A Study of 20th Century Industry in Worcester, Massachusetts

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Abstract

Worcester has always been an industrial leader. Worcester's past has included companies such as: The Washburn Company, Jamesbury Valves, and the Norton Company. These companies, though still producing, are not thriving as they have in the past, as manufacturing has declined to only 4% of the US economy. With the groundbreaking for the Biotechnology Park in 1984, Worcester set itself apart from most cities in the country. The Project focuses on the future of the local economy, what the future might bring, and the problems inhibiting economic growth.

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Introduction

This project deals with the present conditions and the future of Worcester's economy. A previous group has done extensive research on the period of 1919 up to the present generation's economic state, but there is still a lot more to be discovered about the future of the industrial sector of Worcester's economy. The ultimate goal for our project is to discover how all the facets of industry, politics, aesthetic qualities, and the people play a role in creating an influential and prosperous City.

We are separating the project into two different time frames, in order to adequately answer questions about Worcester's present, and future. The first time frame we are going to consider is today's economy. In this section background information on the new technologies and how they are being used in Worcester will be included as well as a few company profiles that have begun research and development in the city. There are many problems in the city that need to be addressed in order for the future to be a good one. Therefore we are focusing our research on the problems of Worcester and the collaborations that must be made to create a prosperous future. The collaborations between biotechnology, medical devices, medical research, and high-tech manufacturing will be very important to create lucrative futures for the companies and the city. If a new industrial company comes out with a breakthrough product, could it potentially raise the demand for production of an older manufacturing company? Or, could new companies come into the city to manufacture such a product? Would it also be a possibility that a

manufacturing firm could create a new product that could help in the expansion of the technology of certain new industries?

We will also ask more specific questions to dig more deeply into the basis of the new economy. Specific questioning will be asked to leaders in the research and development side of the economy including: Kevin O'Sullivan, Julie Jacobson, Gordon Lankton and Timothy Gerrity Ph. D.

Besides the new technologies being developed and how they are incorporated in the economy, another focal point of our project is the local political context. The political motivation is a key to economic development. We will delve into the politics by interviewing two key political leaders in the city, Mayor Tim Murray and Congressman James McGovern. In order to develop the city, seed funding so to speak for businesses must be a high priority. For that reason alone politics is the match to light the fire. We will research this subject in order to find out what the economic goals of the city are.

Between the Brownfields Problem and restoration of city monuments and places, Worcester has a lot of cleaning up to do. Our focus on this particular section will be to explore these problems, and see what the city is doing about them. The final variable is the people. Quality of life depends dramatically on the economy. But vise versa is true; the economy depends greatly on the quality of life. For instance, in order to keep highly trained individuals here, they must enjoy living in the city, or they will move elsewhere. All of these variables; industry, politics, physical infrastructure, and quality of life; are the contributors to success. All four of them need to be present in order for Worcester to move forward again. We will discuss all of these points through out this report.

History of Biomedical Devices:

It has only been in the past 20 years that the application of engineering principles to medicine has become popular, but the culmination of bio medicine has its roots back in the 16th Century. Leonardo Da Vinci was one of the earliest pioneers, discovering the science of the human anatomy, studying the motion of bones and muscles. Sanctorius helped develop how the body's metabolism worked, along with new measuring techniques. Rene Descartes wrote the first real physiology book called *De Homine*, which demonstrated that the nervous system played an important role in the functioning of the human body (Jensen 5).

The 17th century brought about new ideas, which further expanded the knowledge of the human body. The three main new theories were "iatrophysics," "iatrochemistry," and "vitalism." Sylvius of Holland discovered much about iatrochemistry with his work on the chemical properties of different fluids. Stahl, who was a German scientist, tried to take a whole new direction about the workings of the body. He differed in his views because he thought that the body was driven by the soul, and his theories came to be known as vitalism (Jensen 6). There was an incredible amount of knowledge amassed by the advancements in chemistry and physics.

The 18th Century took hold of the new found achievements and put them to practical use. Boerhaave, and his student Albrecht von Haller started the use of medical clinics to treat patients. This was an important innovation, which gave rise the current hospitals and medical clinics that we have today. Haller went on to discover more in the

areas of respiration, bone formation, embryology, and digestion (Jensen 7). There were also discoveries about the circulatory system, the electrical applications that exist in the body, and further findings about respiration. Public health improved by leaps and bounds over the century, and the culmination of medical improvements happened in 1796, when Edward Jenner of England developed the first vaccination. His research was based on careful case-studies and clinical observation more than a hundred years before scientists could explain the viruses themselves (Jensen 8). After his discovery, vaccination was the only treatment used for the horrible outbreaks of diseases like smallpox, which were responsible for a massive number of deaths.

The 19th Century was also a time of a vast number of improvements in medicine and the knowledge of the body. A French scientist, Claude Bernard, and two German scientists, Muller and Ludwig, discovered much about human physiology. They made improvements on our information about the brain, nervous system, and the cellular nature of the body. This gave rise to the study of human tissue, which sparked a whole new science in it. Pasteur also made significant progress in the study of germs and microorganisms. This evolved into Bacteriology, which was incredibly important. Scientists learned about the immunity of diseases, antiseptics, and anesthetics (Jensen 8). By the end of the 19th Century development of the x-ray changed patient care in dramatic ways, which was initially discovered by Rontgen in 1895.

It has been in the past one hundred years, though, that these discoveries have come to seem almost trivial. The newly developed discoveries that stand out have been immunology, chemotherapy, endocrinology, and nutrition. Some important off-chutes of these are antibiotics, new vaccines, insulin discoveries, and the vitamin and nutrient

needs of the body. Advances in surgical procedures evolved from the many patients of World War I and II, in which new techniques of surgery developed. The 20th Century also marked the start of the use of metals, plastics, and ceramics in the body. Metals have been used to repair broken bones, and joints. Ceramics have also been used for joint repair and procedures like jaw bone replacement. Artificial organs also rely heavily on these materials along with cartilage and different grades of rubber (Jensen 8).

The impact of biomedical research on the quality of life is quite impressive. In 1988, the birth mortality rate was 10.1 in every one thousand babies born. Since 1900, there has been an improvement of 1400%. This illustrates the benefits of the application of new knowledge through more effective medical intervention (Malone 11). The human genome project has been one of the most significant evolutions in the past fifty years, developing the structure of the human genome for thousands upon thousands of applications. One of the most important tools for biomedical research has been the animal. It has been used as a tool in the advancement of biomedical research, but the moral implications have limited free based testing, because animal welfare organizations have existed since the beginning of the 20th Century (Malone 15).

The future of the biomedical industry lies in the advancement of technology, and the personal research efforts of scientists who are applying engineering principles to providing ordinary clinical care (Gerrity). There are hundreds of uses of the innovation happening everyday that could be discussed. One very important, very general application of medical devices has to do with streamlining the whole health care system in the United States. "It is expensive to have people go to hospitals and clinics to receive medical care, when all that medical care may be is getting your blood pressure checked, a

few other vital signs, or talking briefly to a physician about how you feel. That is actually not an inexpensive proposition. We are looking for better ways we could do that from remote locations, so we won't have to move a person from their home to the hospital" (Gerrity). Tim Gerrity explained that all of the abilities to do this, and related things are there today, it's just a matter of developing and utilizing them. This example is one of the reasons bioinformatics will play such a huge role in the rise of biotechnology, and biomedical devices.

History of Biotechnology

Biotechnology has been termed as the "integrated use of biochemistry, microbiology, and chemical engineering, in order to achieve the technological application of the capabilities of microbes and tissue cells" (Reed 1).

In less than a generation, our definition of life and our whole existence has been altered (Rifkin 1). Biotechnology is the motivating force behind this. Scientists are beginning to reorganize life at the genetic level, and the future of biology will be dependent on this (Rifkin 1). Computers and telecommunications were the focus of the 20th Century, but that is beginning to change. Information and life sciences are slowly beginning to come together in a single technological force. Researchers will begin to remake the genetic world.

Scientists and engineers in the 20th Century became the new authorities by learning more about physics and chemistry, which has evolved into biotechnology (Rifkin 5). The biotechnology revolution has been fueled by discoveries in biomedical research, funded originally by the national institutes of health. Biotechnology is not only

achieving its goals, but doing it earlier than expected (Perpich 5). Biotechnology is dependent on the knowledge of life itself, and is able to circumvent basic differences among organisms. It is getting Mother Nature to move faster, and in new ways, using the developments in genetic engineering. Between 1945 and 1975, the United States spent billions of dollars on basic research at universities, research centers, and the National Institute of health (Perpich 7). In the beginning, scientists were not intent on creating a commercial product, because they were focused on searching for fundamental truths. The progress in biotechnology would be impossible without the breakthroughs since 1945, before they dreamed of practical applications.

The bridge between basic researches to an actual application can take a very long time, and this has been shown to be quite evident (Gerrity). There have been four steps in the development of biotechnology. The first is the biotechnological production of foods, which is a process that has been in practice for hundreds of years. The next is the biotechnological production of organic solvents, acids, bases, and biomass under non-sterile conditions. These processes made it possible for the growth of undesired microorganisms, which was one also one of the first developments in this new technology. The third is the biotechnological processes under the conditions of sterility. The last that ties it all together are the applications of modern scientific results in biotechnology. Applications of new scientific results have led to many developments in biotechnology (Reed 8).

The biggest advancement in the biotechnology, according to Tim Gerrity, has been the discovery and adaptation of DNA (Gerrity). "DNA was identified over fifty years ago, and it was an amazing accomplishment of basic research." "Everybody knew

from that point forward that the key to disease was in that genetic code. It was not just a matter of cracking that genetic code; it became a matter of understanding how it actually works" (Gerrity). In the next 25 years global corporations, research institutions, and governments could hold patents on 100,000 genes, which make up the blueprint for humans, along with over 10,000 microorganisms, plants and animals (Rifkin 2). Agriculture is now starting to be grown indoors in tissue culture, and in giant bacteria baths. They are doing it at a price that is far less than the capability of farmers. As our natural resources are being diminished, alternative fuels are also in the scope of the future, which will be made from bacteria, viruses, plants, and animals. Artificial wombs will soon eliminate the hardships of pregnancy; along with being able to alter the genetic code to cure heritable diseases or disorders (Rifkin 3). This will all be a spin off of the discovery of DNA, and there are hundreds of other examples.

