gina Roffo, Kayla Sousa		
Date of Survey		**Surveyor(s)**	

Company Specific Information			
Name		*[Company Name]*	
Address		*[Company Address]*	
Contact	*[Name]*	*[Email]*	*[Phone Number]*

Current Status		
Prospective Tenant □	Current Tenant □	Past Tenant □

Survey Questions

1. How did you hear about MBI?

Word of Mouth □	Website □	Recommended by □ Affi□iated MBI C□mpany	Other □

If "Other", Please Specify:

2. What specific needs or factors originally attracted you to MBI?
3. Was MBI responsive to initial request to join their facility? If yes, in what specific ways?
4. Was there anything specific that discouraged you from coming to MBI or was there anything that would have caused you to investigate other real estate options?
5. **On a scale of 1 to 5**, rate the level of ease in obtaining needed information from MBI about their facility and application process before making your final decision. Please provide a specific example to help explain your rating.

1	2	3	4	5
Very Difficult	Somewhat Difficult	Neither Difficult Nor Easy	Somewhat Easy	Very Easy

6. Did you find that there were any accommodations MBI lacked? Please explain.
7. **On a scale of 1 to 5,** rate your satisfaction with the layout of MBI's facility?

1	2	3	4	5
Completely Unsatisfied	Unsatisfied	Neutral	Satisfied	Extremely Satisfied

8. Please explain positive and negative aspects of the lab, office, and shared equipment layout of MBI. Were there any layout aspects of the MBI facility that you could suggest should be changed? How so?
9. What suggestions do you have for improvement for MBI and its facility?
10. Are there any other comments about MBI you would like to share with us?

Thank you very much for your time. Your responses will help us improve MBI in the future. Do you mind us contacting you if we have any further questions or need clarification?

CURRENT TENANT AND GRADUATE SURVEY

Massachusetts Biomedical Initiatives
Incubator Survey

Created By	Kayla Sousa	**Revision Date**	February 10, 2011
Revised By	Dave Arnold, Amanda Eaton, Gina Roffo, Kayla Sousa		
Date of Survey		**Surveyor(s)**	

Company Specific Information			
Name		*[Company Name]*	
Address		*[Company Address]*	
Contact	*[Name]*	*[Email]*	*[Phone Number]*

Current Status		
Prospective Tenant □	Current Tenant □	Past Tenant □

Survey Questions

1. How long have you been at MBI or how long were you at MBI?
2. Which MBI Facility is your company located at?
3. How did you hear about MBI?

Word of Mouth □	Website □	Recommended by □ Affiliated MBI Company	Other □

If "Other", Please Specify:

4. What specific needs or factors originally attracted you to MBI?
5. Was MBI responsive to initial request to join their facility? If yes, in what specific ways?
6. Was there anything specific that discouraged you from coming to MBI or was there anything that would have caused you to investigate other real estate options?
7. **On a scale of 1 to 5**, rate the level of ease in obtaining needed information from MBI about their facility and application process before making your final decision. Please provide a specific example to help explain your rating.

1	2	3	4	5
Very Difficult	Somewhat Difficult	Neither Difficult Nor Easy	Somewhat Easy	Very Easy

8. Once in MBI's facility, what did you specifically like best about their accommodations such as: the physical facility, shared services, cost, etc.?
9. Did you find that there were any accommodations MBI lacked? Please explain.
10. **On a scale of 1 to 5,** rate the adequacy of MBI's services and support system while you were part of the facility.

1	2	3	4	5
Completely Inadequate	Somewhat Inadequate	Neither Inadequate Nor Adequate	Adequate	Extremely Adequate

11. **On a scale of 1 to 5,** rate your satisfaction with the layout of MBI's facility?

1	2	3	4	5
Completely Unsatisfied	Unsatisfied	Neutral	Satisfied	Extremely Satisfied

12. Please explain positive and negative aspects of the lab, office, and shared equipment layout of MBI. Were there any layout aspects of the MBI facility that you could suggest should be changed? How so?

13. Approximately how much start-up time did MBI save you?
14. **On a scale of 1 to 5,** rate the amount that MBI helped to grow and enhance your business?