Information on Bioinformatics

Bioinformatics is a new technology which intersects computer science, information technology, mathematics and biology, and includes archiving, searching, displaying, manipulating, and modeling biological data. Bioinformatics is the science of creating and managing biological databases to keep track of, and simulate the complexity, of living organisms (Adler). There are millions upon millions of uses for it, and right now we are only at the start of this technology. Almost all the advancements in biology have come from the development of previous knowledge about a certain subject. Especially in recent years the information examine and decode has become extremely complex and cumbersome to analyze. Bioinformatics is going to play a huge role in new

discoveries because new high-output computer data storage and recovery technologies for generating biological and biochemical data are now being used, and will be able to sift through the extremely large amounts of data to make it easy to organize, retrieve, and use large databases (Adler). This will allow scientists to be able to bring experimentation and analysis to a whole new level.

Bioinformatics is alternatively called biocomputing, or computational biology depending on what you are working with. Colleges and universities have caught on to the power this technology will have by creating programs to teach bioinformatics as a major area of study. What makes bioinformatics such a powerful tool is the communications medium, with very fast data transfer rates, which is able to compute and display information, and make it simultaneously useable for many people (Adler). The medium that has made that possible is the Internet and the World Wide Web. Online resources are now an important part in the study of biology, and with even faster connection speeds that have been available in the past few years, the technology will only improve upon itself.

An example of the use of bioinformatics is the experimentation on the human genome. There are over three billion base pairs of human genetic information, and this genetic data has to be stored, documented, and analyzed. Being able to manipulate biological information is now making strong contributions solving problems such as the relationship about the structure and function of biomolecules, and their role in the biological process (Adler). Some other biological data with which bioinformatics is dealing are gene maps, gene and protein sequences, and gene expression profiles. Biomolecules contain literally tons of information to gather about the development and

functioning of living organisms. The analysis of nucleic acid sequence, protein structure/function relationships, genome organization, regulation of gene expression, interaction of proteins and mechanisms of physiological functions, can all benefit from a bioinformatics approach.

There is also a vast amount of scientific literature about anything that is contained in biotechnology and biomedicine and it is all stored in digital databases. The largest database in the world is called Medline. It contains various journal references that cover from 1965 to the present. The searching mechanism is executed within seconds that allows the user to see full text articles, and high-resolution graphics (Adler). This will only be the start of what is to come, because there are already new concepts being developed that will make our current systems obsolete to bring us into the future of information. In that future there also lies the risk of ethical problems. There is and will be certain sensitive information that is contained in these databases, and the protection of this information is a cause for concern as new technologies are being developed.

The start and growth of the new industries in Worcester

It may seem as though biotechnology and all the new technology sectors have been just recently developed in the Worcester area, but it stems back almost twenty five years ago. "The number one engine in terms of growing this field (biotechnology) has been the UMass Medical Center and School ... That's why the Biotech park was built here in 1984, because it was right across the street from a teaching hospital" (O'Sullivan). That institution gave the birth to local developments in biotechnology, but there are many other institutions, which have helped along the way. Worcester also has other health care

facilities in the city, which include UMass Memorial Healthcare, the Fallon Healthcare, St. Vincent Hospital, and the recently introduced Worcester Medical Center.

The University of Massachusetts Medical School was first built in Worcester to meet the health care needs of the community. The school focuses on health science education, research, public service, and clinical care (website). The school is distinguished by its service based facilitation, supporting the public with voluntary service and community activism. Without the establishment of this school, many of the institutions here today would have never been started in Worcester.

Tuft's University School of Veterinary Medicine is also among the leaders that helped put Central Massachusetts on the map as a biotechnological center. It touts a 585-acre campus with many different schools included. Among them is the Hospital for Large Animals, the Bernice Barbour Wildlife Medicine Building, and David McGrath Veterinary Teaching Laboratory, and a 250-acre working farm (website). Their five signature programs include International Veterinary Medicine, Wildlife Medicine, Equine Sports Medicine, Veterinary Biotechnology, and Ethics and Values in Veterinary Medicine. An important aspect of Tufts is that it studies the relationship between human, animal, and environmental health, on both the local and global sides (website). In 2001, it was given a grant of one million dollars to fund a new science park, which has helped bolster the local economy. It has been used to house tenants for different biotechnological firms that needed a place to start-up relatively cheaply, and quickly (De Leo).

Another catalyst of the advancement of biotechnology has been the Worcester Polytechnic Institute. The recently established Bioengineering Institute developed

because of the need for the bridge between academics and the industry. "Our goal is to create significant growth for the institute in the next five to ten years (Astell). The BEI is involved with three activities: applied research, product development, and product realization. Its objective is to develop intellectual property, which can be utilized by companies to form a basis of new start-up ventures. The end result of the institute is to stimulate economic growth and to create jobs in the area (website). It has four centers that all have a bioengineering focus: the Center for Bioprocessing and Tissue Engineering, the Center for Comparative NeuroImaging, the Molecular Engineering Center, and the Center for Untethered Health Care. One example of the work the Institute is achieving is seen in the Center for Untethered Health Care. "Bill Michaelson, the director for the Center of Untethered Health Care, and also a professor in the ECE department at WPI, is one of the leading experts in Global Positioning Systems. What he is doing is developing systems where we can actually locate someone within one foot of their actual location and see if suppose, it was mid-day and someone hasn't moved for two hours, or they are doing something outside of their usual pattern" (Gerrity). It is an exciting technology, which has its roots in bioinformatics that could possibly transform the way we do health care in the future. The center is also working with the U.S. Department of Defense to create a monitoring system to take readings on the state of troops in the battlefield to see if they are dehydrated, or wounded (Astell Emilie). It is clear that WPI, and the institutions and universities like it will play a major role in advancing new technology industries.

The future of Worcester's biotechnological growth is plainly seen in the Massachusetts Biomedical Initiatives Corp. It is an independent, tax-exempt corporation,

which supports the growth and expansion of biotechnology and medical device companies, working to make Worcester a leader in biomedical and biotechnology fields. "Our simple role is to create small start-up companies and growth them to be the chief cheerleaders for the biomedical industry. We now have over sixty bio companies in Massachusetts with roughly 2700 jobs; and the companies are generating close to $350 million dollars in revenue a year" (O'Sullivan). The three initiatives of MBI include the MBIdeas Innovation Centers, the Central Massachusetts Biomedical Initiative, and the Technological Commercialization Center. The Innovation Center provides companies with accelerated start up, a staff that handles certain business operations for the companies, and gives them an expertise to avoid many of the pitfalls of technology entrepreneurship (website). The Central Massachusetts Biomedical Initiative's job is to work with the area organizations involved in biotechnological affiliations to develop team work in the region to help the overall commercialization of the region's academic and science research. The Technology Commercialization Center provides academic institutions and entrepreneurs with the technical expertise to further the industry by technology transfer, commercial assistance, and business consulting (website). The incubator companies in the MBI's facilities on Barber Ave. and Winthrop St. include Antigen Express, Inc., Biomedical Research Models Inc., DXA Resource Group, Inc., Avatar Pharmaceuticals Services, Inc., Beckman-Coulter, Inc., Bioheart, Inc., Gene-It, GlycoSolutions, Corp., Hypromatrix, Inc., J-Que Biologics, PolyGenyx, and Vera Biomedical Incorporated.

MBI was started in March of 1998, but was initially called Massachusetts Biotechnological Research Institute. Since the change, it has taken a new, more

aggressive role in bringing biomedical companies to the region. Its new role is as a business incubator (Pappas). MBI's CEO Mark Roosevelt said that it would have taken ten years to bring the companies in under the old MBRI model. In the Mid-80's biotechnology started up at the biotech park, but initially it proved to be too high-risk and costly to become a job engine. The MBRI was established fifteen years ago to try to draw biotechnology companies to the Worcester area. Most of the companies that came to Worcester did not thrive (Stringer). To make progress, biotech companies need some specialized support that other tech firms don't require. The conditions have to be just right for a biotech firm to thrive. The life science incubators also depend largely on getting universities and other public research out of the laboratory and into the marketplace. To measure how effective a region's commercialization is depends on the total amount of licensing revenue, patents filed and issued, and industry sponsored research (James). The Biomedical Initiatives turned that around by focusing on recruitment, networking, and business consulting efforts. Biomedical companies are advancing at an accelerated rate now, doubling research information every 12-14 months. Part of the teamwork strategy they are focusing on is definitely working. They have lured biotech businesses from the UMass Medical Center and Tufts Veterinary School science park, to help them grow even more with their many facilities (Stringer). These incubation programs allow alliances with local hospitals, schools, or other research institutions to provide clients the access to high-end equipment that might not be practical for the company to buy. The MBIdeas Innovation Center has permits, a fully equipped wet lab, shared facilities, and equipment including: a cold room, hazardous waste storage,

a purified water system, autoclave, glass wash, a centrifuge, -80 degree freezer, and flammable refrigerator (website).

Significance to the City

"We now have over sixty bio-related companies in Worcester with roughly 2700 jobs, and the companies are generating close to $350 million dollars in revenue a year. The projected revenue for 2010, that they will be generating is one billion dollars. So it's a growing industry by leaps and bounds. It's a well organized cluster" (O'Sullivan). This fact alone shows one the importance of the biological industry to Worcester's future. Another fact Kevin O'Sullivan pointed out, was that in the United States there are four billion prescriptions filled yearly. "In five years, five billion will be filled. That tells you the acceleration of drug discovery that will be needed to keep people living longer and healthier" (O'Sullivan). It is essential that Worcester build upon what it has now in the way of biotechnology, and foster even more companies to come to the city.

Worcester is now seen as one of the two biomedical anchors in Massachusetts, along with Boston. One key fact that gives Worcester an edge over Boston is that it has a lower cost of living, business real estate and home ownership, quality of schools, and the availability of money and talent. Howard Haimes, the vice president of Bioheart Inc., an incubator in the MBI office, says he and his teammates "love it in Worcester," with the only drawback being the lack of quick access to Logan Airport. It also has the newly renovated Union Station, where commuter rail services will eventually go between Worcester and Boston (Ciottone).

Given the economic climate of today, the state cannot allocate additional financial investment to promote the industry, and O'Sullivan would like to see more tax incentives for biotech job creation, along with more "pad-ready" manufacturing sites. The outlook remains totally optimistic, though. Representatives James Leary and Vincent Pedone have recently unveiled a five-point plan, which will help to boost the bio-related industries in the Worcester area. The plan includes the improvement of science and technology education, site readiness, to encourage biotech-rich regions of the state to work together instead of against each other, and to develop a regional strategy to promote state business development tools to expand the industry (Baca).

Despite the economic downturn in recent years, the corridor of Worcester to Boston is hiring employees at a rapid pace. There are few companies in the area who have slowed down the hiring process, unlike many other technology sectors (Rosenburg). The big pharmaceutical companies are also seeing this growth in the area and are moving their operations closer and closer. Novartis, originally based in Switzerland, is moving to Cambridge, Ma. Wyeth, Merck, and Pfizer are also beefing up biotech research and production in the area (Katzeff). There is also a ripple effect of money flowing into other industries like the law profession, construction, and research at universities and hospitals. "Researchers want to be near others succeeding in the same field. They want to learn from their competitors as well as the university and hospital researchers. They don't want their competitors to have all the talent to themselves in the area (Katzeff).

Having Abbott Laboratories in Worcester has also helped to solidify Worcester as a bio-tech community. Their new drug called "Humira" is expected to generate over $1 billion in sales. Abbott is putting money back into the economy also because they have

had to invest in research and development, spending millions on equipment. A company like Abbott attracts people with different career goals, which will become good resources for the smaller-cap companies (Esposito). Fifty percent of the bio-related companies in Worcester have revenues of less than one million dollars. This is important because the future of these start-ups is unknown, and potentially tremendous for the economy.

In the past years in Worcester and most other areas, the fusion of biotechnology, biomedical engineering, and the computing side of the equation has started to congeal together. "Biomedical is really the umbrella we define as biotech, medical devices, informatics, encyclical biology, molecular biology, and computer science," says Kevin O'Sullivan. "The distinction between the whole drug discovery processes is all becoming blurred that they are all interrelated ... We at MBI several years ago just focused on biotech, but there was a board mandate about five years ago to say hey, let's broaden that mandate to include the medical device, computer molecular biology, and informatics side. It's hard to have one without the other today, especially in the drug discovery process" (O'Sullivan).

Bioinformatics is the newest arena that will totally reshape the bio-related industry. Right now bioinformatics is "another tough hire" because biologists and computer professionals have such opposite backgrounds (Rosenburg). One Worcester Company that hopes to make a big impact in the industry is the Blackstone Technology Group. It is developing a piece of high-tech software that called PowerCloud that will help companies manage the complex information systems of the biotechnology industry. "The compute farms increase the speed and capacity of a system to run analyses and programs that require tremendous amounts of memory and time." The revenues from

computer equipment, software, and services in the biocomputing market are expected to grow 52% through 2004 to nearly $12 billion (Eckelbecker April). This will be very interesting in the future to find out what the potential for this industry is.

Company Profiles

In the following paragraphs, three companies focused on biological research will be profiled. They were chosen because each plays a significant role in Worcester's economy, and the future looks very bright for them. There are many other important technology firms in Worcester, so this is simply a sampling of the biological companies in the industrial sector of the economy. Each deals with a variety of fields included in the biotechnology and biomedical areas.

Athena Diagnostics

Athena Diagnostics operates at Four Biotech Park in Worcester, MA. Athena began its existence in 1989 as Genica Pharmaceuticals. The primary actions of the company were focused on diagnosing Duchenne Muscular Dystrophy. Six years later Genica merged with Athena Neurosciences, Inc., which at that time was a neurological-based pharmaceutical company. At that time the company was diagnosing Alzheimer's disease, but it was just the beginning. In 1996, the companies were bought out by Elan Corporation, plc., and finally purchased by Behrman Capital in 2002 (website). They are recognized as one of leaders in their field, which apparently was noticed by the Medlink Corp., which recently signed a one-year contract agreement with them. Medlink operates a database for clinical reference information for physicians, and is currently expanding

their neurology content library. Athena will supply information about their products and service to those who access the Medlink database (website).

Today the company still is focused on diagnostic testing for neurological diseases, helping patients and physicians continually improve quality of life. Athena has expanded its involvement in diagnostics to peripheral nerve disorders, neurogenetic disorders, Alzheimer's disease, paraneoplastic syndromes, movement disorders, neuromuscular disorders, and ataxia. It currently holds over sixty patents on various diagnostic tools and devices. Athena is obviously at the cutting-edge of technology using fluometry, Gas Chromatography, Mass Spectroscopy, Isotope Substitution, Spectrophotometry, Enzyme-Linked Immunosorbent Assay, Radioimmume Assay, Western Blot, Southern Blot, Polymerase Chain Reaction, Pulsed Field Gel Electrophoresis, Covalent Technology, Viral Cytopathic Assay, and Automated DNA Sequencing (website). They have an online ordering system, in which the consumer can order Diagnostic tests ranging from Dementia to Strokes/Thrombosis, which provides easy access to all of the new technologies Athena has developed to diagnose disease. Athena is also unique because they offer programs like LabCAST, which is Internet based and keeps people up to date on laboratory methodology, technologies, and neurological diseases. NeuroCAST is a similar program that is offered, which provides current information on the early diagnosis of neurological diseases

Abbott Bioresearch Center (ABC)

Abbott Bioresearch Center is a part of one of the world's leading healthcare companies, Abbot Laboratories. ABC specializes in drug discovery and biologics manufacturing. This division of Abbott Laboratories was constructed in 1989. Located

near the Worcester Biotechnology Park and University of Massachusetts Medical Center, it is in an ideal location for collaborations with intellectually sound students and scientist from the research facility. The facility is approximately 370,000 sq. feet, and employs about 400 employees (website).

Their research involves the attempt to discover new drugs to treat cancers, immunological diseases, and for prevention of transplant rejection. They are also developing human monoclonal antibodies. These antibodies, "block important mediators of the immune response as well as targets important in cardiovascular disease." (website). In January of 2003, Abbott reported that Humira, the monoclonal antibody, was ready to start the production phase. Humira, also called D2-E7 helps patients who suffer from rheumatoid arthritis. In the US alone over 5 million people suffer from rheumatoid arthritis (Espisito January 2003). Humira is an antibody that neutralizes the tumor necrosis factor. This antibody helps out the immune system by turning on a switch, which is off in the body of patients that suffer from rheumatoid arthritis (Eckelbecker January 2003). Kevin O'Sullivan, Vice President of Business Development for the Massachusetts Biomedical initiatives has his opinion of the new D2-E7, "I call it liquid gold, and if it hits, and I believe it will, the drug will revolutionize the rheumatoid arthritis treatment." (O'Sullivan).

The drug is in competition with two others: Enbrel [a fusion protein], and Remicade [a nonoclonal antibody] (Eckelbecker January 2003). All the drugs have different delivery systems. Enbrel uses a system where the user take two shots per week, Remicade users have an intravenous infusion every other month, and Humira is a shot that the patient gives themselves every other week. ABC believes this delivery system

will appeal to patients. The syringes are developed for arthritis patients. The engineering of it includes pre-filed doses, oversize grips and plungers (Eckelbecker January 2003). The expected price for a full year is estimated at $13,000. Abbott has project sales of over 150 million in the first year, and a whooping 500 million for 2004. These statistics are considerable, but officials from the company believe in these forecasts. If this drug is as good as they say, then Worcester would be home to a beneficial and profitable cure of a painful disease. Abbott is also researching many other topics, and depending upon funding, they will probably develop another cure for another important disease.

Advanced Cell Technology

Advanced Cell Technology (ACT) is located on One Innovation Drive, Biotech Three in Worcester, Mass. ACT is researching and developing technologies in genetic manipulation of cells to produce transgenic animals for pharmaceutical production. They are also creating transgenic cloned cells and tissues for applications in cell and organ transplant therapy (Bioengineers 2002). The two main programs are labeled Animal Cloning and Human Therapeutics. President and CEO, Dr. Michael West, who received his MS in biology at Andrews University and his PhD in biology from Baylor University is the head of this biotech company. West founded ACT three years ago after he left his old job at Geron, situated in Menlo Park, California.