1	2	3	4	5
Weakened Business	No Enhancements To Business	Very Few Enhancements To Business	Moderate Enhancements To Business	Substantial Enhancements To Business

15. What specific services provided by MBI best helped enhance your business? How did those factors enhance your business?
16. Can you explain what your company-desired success metrics entail?
17. How did your company create success metrics? Did MBI play a role in this creation process? Please list specific examples.
18. How is the company performing compared to company-designed success metrics and goals? What role do you feel MBI plays or played in this? Can you list specific examples?
19. **On a scale of 1 to 5,** please rate the overall success of MBI and their facility related to your operation.

1	2	3	4	5
Extremely Unsuccessful	Somewhat Unsuccessful	Neither Unsuccessful Nor Successful	Somewhat Successful	Very Successful

20. Based on your rating, can you provide specific examples of beneficial and/or detrimental aspects of MBI and their facility in your opinion?
21. What suggestions do you have for improvement for MBI and its facility?
22. Are there any other comments about MBI you would like to share with us?

Thank you very much for your time. Your responses will help us improve MBI in the future. Do you mind us contacting you if we have any further questions or need clarification?

APPENDIX E: MBI INTERVIEW SCHEDULE AND COMPLETION TRACKING FORM

Completed and Sorted Alphabetically by Company Type

Company specific information has been removed for confidentiality purposes.

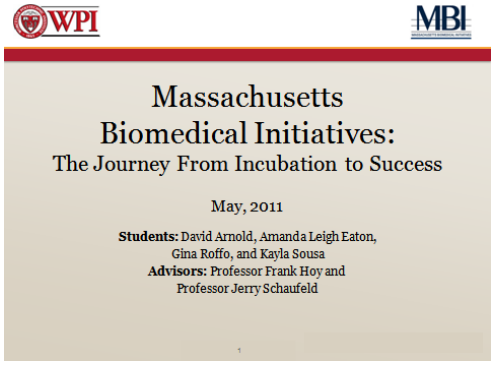
Company Name	Date 1st Contact	Date 2nd Contact	Response Date	Response Type	Survey Date
Current Tenant A	February 17, 2011	March 1, 2011	March 1, 2011	Online	March 2, 2011
Current Tenant B	February 17, 2011	-------	February 22, 2011	Phone	February 22, 2011
Current Tenant C	February 17, 2011	-------	March 4, 2011	Phone	March 4, 2011
Current Tenant D	February 17, 2011	-------	February 17, 2011	Online	March 4, 2011
Current Tenant E	February 17, 2011	-------	February 24, 2011	Phone	February 24, 2011
Current Tenant F	February 17, 2011	-------	February 24, 2011	Online	February 24, 2011
Successful Graduate A	February 17, 2011	March 1, 2011	March 2, 2011	Online	March 2, 2011
Successful Graduate B	February 17, 2011	February 28, 2011	-------	Online	February 28, 2011
Successful Graduate C	February 17, 2011	-------	February 22, 2011	Online	February 22, 2011
Successful Graduate D	February 17, 2011	-------	February 24, 2011	Phone	February 24, 2011
Successful Graduate E	February 17, 2011	February 21, 2011	**-------**	-------	-------
Successful Graduate F	February 17, 2011	March 1, 2011	-------	-------	-------
Successful Graduate G	February 17, 2011	February 22, 2011	-------	-------	-------
Successful Graduate H	February 17, 2011	-------	February 17, 2011	Online	February 17, 2011
Graduate A	February 17, 2011	March 1, 2011	-------	-------	-------
Graduate B	February 17, 2011	March 1, 2011	March 4, 2011	Online	March 4, 2011
Graduate C	February 17, 2011	-------	February 22, 2011	Phone	February 22, 2011
Graduate D	February 17, 2011	-------	February 21, 2011	Phone	February 21, 2011
Prospective Tenant A	February 17, 2011	-------	March 1, 2011	Phone	March 3, 2011
Prospective Tenant B	February 17, 2011	February 22, 2011	February 24, 2011	Phone	February 22, 2011
Prospective Tenant C	February 17, 2011	March 1, 2011	March 1, 2011	Phone	March 1, 2011
Prospective Tenant D	February 17, 2011	-------	February 21, 2011	Online	February 21, 2011
Prospective Tenant E	February 17, 2011	-------	February 17, 2011	Phone	February 17, 2011
Prospective Tenant F	February 17, 2011	March 1, 2011	-------	-------	-------

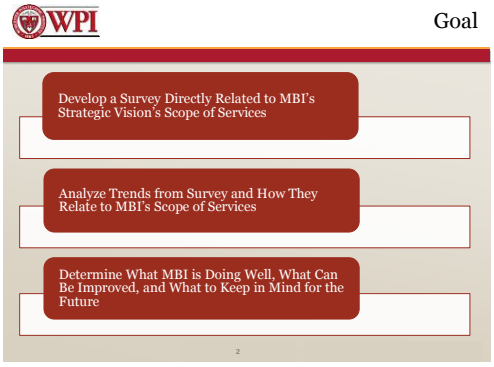
APPENDIX F: EXCEL QUESTIONNAIRE TRACKING SHEET

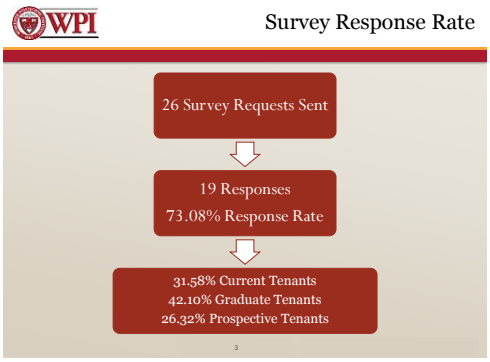
Company specific information has been removed for confidentiality purposes.

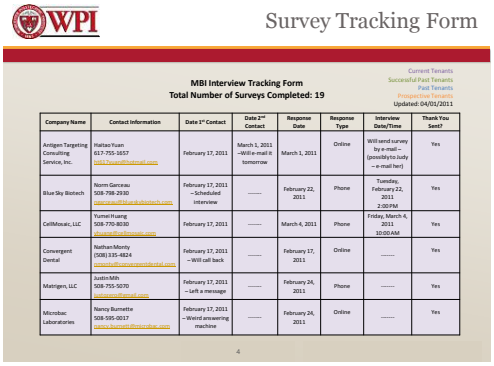
Company Information			Gathering Information on MBI				MBI Accommodations		Outcomes of Using MBI		
Date of Interview	Status	Length of Stay at MBI (In months)	Found Out About MBI Via:	Was MBI Responsive? Yes (1) No (0)	Was Anything Discouraging? Yes (1) No (0)	Ease of Obtaining Data Rating	Support System Rating	Facility Layout Rating	How Much Start-Up Time Saved? (In months)	How much MBI helped with growth Rating	Overall Success of MBI Rating
03/01/11	Current Tenant	24.0	Website	1	0	4	4	4	2.5	3	3
02/22/11	Current Tenant	84.0					5	4			5
03/04/11	Current Tenant	12.0	Website	1	1	4	5	4	6.0	4	4
02/17/11	Current Tenant	4.0	Word of Mouth	1	1	5	5	5		5	5
02/24/11	Current Tenant	5.0	Word of Mouth	1	1	5	5	4	3.0	4	5
02/24/11	Current Tenant	24.0		1	0	5	5	5		4	4
03/02/11	Past Successful Tenant	120.0	Other	1	1		5	4		5	4
02/28/11	Past Successful Tenant	48.0	Other	1	0	5	4	4	6.0	4	4
02/24/11	Past Successful Tenant	114.0		1	1		5	4	6.0	5	5
02/17/11	Past Successful Tenant	17.0	Other	1	0	5	2	3	0.3	4	5
03/04/11	Past Tenant	24.0	Other	1	0	5	5	5	24.0	5	5
02/22/11	Past Tenant	18.0	Word of Mouth	1	1	5	5	4	8.0	5	4
02/22/11	Past Tenant	12.0	Word of Mouth	1	0	5	5	4		3	3
02/21/11	Past Tenant	18.0	Other	1	0	4	5	4	3.0	5	5
03/01/11	Prospective Tenant		Affiliated Company Recc.	1	0	5		5			
02/24/11	Prospective Tenant		Other	1	1	5		5			
02/17/11	Prospective Tenant		Other	1	1	5		4			
03/01/11	Prospective Tenant		Website	1	0	5		5			
02/21/11	Prospective Tenant		Website	1	0	5		4			