The major innovation currently being developed is the animal cloning unit. ACT has successfully cloned milking cows. Working with its subsidiary, Cyagra LLC, they grossed over one million dollars cloning cows ($20,000/per). The future of cloning will still involve cows, but in a much different shape. Just this past summer they created working artificial kidneys (Keenan B). The procedure was done by using cells from

cloned cow embryos "seeded" onto polycarbonate membranes. Stated in the journal, Medical Materials Update, "The study marks a milestone in the journey toward the manufacture of spare part organs and tissue from human stem cells by means of therapeutic cloning by furnishing the first scientific evidence that cloned tissues can be transplanted back into animals without being destroyed by the body's immune system." (Bioengineers 2002). Animal cloning is not the only research-taking place at ACT; the other developing research is Human Therapeutic Cloning. The therapy programs are built upon a newly discovered class of cells that can be formed into almost every type of cell in the body. There are two types of stem cells: Embryonic Stem Cells (ES) and stem cells from the Inner Cell Mass (ICM). Advanced Cell Technology believes that these cells can treat an array of diseases and disorders. The diseases include: treat Parkinson's diseases, spinal cord injuries, heart failure, cartilage for arthritis, and pancreatic cells for diabetes. These human ES cells are acquired from embryos during in-vitro fertilization or by other means through fetal sources. A problem arises because the cells are transplanted into another human, and their new human host can reject the cells. In order for this problem to not occur ACT has begun research of three different methods. The three are: Somatic Cell Nuclear Transfer, Parthenogenesis, and Ooplasimc Transfer. These efforts are trying to produce autologous embryonic cells. Which have a good chance of surviving in an unknown host. The future of ACT will depend on the amount of investments they receive, and how there technologies will be used, if at all. However, the Advanced Cell Technology is on a breakthrough of new information and technologies, as long as there is a demand for their products there future is extremely bright.

Brownfield Problem

The largest problem, which poses challenges to economic development facing the city of Worcester today is the Brownfield situation. A Brownfield site is a, "...abandoned, idled, or under-used industrial and commercial facilities where expansion or redevelopment is complicated by real or perceived environmental contamination." (Reed and Gross 18). The Mayor of Worcester, Mr. Timothy Murray explained in his own words the Brownfield situation, "I've said in my inaugural address, and I've said that as a member of the council; there is no single issue in Worcester that presents a bigger challenge, but also a great opportunity." In order for Worcester to flourish the problem needs to be solved. The city has over 200 documented "Brownfield" sites, and another 400 that are not listed, but do exist. Worcester is at a disadvantage because we were the home of the Industrial Revolution; environmental problems were not the center of attention 150 years ago (McGovern, James. Interview. Dec. 22, 2002). In 1998, the Massachusetts Department of Environmental Protection (DEP) estimated that the state had around 7,000 Brownfield sites.

In August of that year, then Governor Paul Cellucci signed the Massachusetts New Brownfields Provision Act. The act would help cities and towns with significant numbers of sites. The law explained three different categories of relief. The first was classified *eligible persons*, defined as an owner who did not cause the pollution and did not own the land at the time of the pollution. However, eligible persons have to clean up the site to meet a set of standards, but not to the extent required to meet residential standards (Sullivan 14). The second category was named *eligible tenant*. These owners have the responsibility to keep the pollution limited. It also explains that if an owner is

using petroleum products or other hazardous materials, he/she must make sure that his uses will not increase the pollution to the site. The third and final category is lenders. The most basic of the three, lenders are told that if they did not pollute the site then no responsibility is given to them (Sullivan 15). The major incentive included in the law is that innocent parties, "...will receive up to a 50 percent tax credit for all cleanup-related costs associated with a permanent solution..." (Sullivan 15). Also, if the company only meets the minimum standards, it will receive a 25 percent tax credit. The stage was set for Brownfields to be finally cleaned up.

Out of Worcester's 200 documented sites, plus the estimated 400 others, none appeared on the Environmental Protection Agency's National Priority List, where over 1300 "superfund" sites were recognized. In cases of being a "superfund" site, the EPA oversees the cleanup (Reed and Gross 19). For the sites to become "pad-ready", federal funding, state funding, and local funding must be pushed for and then offered. The city must clearly explain why certain sites need to be revamped and renovated. Many old buildings and land parcels could be great places for new industries to appear. The clean up has begun, as stated by Congressman James McGovern, "The Federal and State government has given funds to the city. Property by Property we are beginning to clean the old industrial sites up, which is essential if we're going to bring new businesses here" (McGovern). Through the U.S. Department of Housing and Urban Development these funds have been secured.

Worcester's Brownfields sites are attractive to prospective developers because of characteristics including: right mix of parcel size, utilities, and access. Brownfield sites in cities are more attractive to be made pad-ready than sites in rural towns because of the

infrastructure that most companies need to have for the company to be successful. Once the redevelopment occurs benefits such as: increasing the city's tax base, creating more jobs, lowering public health risk, and protecting greenfields from development will occur (Reed and Gross 19). From our view, the major benefit will be the chance for new industries such as: biotechnology, biomedical, and manufacturing companies to build plants in the city. Creating pad-ready sites does have its obstacles. Pertaining to dollar bills, there was a study done two years ago by the Economic Development Office that said if you took the 600+ Brownfield sites their value would be around $300 million. And if all the Brownfields were cleaned up the assessed value would go from $300 million to $1 billion. That is an extra 30 million of revenue for the city's budget (Murray). There is a great opportunity here, as the Mayor said; the sites pose a great obstacle, but the rewards are beneficial to the economy as well as the citizens of the city.

Pertaining to the clean-up's Murray explained one of the problems hindering them, "One frustration that I have had with the city administration and the city manager is that we don't have a team of people working on this solely, on a day to day basis. I think you need to be literally knocking on the doors of everyone who owns a Brownfield site and tell them what we can do about their situation. Some have the perception that the city is going to come and shut them down, and that's not the case at all" (Murray). In September of 2002 the Mayor set-up a Brownfield's Roundtable group, where the members are small business owners who have owned and cleaned a site up, small business owners who own a contaminated site, bankers, environmentalists, developers, licensed site professionals, legislators, representatives from the Congressman's office, and city administration (Murray). During these meetings they consider what can be done

and how it can be accomplished. He is worker to a larger forum in May where anyone who is anyone from the city will attend. His work and the work of many others is needed for the city to clean up its buildings and parcels of land. When these sites are cleaned up they will create more jobs and new housing opportunities.

Past and Current Brownfield Projects

A major example of a Brownfield project was the creation of Medical City in 2000. This was a successful project. In terms of money; the project cost about $215 million, and $42 million to prepare the site. The final product was a hospital with 299 beds and medical offices (Reed and Gross 20). The company in charge of the project was the Worcester Redevelopment Authority (WRA). Coordination and close relationships between all facets of the clean up and construction was the main reason for success. The hospital has created hundreds of new jobs, and transformed what was an unclean part of the city, into a prosperous center of business.

Another Brownfield project in production is the Main South neighborhood. Poverty runs rampant in this area, where unemployment is twice the national average. In 1996, Clark University partnered with the Main South Community Development Corporation to renovate a 100-acre plot of land that includes the neighborhood and the campus of Clark. When these plans were made public an addition was added (Brownfields Assessment Sheet). The plan was to also include the Boys and Girls Club of Central Massachusetts and the City of Worcester. Restoring a 6-block, 30-acre plot within the Main South neighborhood was the extra idea. This spin-off project was named the Gardner-Kilby-Hammond Street Neighborhood Revitalization Project. The estimated cost for a 10-acre portion is $161,500 (Brownfields Assessment Sheet). The major

objectives are to build a new Boys and Girls Club, construct owner-occupied housing, and affordable rental housing. The Main South CDC will oversee the housing.

Worcester County Alliances

A problem that arises in Worcester County is the competition between towns in bringing companies to the Central Massachusetts region. When companies are looking at prospective sites, the county as whole has no character. Each town wants the business just as much as the next. However, when competition gets too intense, the companies will become confused. Roberta R. Schaefer, executive director for the Worcester Regional Research Bureau states it the best, "Too often in the past we worried too much about whether a business was coming to Auburn, Worcester or Shrewsbury instead of worrying whether it would come here or Maryland or Georgia" (Bodor). There lies the problem. Including the city of Worcester, each surrounding suburb adds to the quality and quantity or commerce. Bringing in jobs to the county should be the focus. When surrounding towns become wealthy, residents will enter into the city and spend money, increasing the city's overall economy. And when suburbanites travel to near by suburbs this will also increase commerce over the entire county. It will act as an economic multiplier, increasing the amount of disposable income per person.

The alliance region would be bounded by Westborough (east), Sturbridge (west), Princeton (north), and the state line (south). A study released by the state Department of Economic Development in early October stated, "Towns from the Central region are organized into many different planning bodies" (Bodor). It went on to say, "Coordinating these various groups has proven challenging. The resulting multiplicity of contending

voices has complicated efforts to pursue regional planning solutions" (Bodor). Companies coming into this area have no way of finding out what this county has to offer. Rita A. Moran, VP of the Business Services at the Massachusetts Electric Co. used an analogy to explain the situation, "The economic development community in the Central Massachusetts region is like a group of virtuoso musicians who don't have a conductor"(Bodor).

A plan is on the drawing board, where both the Worcester Regional Chamber of Commerce and the Central Massachusetts Regional Employment Board would participate. If this plan were to take place, it would be headed by an executive committee, which would meet monthly. It would also have a larger board that would meet quarterly. The existing chambers would not be dissolved or changed; the idea will just bring everything "...under one roof." (Bodor). Central Massachusetts is trying to copy already present Regional Chambers, such as the Merrimack Valley Economic Development Council, Western Massachusetts Economic Development Council and the South Coast Economic Development Council. These were created in 1999, and have been an attribute to the towns and cities located within these sections of Massachusetts (Bodor).

Worcester Leadership

Worcester, as a city, is experiencing similar problems that certain industries in the area are dealing with to keep everyone in a prosperous situation. The problem is the inability of the leaders of the city to function as one entity. In a recent interview our Congressman, Mr. James McGovern, talked about the ties between all the assets in the city. "We have some of the best colleges and professors in the county here in Worcester.

We need to tie all this together and have a plan because to me good economic development requires that what is happening on the Westside compliments what's happening on the east side and the south and the north as well. We have a lot going for us. We need the leadership to tie it all together" (McGovern). His opinion is well taken in the city. Being in office for the last three terms, he has become popular throughout the city.