APPENDIX G: PRESENTATION FOR MBI BOARD OF DIRECTORS

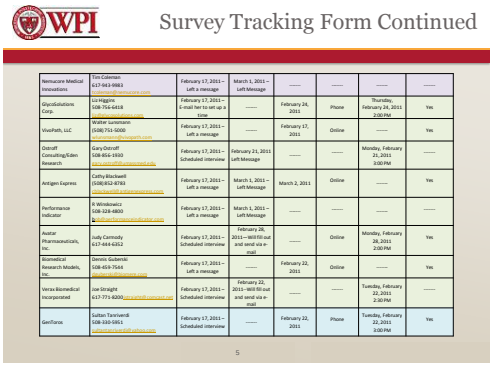




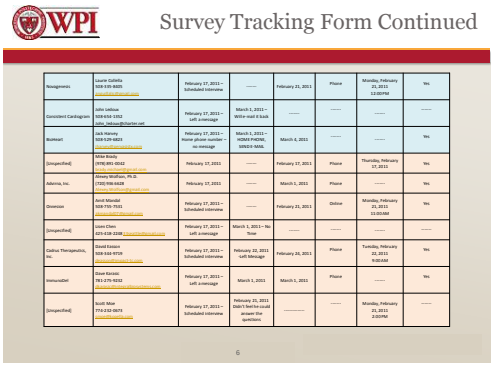




Company Name	Contact Information	Date 1st Contact	Date 2nd Contact	Response Date	Response Type	Interview Date/Time	Thank You Sent?
Antigen Targeting Consulting Service, Inc.	Haitao Yuan 617-755-1657	February 17, 2011	March 1, 2011 –Will e-mail it tomorrow	March 1, 2011	Online	Will send survey by e-mail – (possibly to Judy – e-mail her)	Yes
Blue Sky Biotech	Norm Garceau 508-798-2930	February 17, 2011 – Scheduled interview	------	February 22, 2011	Phone	Tuesday, February 22, 2011 2:00 PM	Yes
CellMosaic, LLC	Yumei Huang 508-770-8030	February 17, 2011	------	March 4, 2011	Phone	Friday, March 4, 2011 10:00 AM	Yes
Convergent Dental	Nathan Monty (508) 335-4824	February 17, 2011 – Will call back	------	February 17, 2011	Online	------	Yes
Matrigen, LLC	Justin Mih 508-755-5070	February 17, 2011 – Left a message	------	February 24, 2011	Phone	------	Yes
Microbac Laboratories	Nancy Burnette 508-595-0017	February 17, 2011 – Wierd answering machine	------	February 24, 2011	Online	------	Yes



Nemucore Medical Innovations	Tim Coleman 617-943-9983	February 17, 2011 – Left a message	March 1, 2011 – Left Message	------	------	------	------	------
GlycoSolutions Corp.	Liz Higgins 508-756-6418	February 17, 2011 – E-mail her to set up a time	------	February 24, 2011	Phone	Thursday, February 24, 2011 2:00 PM	Yes	
VivoPath, LLC	Walter Lorenzano (508) 751-5000	February 17, 2011 – Left a message	------	February 17, 2011	Online	------	Yes	
Ostroff Consulting/Eden Research	Gary Ostroff 508-856-1930	February 17, 2011 – Scheduled interview	February 21, 2011 Left Message	------	------	Monday, February 21, 2011 3:00 PM	------	
Antigen Express	Cathy Blackwell (508)852-8783	February 17, 2011 – Left a message	March 1, 2011 – Left Message	March 2, 2011	Online	------	Yes	
Performance Indicator	K Winkowicz 508-328-6600	February 17, 2011 – Left a message	March 1, 2011 – Left Message	------	------	------	------	
Avatar Pharmaceuticals, Inc.	Judy Carmody 617-666-6352	February 17, 2011 – Scheduled interview	February 28, 2011 – Will fill out and send via e-mail	------	Online	Monday, February 28, 2011 2:00 PM	Yes	
Biomedical Research Models, Inc.	Dennis Gutierski 508-459-7544	February 17, 2011 – Left a message	------	February 22, 2011	Online	------	Yes	
Verax Biomedical Incorporated	Joe Straight 617-771-8200	February 17, 2011 – Scheduled interview	February 22, 2011 – Will fill out and send via e-mail	------	------	Tuesday, February 22, 2011 2:30 PM	------	
GenTorus	Sultan Tanriverdi 508-330-5851	February 17, 2011 – Scheduled interview	------	February 22, 2011	Phone	Tuesday, February 22, 2011 3:00 PM	Yes	



Nowgenetics	Laurie Gallella 508-595-8605	February 17, 2011 – Scheduled interview	------	February 21, 2011	Phone	Monday, February 21, 2011 11:00 PM	Yes
Consistent Contingram	John Leblow 508-616-1352 John_leblow@charter.net	February 17, 2011 – Left a message	March 1, 2011 – Write mail it back	------	------	------	------
Biomart	Jack Hanery 508-529-6823	February 17, 2011 – Home phone number – no message	March 3, 2011 – HONY PHONE, SENDS MAIL	March 4, 2011	------	------	Yes
[Unspecified]	Mike Brady (978) 851-0152	February 17, 2011	------	February 17, 2011	Phone	Thursday, February 17, 2011	Yes
Adonia, Inc.	Alexey Wolfson, Ph.D. (720) 998-6428	February 17, 2011	------	March 1, 2011	Phone	------	Yes
Diversion	Amit Mandal 508-755-7531	February 17, 2011 – Scheduled interview	------	February 21, 2011	Online	Monday, February 21, 2011 11:00 AM	Yes
[Unspecified]	Liam Chen 603-438-2208	February 17, 2011 – Left a message	March 1, 2011 – No Time	------	------	------	------
Cadrus Therapeutics, Inc.	David Easton 508-868-9759	February 17, 2011 – Scheduled interview	February 22, 2011 Left Message	February 20, 2011	Phone	Tuesday, February 22, 2011 9:00 AM	Yes
ImmunoDef	Dave Kocsis 781-275-9232	February 17, 2011 – Left a message	March 1, 2011	March 1, 2011	Phone	------	Yes
[Unspecified]	Scott Moe 770-232-0675	February 17, 2011 – Scheduled interview	February 21, 2011 Didn't feel he could answer the questions	----------	------	Monday, February 21, 2011 2:00 PM	------

Survey Results

Survey Question: How long were you/have you been at MBI?

Responses:
- Average Current Tenant Stay: 26 months
- Average Graduate Tenant Stay: 18 months
- Average Successful Graduate Tenant Stay: 59 months

Conclusions:
- The data shows that successful graduate tenants stay at MBI for longer lengths of time

*Note: Many Successful Graduates were a part of MBI in the 1980's and 1990's which may contribute to the longer stay than graduate companies today

Correlation to MBI Scope of Services:
- Better understand the factors that result in firms becoming "winners"
- Offer affordable incubator facilities, support for incubated companies, and expansion/ relocation advice

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Survey Results

Survey Question: How did you initially hear about MBI?

Responses:
- 44% 'Other'
  - 'Other' Responses Include: Through Alexandria Development, Was a Previous MBI Tenant, Worked in the Same Building
- 25% Word of Mouth
- 25% Website
- 6% Affiliated MBI Company Recommendation

Conclusions:
- Among 'Other' responses, no common theme
- Current and Prospective Tenants were more likely to hear via website
- Suggests the website is becoming more important
- Also tells that MBI is doing a good job getting their name out in the biomedical community

Correlation to MBI Scope of Services:
- Increase efforts to enhance awareness of MBI and its reputation, domestically and internationally
- Identify and attract entrepreneurial scientists and emerging companies, keeping existing criteria for incubation

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Survey Results

Survey Question: Was MBI Responsive to your initial request to join their facility?

Responses:
- 100% of Respondents answered that MBI was very Responsive

Responsiveness:
- Timely
- Facility Tours
- Efficient
- Effective

Conclusions:
- Respondents were very impressed with MBI's responsiveness
- Respondents were drawn more to MBI because they were very responsive to their requests
- Personability was also noted to be high among MBI staff

Correlation to MBI Scope of Services:
- Identify and attract entrepreneurial scientists and emerging companies, keeping existing criteria for incubation
- Increase efforts to enhance awareness of MBI and its reputation, domestically and internationally

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Survey Results

Survey Question: Rate the ease of obtaining information from MBI.

Responses:
- 13 respondents answered that it was very easy
- 3 respondents answered that it was somewhat easy

Conclusions:
- MBI is both efficient and effective when answering tenants questions
- MBI staff is knowledgeable and able to provide the information tenants need

Correlation to MBI Scope of Services:
- Identify and attract entrepreneurial scientists and emerging companies, keeping existing criteria for incubation
- Increase efforts to enhance awareness of MBI and its reputation, domestically and internationally

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Survey Results

Survey Question: Was there anything discouraging about joining MBI's facility?