For Worcester to create good economic development the different leaders of the city need to focus in on their own specific duty and not that of their peers. The Congressman used a well-thought out analogy to explain the situation. The analogy was a comparison to his son's Patrick Pre-Kindergarten soccer team. McGovern said, "One kid kicks the ball to the left, and everyone runs to the left. Then someone kicks the ball to the right, and everyone runs to the right. Nobody knows their position, and we're all scrambling around the field without our eyes on the goal" (Bodor). This explains exactly how the city has acted in the past. The city needs to write a precise outline for each project assembled. In the outline there should be a list of information including: the specific goals for the project should be told, how the project will benefit the city and people, and how the project will allow the city to grow (Bodor).

In past projects, the end products for projects have been incomplete. Union Station was reconstructed in the late 90's, and the present state of the train station is extremely unclear. The underlining problem with the station is the inability to find tenants. The cause for such a dilemma is poor planning (Bodor). Another expensive undertaking was the Worcester Airport. Presently there are no commercial airlines flying in and out of Worcester Regional Airport. For the coming year the Chamber of

Commerce will promote economic development of the airport, Union Station, try to create tax equity for businesses, and take part in the Worcester Common project (Bodor).

The Worcester Regional Airport

The plan for the city was discussed at the 127th Worcester Regional Chamber of Commerce annual meeting (December 2002). Many of the problems of the city were discussed. U.S. Rep. James McGovern, Chamber President Mark T. Love, and City Manager Thomas R Hoover were all present. During the meeting topics such as Worcester's Airport, Union Station and the Common were discussed (Bodor).

Despite much involvement by the Massachusetts Port Authority, the airport has failed to retain airlines. Soon after the 127th annual meeting, the last of the commercial airlines, US Airways Express, decided to discontinue service with the airport. They were providing three daily flights from Worcester to Philadelphia with their Dash-8 turboprop planes (Eckelbecker). One reason for the departure is that, between November and December the flights were only around 50 percent filled. "Demand just doesn't exit…we're not filling airplanes, and we're not making money," stated David A. Castelveter of US Airways in an interview with Lisa Eckelbecker. Another, reason was the airline filed for bankruptcy and, as a result, the Corporation planned on eliminating flights to Worcester and Columbus, GA (Eckelbecker). The economic downturn of Airlines can be attributed to the September 11th attacks on the World Trade Center. In 2002 alone, Pan American Airways, American Eagle and ASA/Delta Connection ended flights to Worcester.

Excluding all of these tribulations, the airport might still be able to save itself. Federal and State grants have amounted to $34 million for improvements in the past few years. With that amount of money allocated to the facility, closing the airport is not an option for the time being. As the news broke of the event, leaders of the region issued a statement suggesting that work will continue on improving the airport. "Today we call for a summit of federal, state, and local officials, as well as Massport, airline representatives, leaders from the business community and other interested parties to have an open and honest discussion about the airport's future," statement from U.S. Senators Edward M Kennedy and John F. Kerry, Mr. McGovern, Mr. Murray and Mr. Hoover (Eckelbecker). Even though the commercial aviation industry is lifeless, flights still occur. General Aviation flights, which include corporate jets, air taxes, and other non-commercial flights, take place daily.

The future of the airport depends on many factors. Factors include economic stability in the region, availability of access roads to the facility, more appealing flights for passengers, and many more aspects that must be meant in order to compete with other local airports. Worcester's competitors include Boston, Manchester N.H, Warwick R.I., and Windsor Locks, CT (Eckelbecker). The politician's aptitude to figure out which options are a must for the survival of the airport will determine the f

The Gateway Project

The idea of creating intellectual superiority positioned near locations of businesses is the concept behind the Gateway Project. The Gateway Park area is a 55-acre plot of land bounded by Highland Street, Salisbury Street, Humboldt Avenue, Grove Street, Garden Street, I-290, and Lincoln Street (Martin 13). Paul Kennedy, of Kennedy

Die Castings, explains the project by comparing it to MIT. He wants the park to be like the campus of MIT. Where on one side of the street all Academic Buildings and Laboratories are located and on the other side are private businesses. This set-up will allow WPI students, especially graduate students, the chance to work hands on by researching and developing new technologies that will only advance the infrastructure of Worcester (Martin 17).

The physical structure of the park will be sophisticated and appealing to the people of the city and its employees. The goal for the final product is to have a lively office and residential area, series of plazas, and restaurants, which will feed local residents, employees, as well as the rest of Worcester's people. These visions cannot be completed without the restoration, and clean up of many Brownfield sites (Gateway Project Pamphlet). They have recently, however, begun the clean up and construction of the project area. Just recently in 2002 the Bioengineering Institute was found. Located on 85 Prescott Street and head by Mr. Timothy Gerrity, Ph. D. Along with being beautifully constructed, the research of the park will be ahead of its time.

WPI and the Worcester Business Development Corporation (WBDC) and others have formed an alliance to create the Gateway Park LLC. The project land is separated into 28 parcels of land. The Gateway LLC owns seven parcels, the city owns five, and the rest are owned by private ownerships (Martin 13). Production of the park needs the coordination of the city. The government of the city needs to play a role in rezoning, and help with infrastructure issues. Going back to the placement of the park, Wallace Floyd Design Group explains the idea, "Worcester's current and future market positioning relies to a great degree on its competitive strengths which include the market power of its

existing businesses and institutions, its physical quality and its relative affordability" (Martin 13). The park will include many new and currently operational research tools.

Already the Gateway Project has brought in schools and programs to help grow the area. The Massachusetts Science and Math Academy has been around for nearly ten years. In those ten years they have produced some of the finest young graduates in the studies of math and science. The school is an educational asset that creates value within the project area. Another exciting program is the Manufacturing Assistance Center (Martin 14). In coordination with the Manufacturing Extension Partnership, these programs have been developing highly trained human capital in support of advanced manufacturing. The MAC is also providing Massachusetts Manufacturers with the technology needed to support the 21st century (Martin 14). These schools and programs are being developed to house the WPI research enterprise, which is an extremely important resource of the Gateway. There are many other programs that will benefit both the park and the city.

Along with public programs, the park must also include private businesses, where the collaborations and partnerships with the Bioengineering Institute will produce the transfer of technology. One program, The Metal Processing Institute has been quite efficient in the transfer of information (Martin 15). The MPI has recently, planned for the development of the Nanostructured Materials Processing Technology Center. The focal point of research will be the science and manufacturing technologies of nanostructured materials. This technology, by the year 2015, is predicted to be a 1 trillion dollar industry. The schools, MAC, MEP, and the MPI encompass one part of the park (Martin 15). There is also however, another important section of the park.

Besides the Bioengineering Institute, the Center for Advanced Manufacturing will also play a key role in the park. This part of the park will include the Manufacturing Assistance Center. The basics of which have been already explained in the beginning of this section. However, the MAC is a force in the efforts of the Massachusetts Advanced Manufacturing Leadership Forum. This forum will give support to the improvement in productivity and competitiveness of manufacturing on a global scale (Martin 15).

A major goal for the Gateway Project and the Bioengineering Institute is to use the intellectual capital already existing in the city, mainly WPI, and to create a centralized location where research and development can occur. Another major goal of the project is to bring people and businesses together from Bioengineering, especially concentrated in Biodevices, Biotechnology and Biomedical to create alliances that will be necessary for the future of this city. Central Massachusetts has over 60 Biomedical companies. Between the Biotech Park already in existence, MBI, and soon the Gateway Park, the city of Worcester has staked its future on the new biotechnology industries. Marketing this idea will have businesses streaming to the park. Professor Michael Porter, who helped aid in the research of the project, explains his views of his economic model. The economy of a city, "...must begin with the premise that inner city businesses should be profitable and positioned to compete on a regional, national, and even international scale...the cornerstone of such a model is to exploit the competitive advantages of inner cities that will translate into truly profitable business." (Martin 17). The inner city here will include the Gateway Park. This project, if constructed properly, with the right collaborations, will be very profitable in the years to come. The park will be a stepping-stone for the city to once again be the center of the industrialized world.

Worcester Common Cleanup

In any city, the physical attributes are an important feature of the city as a whole. When visitors enter a city where cleanliness and appearance are lacking, the attitude towards the city lean towards negativity. However, the opposite is true. Behind this theory, the city of Worcester has begun the redesign of the Common. The Worcester Common dates back to 1669, when Blackstone Valley settlers came to the town. They established the common as a training field, constructed a schoolhouse, and a meeting-house (Restoration of Worcester Common). Still today, the common is centrally located in the city. Adjacent to the historic City Hall and major businesses, the common is frequently visited daily. Under the supervision of the City's Managers Office and the Parks, Recreation and Cemetery Department, and help from Congressman James McGovern the project is set for the beginning phases.

In the early 1990's plans began to develop the future of the common. Called the Preferred Plan, the plan called for the improvement of the infrastructure, pathways, open lawn spaces, lighting and access. The state government will match the city's funding. The projected cost is over 7 million dollars. Presently, the city has offered to pay 2 million, the federal government 2 million, and the majority of the rest must come from private investors (Restoration of Worcester Common). The 2 million from the federal government came from the Land and Water Conservation Fund, which Congressman McGovern actively involves him in. Currently, the first phase of construction is underway (Restoration of Worcester Common). This beginning phase will be the completion of the rear plaza so that it compliments City Hall. Renovating the area will include improving such things as: laying down granite paving, wrought iron rails, period

lighting, benches, and 'tie-ins' in order for the common to host major events on the common and plaza. The estimated cost for the first phase is over 2.4 million (Restoration of Worcester Common). Future phases will concentrate on creatively redesigning the reflecting pool area. The need for phases is necessary. The funding is not available to reconstruct the land in one phase. Reinvestments and bidding for funding is a necessary evil (Restoration of Worcester Common). In the appendix part of our paper is a list of the goals and aspirations for the cleanup.