Responses:
- 56% of respondents answered that there were no discouraging factors
- 44% answered that there were discouraging factors
- Common discouraging factors included location and cost

Conclusions:
- Although a high percentage found a discouraging factor, several respondents expressed that those factors were insignificant in comparison to the benefits provided by MBI

Correlation to MBI Scope of Services:
- Modify incubation model
- Identify and attract entrepreneurial scientists and emerging companies, keeping existing criteria for incubation

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Survey Results

Survey Question: What specific needs or factors originally attracted you to MBI?

Responses:
- Ready to move in space
- Price
- Need for equipment/having shared equipment available that did not need to be purchased
- There were several other needs and factors collected that did not show any trend

Conclusions:
- Results indicate that space and shared equipment are what draw companies in to MBI initially
- The surveys also show that MBI's responsiveness to tenants questions draw them in further

Correlation to MBI Scope of Services:
- Identify and attract entrepreneurial scientists and emerging companies, keeping existing criteria for incubation
- Offer affordable incubator facilities, support for incubated companies, and expansion/relocation advice

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Survey Results

Survey Question: While in MBI's facility, what did you like best about the accommodations?

Responses:
- Professional Environment
- Cost
- Shared services

Conclusions:
- The professional environment MBI provides for companies what the most popular answer and shows that MBI does a good job providing a professional environment to all tenants

Correlation to MBI Scope of Services:
- Offer affordable incubator facilities, support for incubated companies, and expansion/relocation advice
- Mentor start-up firms, and provide partnership opportunities
- Better understand the factors that result in firms becoming "winners"

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Survey Results

Survey Question: Were there any accommodations you felt MBI lacked?

Responses:
- The majority of respondents answered that there were no accommodations lacked
- Among respondents that answered yes, popular responses include: lack of support in the area of operations and lack of shared space for example: conference rooms

Conclusions:
- In general, respondents were very happy with what MBI provided them with

Correlation to MBI Scope of Services:
- Mentor start-up firms, and provide partnership opportunities
- Offer affordable incubator facilities, support for incubated companies, and expansion/relocation advice

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Survey Results

Survey Question: Rate MBI's services and support system.

Responses:
- 11 answered that the support system was excellent
- 2 responded that the support system was adequate
- 1 answered that the support system was somewhat adequate

Conclusions:
- Tenants were very happy with the support system provided by MBI
- The lower rating of somewhat inadequate came from a company who was at MBI several years ago. This tenant also noted that since he has been gone, MBI's support system has gotten better and specifically noted Jim Duffy as a large help

Correlation to MBI Scope of Services:
- Offer affordable incubator facilities, support for incubated companies, and expansion/relocation advice
- Mentor start-up firms, and provide partnership opportunities

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Survey Results

Survey Question: Rate your satisfaction with the layout of MBI's facilities.

Responses:
- 6 respondents answered that they were completely satisfied
- 12 answered that they were satisfied
- 1 answered that they were neutral

Conclusions:
- The majority of respondents were satisfies with MBI's facility layout. Many tenants noted that the layout was not perfect but that there is not much MBI could change regarding layout.

Correlation to MBI Scope of Services:
- Consider adding affordable incubator space
- Offer affordable incubator facilities, support for incubated companies, and expansion/ relocation advice
- Assess extent to which hospitals in the biomedical cluster may require non-lab support and/or services

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Survey Results

Survey Question: Explain positive and negative aspects of the layout of MBI's facilities

Responses:
- The majority of respondents did not provide any negative aspects
- Of those who did provide negative aspects, common answers included: Office space far from lab space, their company had outgrown MBI's facility, and shared equipment comes with problems such as timing and cleaning the equipment

Conclusions:
- Again, most tenants are satisfied with the layout
- Problems with the shared equipment, we feel, could be handled a little better
- Perhaps tenants could sign out times to use the shared equipment to ensure they get use when they need it

Correlation to MBI Scope of Services:
- Consider adding affordable incubator space
- Modify incubation model

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Survey Results

Survey Question: Did MBI Save or Cost your company start-up time? Approximately how much?