The underlying idea in creating a more aesthetic part of the city is that the new common will make both citizens of Worcester more proud, and make a better impression on visitors who come to the common. The Vision Statement for the project cites: "Upon the successful conclusion of this process, the articulated goals of so many will have been achieved, and the social, cultural, historical, institutional, and commercial fabric of our city will be greatly strengthened. Worcester Common, a place to gather, a place to enjoy, and a place proudly recognized by all, will have been restored to its former glory" (Restoration of Worcester Common). The final product will enhance the city's appealing ness for small and large companies to come into the city and run their businesses. This will create more jobs, and increase Worcester's economic status. As I said before, the look and feel of a city is just as important as what it has to offer.

The New Marketing Plan

Worcester has recently adopted a new marketing approach. Headed by Adrienne Davis Brody and Dana Dolabany, many people comprise the marketing team. The team is called DBD. The city government and the Worcester Marketing Corporation approved the plan in June of 2002. The team proposed three different budget options: one was for a

budget of 750,000, the second for 930,000, and a superior 1.3 million budget. With the economy in a lagging period, the City Counsel chose the least expensive of the three. In order to obtain the money needed the city government and the Chamber of Commerce allocated 150,000 each, and a left over of 300,000 from last years fiscal budget, was also allocated to the strategy. Adding these figures up it only equals out to 650,000, 100,000 less than what the team wanted (Nemeth). Mr. Gerry Gates, chairman of the marketing corporation noted on this event, "That is less than we need for a baseline effort...because there will be no leftover from the current municipal budget, we'll have even less money next year. So we must get the biggest punch out of every dollar" (Nemeth). The marketing campaign is extensive and carefully planned.

The slogan for the campaign is, "Idea Central, Where Big Ideas Grow Fast." The strategic planning effort has three objectives to complete. The first two objectives deal with economic development in the city (Nemeth). This objective it to attract new businesses to the Greater Worcester area and to maintain the presence of the businesses already developed, especially the companies in industries that are growing. And the third will highlight the quality life of Worcester's people. The target markets are companies in the industries of biotech, healthcare, and education. The types of promotion in use are radio, print ads in conventional publications such as the Wall Street Journal and trade magazines (Nemeth). The promotional mix is not however, including ads on television and popular magazines. An example of a print ad, has a picture of shiny nails drawn to a bright-red magnet, and says "Worcester. It has the same effect on biotech companies" (Nemeth). Another innovative ad portrays six kittens drinking from a milk bowl at once and in text reads, "Worcester. It has the same effect on growing companies" (Nemeth

November 2002). Along with printed advertisements, they are also using the radio to spread their message. Addresses by Kevin O'Sullivan, from MBI, Fallon CEO Eric H. Schultz, Clark University President John E. Bassett, and Polar Beverages Ralph D. Crowley Jr. Each speaker discusses the resources and opportunities of the four major sectors of industry: biotechnology, healthcare, education, and manufacturing.

Worcester is in a great location for economic development. Located 50 miles from Boston and Providence, this region is known for its intellectuality. Worcester needs to take advantage of being in such a location. The main strategy is to focus on clusters [clusters are defined concentrated group of like businesses and industries] (Nemeth). Worcester County, also known as Greater Worcester needed to be defined in order for the marketing campaign to focus in or their market. They ended up defining it "as a region located in Central Massachusetts that includes 24 cities and towns surrounding Worcester and is bounded by Route 495 and the Rhode Island and Connecticut borders" (Nemeth). City Manager Thomas R Hoover seemed quite optimistic about the most recent marketing approach, "This effort is different from the previous ones for three reasons. First, it is based on a private-public partnership; neither the city nor the chamber could do it alone. Second, a bonafide corporation, with a 24-member board of directors, is overseeing the campaign. Finally, we are working with top-notch professionals" (Nemeth). This new-aged marketing philosophy will help the new projects, especially the developing Gateway Park, to bring in new businesses. Marketing is a way to sell something, in this case a city. By showing perspective companies what we [Worcester] have to offer, more and more lucrative opportunities should come this way.

Collaborations

Touched upon slightly in other parts of our paper, we are going to expand on this idea of collaborations between the industries. The Central Massachusetts area, especially, Worcester has the opportunity to create a new industry, Science Manufacturing (Eckelbecker 3 December 2002). "Biotechnology and pharmaceutical companies with drug-development operations here should look to open drug-production facilities here when their products reach that stage," stated Michael P. Hogan, President and CEO of Massachusetts Development Finance Agency (Bodor 10 October 2002). However, many things need to be accomplished before these collaborations can take place. Having enough ready sites [i.e. Brownfields] is one of the problems, along with trained labor, and the ticket price to run a manufacturing plant in the city. All of these, including more, are pushing back the timetable for Worcester to hold both the research/development and the manufacturing sides of the production.

The Brownfields have already been discussed. Therefore the next problem in creating alliances is the amount of trained labor. In Central Massachusetts there has been a movement where trained labor has moved away, and in their place less-trained workers have arrived. Adding to this, the enrollment of colleges and universities is also down, for which highly skilled labor is needed for some manufacturing jobs (Eckelbecker 3 December 2002). A recent forecast suggests that one-third of all skilled manufacturing workers will leave Massachusetts and Rhode Island by the year 2020 (Eckelbecker 3 December 2002). Adding to this dilemma, President George W. Bush is going to cut funding for extension partnership programs in the next federal budget. When Congressman McGovern heard of the news he was anything but pleased, "If [the]

government cuts back on training, we're not going to be able to compete for these manufacturing jobs" (Eckelbecker 3 December 2002). Creating programs where professionals teach perspective employees is a great way to learn the job. If the budget is cut for these programs Worcester will need to react quickly to maintain a manufacturing presence. Hopefully the next president will see the need for such programs and will add more federal money for their needs.

Another problem is the expense associated with running a manufacturing plant. In study by The Boyd Co. Inc. of Princeton, NJ, ranked 50 U.S. and Canadian cities based on an annual cost of running a 75,000 square foot light manufacturing plant. The city of Worcester was ranker 16th most expensive, where the cost was $10.93 million per year. They were ranked behind Boston, but before other local cities such as: Springfield, Hartford, Portland, and Providence (Espisito 24 November 2002). With the down turn in the economy, the number one priority for manufacturing companies is cost. Worcester has become expensive for a few reasons. The slow population growth , 5.5 percent from 1990 to 2000, which is extreme when compared to the national growth of 13.1 percent, has created inflationary wages and lesser amounts of skilled workers (Espisito 24 November 2002). Another reason is the city's tax rates. Worcester's Industrial tax base has fallen to 25.1 percent from a 30 percent margin in 1996. This in turns decreases the value of property. In surrounding towns property value has risen 23.5 percent while Worcester has risen only 5.5 percent, a significant difference (Espisito 24 November 2002). Worcester is in a state of economic turmoil. Once the economy is back on its feet, more state and federal money should be coming this way to aid in Worcester's development.

When the economy comes back, and the tax situation clears up in the city, Worcester will be a prime target for companies to locate. With the new technology industries already present, manufacturing companies will be looking to outsource their production, and high-tech manufacturing companies will see promise in this region. Cited by John J. Healey, CEO of the Manufacturing Advancement Center in Worcester, he explains about Worcester's manufacturing capabilities, "Worcester is an ideal place for high value-added manufacturing. If you want to make T-shirts, go to China" (Espisito 24 November 2002). Way back when, Agriculture was the prime means of making money, fifty to a hundred years ago was steel and other metal manufacturing, and today the economy has shifted again, to more of a high-tech/service manufacturing. Mr. Gordon Lankton, Chairman of the Nypro Co. has the same view, "Manufacturing is going in a similar transition because the process is getting more sophisticated and automated" Nypro had recently won a prestigious award from the Massachusetts Manufacturing Achievement (Bodor 10 October 2002). They currently employ over 10,000 including 4,000 in China. Nypro is an Electronic Manufacturing Systems company where they only to the process of making the products. They take no part in development or research, they solely produce and manage the supply chain (Gordon Lankton 22 December 2002). Again Worcester has a great intellectual cluster of men and women who can create these products. The collaborations will take place in the near future. And when these are accomplished, the city's economy will rise is direct relationship with production.

Leaders Views on the Future

Worcester leaders are optimistic about the future, "I have an optimistic view with the Manufacturing sector. New collaborations must be completed. We have some of the best colleges and professors in the county here in Worcester. We need to tie all this together and have a Plan," says Congressman McGovern (McGovern). A colleague of his, Julie Jacobson has the same opinion, "The biotech field can sub net into many different areas such as bioengineering, bio-informatics, and distribution, biomedical devices and instrumentation. We still have a very strong manufacturing base in Worcester, and in the region. That base has shifted from the traditional manufacturing to a more modern, high tech manufacturing. It is still a very strong industry" (Jacobson). The Mayor, another non-industry leader, has his view for what the future will bring, "...we can remain competitive in brain power. What is the cutting edge manufacturing, how we can integrate it with biomedical research, and there is a convergence with cellular technology, computer technology with manufacturing, and that's where we can stay ahead of the game, and Worcester is well situated in that regard. We've got WPI, that is a premiere engineering school, well known for its research, manufacturing and other ones, and it's one of the reasons why a lot of business and industry has spawned in Worcester. If we can couple that with the medical and health communities, there is a convergence with a lot of those life sciences, so we can stay ahead of the curve. I hope we do because the manufacturing industry has been a very important part of what Worcester and Central Massachusetts is all about" (Murray). All three of these administrative leaders, who will have a hand in what happens, have basically the same idea of how Worcester can remain competitive. The underlining theme is to keep

Worcester a strong manufacturing base, because it always has been, and to keep the push of development in the new technology industries. If Worcester can obtain these goals, it will be one of the top industrialized cities in the World.

Suggestions to Next IQP Group

With time constraint of three seven-week terms, it would impossible to research every industry well, and to develop a concise plan for the future of Worcester's economy. Our focus was towards the new technology industries (biotechnology, biomedical, bioengineering, and bioinformatics), and how these present and future companies will compliment our already existing manufacturing base in the region. Another center of our research was towards non-industry topics such as: Brownfields, political issues, and clean up projects to boost quality of life. Obviously more time could be spent on these subjects, but we believe we have hit the key points for these topics.

We suggest to the next IQP to approaching this project that they do more one-on-one conversations [i.e. interviews] with leaders in each of the industries, participants in politics, Chamber of Commerce important members, and other significant leaders in their respective associations. Our findings were that interviewing key players in the city was a better source of information than a newspaper article or other written documents. For example, we were never able to set up an interview with the CEO of Advanced Cell Technology, Michael West. Others that would be of great interest could include: Alejandro A. Aruffo, President of Abbott Bioresearch Center; Mr. Paul Kennedy of Kennedy Die Castings; Mr. Howard Greis of the Kinefac Corporation; and Thomas R. Hoover, Worcester's City Manager. These men all have experience in different aspects of

the economy, and would give a lot of information to your project as long as the right questions are asked. Using our plan of video taping the interviews was a good idea on our part. We would suggest the same approach.

Our final suggestion would point you towards more companies to research. At the Biotechnology Park there is a plethora of small to medium sized research and production facilities. Along with more biotech companies we would suggest looking at more manufacturing companies in the area. Manufacturing in this area has declined, but new high-tech manufactures have an opportunity here, especially with all the new technology industries looking to outsource their products. We would strongly recommend that more manufacturing companies would be profiled.

The BVNHCC using our video

We videotaped our interviews in a Digital 8 camera. In order to edit these tapes we had to convert the digital 8 tapes to "mini DV" tapes. With the help of Mr. Keith Babuszczak, who works at the ATC here at WPI, we were able to convert these in a short time. This digital format is appealing when editing video, its must faster and has a better quality than linear editing [i.e. VHS editing]. However, when we hand in our final project we will be giving a final video in VHS format and maybe a digital format. We are skeptical on the digital format because we are not aware of technology offered at the museum's locations. This being so, we think the video interviews could be used in a related exhibit when the museum is finished. If not, the creators of the exhibits could use our video as a starting point or reference point during their projects. The ideas expressed in our interviews are important to the city because present day topics, future ideas, and

plans were discussed during them. We would love to see a part of an interview used in an exhibit.

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Deliverables

Tape 1: Julie Jacobson

Mrs. Julie Jacobson, *Worcester Regional Chamber of Commerce*

Background

Julie Jacobson is the Director of Regional Economic Development for the Worcester Regional Chamber of Commerce, responsible for regional economic development activities on behalf of the Chamber and its four affiliates: Auburn, Blackstone Valley, Holden Area, and Webster-Dudley-Oxford. Julie is a graduate of the College of the Holy Cross in Worcester and earned a Master's Degree in Business Administration from Anna Maria College Graduate School in Paxton.

Synopses

Mr. Kevin O'Sullivan referred Mrs. Jacobson to us, so we took the suggestion and set up an interview. The interview brought up many points including the present economic state, positive attributes of the city, problems hindering the city's future, and the possible look of Worcester's future industries.

Interview Questions and Answers

What is your major role in the Chamber of Commerce?

I am the director of regional economic development here at the Worcester Regional Chamber of Commerce. The WRCC has five chambers: Blackstone, Worcester, Webster, Dudley, and Auburn. Those five affiliates cover 24 towns with Worcester included. Our role is to promote economic development in the 24 communities. We do it in two focuses, direct and indirect involvement. For the active economic development we work with business development assistance, working one on one to expand and relocate in the Worcester area. Jim and I work with financial alternatives, government loan programs, and non-profit loans. We identify potential real estate sites through a site search project advocacy, get contacts in the area, and walk companies through the development process. We act indirectly with work force development; brown fields, marketing, available sites, and pad ready sites.

What do you see as the future commerce and economy in Worcester?

It varies in the region, but the top industries are health care, biotech, and more high tech manufacturing. The biotech field can sub net into many different areas such as bioengineering, bio-informatics, and distribution, biomedical devices and instrumentation. We still have a very strong manufacturing base in Worcester, and in the region. That base has shifted from the traditional manufacturing to a more modern, high tech manufacturing. It is still a very strong industry.

Do you think any industries could take a hold on the economy like biology did?

Every major sector has the potential to, but if you look at the SSC codes: manufacturing, construction, utilities, transportation, wholesale, and underneath it all there are hundreds that fall within those. You also have the potential of getting down to the 3-4 digits SSC. In the early 1990's a lot of high tech started to come in, and back before it actually hit, high tech was really starting to come to the Worcester area. Likewise, fiber optics, which came into play in the late 1990's, and then biotechnology has really emerged in the last eight years. High tech peaked in about the year 2000, They were emerging industries, then solidified, and now have a good chance of having spin off industries, to more distinct high tech industries. A traditional process of manufacturing back ten years ago, right now could be a very high tech manufacturing process. That opens the door for an entirely new industry. I think that high tech will come back, but it leveled off and the growth right now is at about 8% annually, and before 2000 it was 28%. I don't think you will see that growth factor for high tech again soon, but the industries are still solid, but not rising incredibly. Pharmaceuticals, medical devices, and bioengineering have great potentials still. All of the R and D companies that are out there that are researching biotech and various drugs and pharmaceutical products will ultimately have to go to the manufacturing stage, and we are hoping to grab that sector here, while the drugs are being researched, so those companies will eventually have the products that are FDA approved. When they reach that approval, they will go to the manufacturing stage; and we want to keep that manufacturing stage here.

Do you see Biotechnology complementing manufacturing?

Worcester has five organizations that are dedicated to some aspect of economic development, financing, economic planning, business development, and financial assistance, which is what a community needs to be successful. We also need intellectual capital, a skilled job ready work force. There are 16+ colleges in the area also which will make Worcester very competitive. One problem is that there are not enough pad-ready sites available than they get requests for. The brown fields are a big problem, because there are over 200 + documented ones, and 400+ not listed, but need to be assembled and cleaned to put a big company there. There is plenty of room to put businesses in the surrounding towns, but they don't have the physical infrastructure of a city with water, sewer, roads, and other various options a city has.

Tape 2: James McGovern

Congressman James McGovern, *Congressman 3rd District Massachusetts*

Background

Jim McGovern was born on November 20, 1959, in Worcester, the son of two successful small business owners. McGovern attending American University and earned both his Bachelors of Art in 81' and his Masters in Public Administration in 84'. Throughout college he served as an aid in the Office of U.S. Senator George McGovern, and in 1984 he managed Senator McGovern's Presidential Campaign. Besides being the Congressman for 3rd District of Massachusetts, he volunteers at the Mount Carmel house, an emergency shelter for battered and abused women that is administered by the

Carmelite Sisters. He is also a member a member of the Jesuit International Volunteers Board of Directors. Jim married Lisa Murray McGovern, and today they a son, Patrick, and a daughter Molly Ginette.

Synopses

Interviewing the Congressman was a great opportunity to get his views, which are greatly respected, on current issues hindering Worcester's chances of moving forward. In the interview we learned about the Gateway Project, and Worcester Medical City Project. The majority of questioning was focused towards the Brownfield problem and the lack of cohesion between all the leaders of the city

Interview Questions and Answers

What have been the major changes in Worcester's Economy since you have been in office?

There is a lot more economic development going on in the city since I first got elected in 96'. A lot of the successful economic developments are collaboration between the city and the colleges. We're working on a project called the Gateway Project with WPI. Which is about revitalizing the Prescott St. area into a Biotech Park/Medical Devices park. This project is very important to the future of Worcester. There is alot more that needs to be done in the city. We need to develop a comprehensive plan, which we do not have as of right now. I still feel we're doing things as they arise without

connecting all the dots, but we are moving in the right direction. We just need to in the near future bring everything together.

How is Worcester dealing with the Brownfield Problem?

Well, we have a significant Brownfield's problem that most urban areas have. We are the home of the Industrial Revolution and we made all kinds of things, which were vital to the economy but their wasn't much attention put on our environment. Therefore we have a lot of vacant buildings here in city, which would be great places for businesses. They need to be cleaned up and that's a multi-million problem. The Federal and State government have given funds to the city. Property by property we are beginning to clean the old industrial sites up, which is essential if we're going to bring new businesses here. Worcester Medical City is the biggest Brownfield Sites in the country. That used to be a polluted site and now it's a hospital. A bunch of buildings in the Gateway Project are Brownfield sites that have been cleaned up.

What is your view of Worcester's future industrial sector?

I have an optimistic view with the Manufacturing sector. New collaborations must be completed. We have some of the best colleges and professors in the county here in Worcester. We need to tie all this together and have a Plan because to me good economic development requires that what happens on the west compliments the eastside and south and north. We have a lot going for us. We need the leadership to tie it all together. I like

to joke about economic development in the city. It reminds me of my son, Patrick's, pre-k soccer team, when some kid kicks it to the right they all run to the right, when one kid kicks to the left they all run to the left. They all do this with no regard for their position. Well, that's like here, they all follow the ball but we all have position assignments and we must fulfill those assignments and to the extent that we can do that. I think we have an optimistic and very good future.

Tape 3: Gordon Lankton

Mr. Gordon Lankton, *Chairman Nypro Co. Clinton, MA*

Background

Mr. Lankton is a native of Peoria, Illinois. He received a Mechanical Engineering degree from Cornell University in 1954 and served two years in the Army in Europe. He started his business career as Plastics Technologist at DuPont, then as General Manager of Injection Molding at Stanley Tools, and for the past 40 years at Nypro Inc. starting as General Manager and then as President for over 30 years and now as Chairman. Nypro currently has 30 locations around the world.

Synopses

This was our first and only interview with a manufacturing twist. Lankton, Chairman of a global corporation, is well respected in the world economy. We wanted his views on the present and future of manufacturing in Worcester country, as well as its future in America. Some interesting information came out of this interview. The main

topic was the change from regular manufacturing to a more high-tech type of manufacturing.