Responses:
- 100% of respondents answered that MBI saved start-up time
- It was difficult for some to say how much start up time was saved
- On average companies reported MBI saved them about 3-6 months of start-up time

Conclusions:
- Since MBI is saving companies start-up time this shows that they are helping produce free standing, financially stable companies, as the National Business Incubation Association (NBIA) cites, should be the goal of all incubators

Correlation to MBI Scope of Services:
- Increase efforts to enhance awareness of MBI and its reputation, domestically and internationally
- Mentor start-up firms, and provide partnership opportunities

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Survey Results

Survey Question: Rate the amount that MBI helped grow and enhance your business.

Responses:
- 6 respondents answered that MBI substantially enhanced their business
- 5 answered that MBI moderately enhanced their business
- 2 answered that MBI had very little enhancements to business

Conclusions:
- We feel these responses show that MBI is enhancing their tenant's companies significantly, but could be enhancing them even more

Correlation to MBI Scope of Services:
- Mentor start-up firms, and provide partnership opportunities
- Offer affordable incubator facilities, support for incubated companies, and expansion/ relocation advice
- Create and sustain personal and institutional connections to critical resources

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Survey Results

Survey Question: What are your company desired success metrics? Did MBI help create these metrics?

Responses:
- Tenants informed us that they developed their own success metrics
- Tenants also told us that MBI did not have a role in helping them to create these success metrics

Conclusions:
- Several tenants, especially current tenants, seem to have created their success metrics without help
- We feel that if MBI were able to provide help, if wanted, to create success metrics, companies would benefit greatly, and MBI will have enhanced their business even more

Correlation to MBI Scope of Services:
- Mentor start-up firms, and provide partnership opportunities
- Create and sustain personal and institutional connections to critical resources

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Survey Results

Survey Question: Rate the overall success of MBI in relation to your business operation.

Responses:
- 7 respondents answered that MBI was very successful
- 5 answered that MBI was somewhat successful
- 2 responded that MBI was neither unsuccessful nor successful

Conclusions:
- Many of MBI's tenants feel that MBI is successful in relation to their company, even if their company was ultimately not successful
- It is also clear that MBI tenants have very good relationships with MBI staff and spoke very highly of MBI in general

Correlation to MBI Scope of Services:
- Increase efforts to enhance awareness of MBI and its reputation, domestically and internationally
- Work to build the MBI brand throughout the life sciences corridor

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Survey Results

Survey Question: Do you have any suggestions for improvements to MBI?

Responses:
- The majority of respondents did not have any suggestions for improvements
- Of the tenants who did have suggestions for improvements common answers included: providing more common areas like conference rooms and more networking opportunities

Conclusions:
- MBI is well liked by all tenants we spoke with. Physical layout, specifically the addition of common areas came up several times during the survey

Correlation to MBI Scope of Services:
- Better understand the factors that result in firms becoming "winners"
- Modify incubation model

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Facility Space Layout

Objectives of a Successful Facility Layout

Based on Current Tenant Behaviors

Maximize Open Space for Increased Travel Time

Facilitate Cooperative Efforts Among Tenants

Current MBI Layout

Promotes Successful, Efficient Work Environment

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Facility Space Layout

Current MBI Layout

	Total Space (sq ft)	Rentable Space	Common Space	Shared Space
Barber Avenue	8,000	64%	23%	13%
Biotech 3	9,314	64%	16%	7%
Gateway	7,518	60%	17%	8%
Average	8,277	63%	18%	10%

Successful Future Facility Traits

Maximized Rentable, Revenue Driven Space
Maximized Open Space within Lab Space
Minimized Common Space and Shared Space

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Optimal MBI Layout

	Rentable Space	Common Space	Shared Space
OPTIMAL	60-80 %	5-25%	5-20%
MBI Facilities	63%	18%	10%

Successful Facility Traits

- Maximum Rentable, Revenue Driven Space
- Additional Storage to Maximize Open Space within Facility
  - Wall Storage, Cabinets, Shelving, Etc.
- Minimize Shared Space or Purposeful Shared Space
  - Kitchen, Small Shared Materials Lab
- Minimal Building Common Space

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Recommendations

Based on the survey responses, main areas for improvement in MBI's Incubation Process Include:

- Provide More Networking Opportunities
- Provide More Operational Support
- Help Tenant Companies Develop Success Metrics/Provide More Business Support

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