Interview Questions and Answers

What is the new role of manufacturing companies in the economy?

Manufacturing has been decreasing in the USA, but in the economy of the world it is still very strong. At one time, agriculture represented over 50% of the US economy, now it is only 4%. Manufacturing is going in a similar transition because the process is getting more sophisticated and automated. Less people are getting jobs in the industry and it is moving father away from our communities. China can produce almost anything 30% cheaper than any other country. One exception would be more high-tech manufacturing processes, or in health care where the FDA has certain regulations that need to be passed.

What are the new trends in the manufacturing industry?

In the last 6 to 8 years outsourcing has become a new trend that companies have adapted to. Large companies of 50,000 to 100,000 employees don't manage as well as the smaller ones. In addition, the low cost of manufacturing overseas plays a part. These companies don't want to manufacture anymore, because they can't be competitive, so they have moved away from the manufacturing process. They usually now develop or invent new products and then have someone else manufacture them cheaper. This

brought a whole new part of the market called outsourced manufacturing. The companies who only do the manufacturing are called EMS companies. They produce and manage the supply chain. We were only supplying plastic components, and large companies didn't want to do the whole manufacturing process. They want the EMS companies to do that part, and the end result is squeezed price and profit margins for the original companies. Now we assemble our products along with the original work we did injecting plastic molding. An example of this would be putting our products in circuit boards and speakers before shipping them out.

How do research and development play a role in your business?

We are basically only a manufacturing company. We leave it up to other companies to research and develop. A large part of our business is also analyzing the developed products and look for better ways to make the product. Product design is an important part because by developing new ways and techniques for injection molding it speeds up the process and makes it more efficient. We also are constantly developing new management techniques and giving our employees new incentives to do a good job.

Do you see manufacturing businesses complementing the new technology industries?

Manufacturing is a key part in it because people can design products but if they can't be made, then there won't be any products. There are a lot of electronics and high tech products as opposed components. The new trend is to use circuitry and new ways as

opposed to the old way of manufacturing. Still also, someone has to put it together, but old line manufacturing of bolts, screws, and gears are steadily decreasing.

How has computer technology or the Internet changed your business?

It has completely changed every part of the economy. We have thirty plants around the World, and our customers insist they be managed from one location. Nokia insists that the whole world be managed from Finland or Denmark, so we have to set up a remote location near them, and manage all the activities including Hungry, China, Mexico, and other locations. We have to establish the networks that tell them exactly what's going on around the World. If they need to change a part, they will just tell us once, and Nypro has to make sure it happens immediately all around the World. Everything has to change in exactly the same way so the products are interchangeable. So computer control along with shipping is all computer related. No one likes to keep inventories any more because it is expensive and the products change rapidly and there can't be wasted product. It is very important to set up the supply chain to control inventories to make sure we don't have too much or too little of a certain product. All kinds of information systems are needed and it is all electronic.

Are manufacturing companies looking to different areas of the industry than they did in the past?

We have no intention of doing anything other than manufacturing, and now it has turned to more assembly, either sub-assembling or producing the entire product. So we are not looking elsewhere, but you have to be in a position where you can do this anywhere in the world because everything can change on such short notice.

Tape 4: Kevin O'Sullivan

Mr. Kevin O'Sullivan, *Vice President of Business Development for MBI*

Background

O'Sullivan received his undergraduate degree in Health/Physical education from Springfield College, and then received his Master's in Public Administration from Clark University. In 1984 he worked at the Chamber of Commerce and the Worcester Business Development Corp. He is also very active in the community. He ran against Mr. Peter Blute for the 3rd District Congressman in the early 90's.

Synopses

During this interview, which we consider our best one, we learned about the vast research and development facilities in the Bio industry of Worcester. The present state of the industry was discussed as well as his views of the future. Specific companies were talked about, as well as individual new technologies being developed. O'Sullivan seemed very excited about the future of these technologies.

Interview Questions and Answers

What was your background before you came to the MBI?

I had an interesting background; back in 1984 I worked with the local chamber of commerce and the Worcester Business Development Corp. I helped put the first shovel in the ground at the Mass. Biotech Research Park down on Plantation St. across from UMASS. That was my introduction to biotechnology. They say Bio what? No one really knew what it was, but it was the business leadership of Worcester that created this industry in terms of this region. That was my introduction. I've also time in the Legislature, which I was a part of for eight years. I arrived here because a friend of mine took a job as the president of this organization, and needed somebody to kind of navigate the local waters. I'm pretty familiar with what is going on here. I've always had an interest in the life sciences and biomedical, in particular on the development side, in economic development.

What is your education that you've had?

I have an undergraduate degree in health/physical education and recreation from Springfield College. I've also got a masters degree in public administration from Clark. I've got a lot of community-based experience out there in the real world over the years in a variety of ways. I've been very active in the community in a variety of different areas so taking that education and my own experience; it gives me a pretty good idea of what's going on out there, especially in the biomedical field.

What are some up and coming bio-tech/med companies in Worcester?

Let me start off with the biggest. That's Abbott Biological Research, formerly BASF. They are developing a D2-E7 rheumatoid arthritis drug; by all accounts it's in human clinical trials. It's been likened to "liquid gold," and if that hits, I believe it will revolutionize the rheumatoid arthritis care and treatment. That's being developed here in Worcester. It will not be produced here, but all the pilot manufacturing is going on here and it's producing a lot of jobs. By the year-end, Abbott will have about 800 jobs here at the biotech park. Another company is Advanced Cell Technologies, which took the world by storm last summer if you remember around the human cloning. ACT was the company from Worcester, at the biotech park doing therapeutic cloning. So that company is big. Another company would be called ViaCell, formerly T.Breeders. T.Breeders is one of the companies we got started. They are doing stem cell therapy work. They came to us 6-7 years ago, and people said what stem cell therapy was? Well today it's huge. Athena Diagnostics, another company that does neuro-testing and nuero-physciactric work. Again a big and up-and-coming company. Another company called Bio Valve, which is a non-invasive glucose monitoring system, for not only the insertion, but also the monitor of medicine around diabetes. The Biomedical Research models Inc. has developed a type-2 diabetic rat. As you know most medicine goes through rats before going into humans, so this gentleman, retired from the state, and in his 40's about five years ago now has 45 full time employees in Worcester. Here in this facility we have 38 employees and eight companies doing anything from human heart, cell tissue

research, infectious diseases, colon cancer, specialized pharmaceutical testing, protein chips. You name it; this innovation is going on in the Worcester area. So that gives you a pretty good appetite of what's out there.

How do you compare the biotech to the biomedical fields?

The biomedical is really the umbrella we define as biotech, medical devices, informatics, encyclical biology, molecular biology, and computer science. Those three fall under that umbrella and they are all interrelated, medical device, biotech, and computer science, wet and dry labs. That distinction and the whole drug discovery process is all becoming blurred that they are all interrelated. Biotech is distinct. We at MBI several years ago just focused on biotech, but there was a board mandate about five years ago to say hey, let's broaden that mandate to include the medical device, computer molecular biology, and informatics side. It's hard to have one without the other today, especially in the drug discovery process.

What is your major role at the MBI?

I work for the Chamber of Commerce's private non-profit economic development engine for biomedical, and the life sciences in central Massachusetts. Our simple role is to create small start up companies and grow them to be the chief cheerleaders for the biomedical industry. We now have over sixty bio companies in Massachusetts with roughly 2700 jobs, and the companies are generating close to 350 million dollars in

revenue a year. The projected revenue for 2010 that they will be generating is one billion dollars. So it's a growing industry by leaps and bounds. It's a well-organized cluster, but our role primarily is to start small startup companies. We have another facility on Barber Ave., which is occupied by thirteen companies with 57 total employees, all small startups. Our first graduate from this facility during the latter part of next year, first quarter is going over into a 10,000 sq. ft. space at the biotech park. So that's a real win-win that just got started here sixteen months ago, and now they are growing to be independent, with up to fifteen employees in the park. That's the kind of growth we like to see and promote.

What have been the major advancements in the bio-med field in the past years, and how has Worcester played a role in that?

The number one engine in terms of growing this field has been the UMASS Medical Center and School, which is why the Bio-med field has grown here in central Massachusetts and in Worcester. That's why the biotech park was built here in 1984, because it was right across from the teaching hospital. What is our product? Its brains, and if you look at Tuft's Vet nary School, WPI and the bioengineering institute, the Mass College of Pharmacy, which has 400 students, the Charles River Laboratories, which has 570 employees in Lincoln Square doing animal testing, ten to twelve colleges in the area, and an 800000 sq ft biotech park in Worcester. If you add all of that up, it points in the area of a growing industry. So it's grown since 1984, when the shovel went in the

ground at the biotech park, and all of that evolved because twenty-five years ago the UMASS Medical School and teaching hospital was established.

What do you see as the future of the Bio-med industry and what will Worcester's role be?

I'm absolutely convinced it's our economic future. If you look at all the organizations, agencies, and groups I talked about in the previous question, and take all that, with the health care we have like the Fallen Community Health Plan, UMASS Memorial System, and St. Vincent's Hospital, Massachusetts is a medical Mecca. I am convinced it is our economic future in terms of job growth, and we are seeing that very clearly because we monitor it every year. As I mentioned before there are sixty companies now, and we will monitor it every year, and it will continue to grow. I mentioned it would be a billion dollar industry in 2010; well that's not pie in the sky numbers. It's based on growth factors we have seen over the past few years, especially since we have tracked it starting in '84, when we began this effort.

How has computer technology helped in the advancement of the bio-med industry and other fields you are familiar with?

Computer technology and computer science will be the most important aspect of the biomedical field. I mentioned earlier the molecular biology and computer science side of the equation; the dry lab side will play a role because right now we have a lot of wet labs, with a lot of people generating lot of data through experiments with the human

genome and public domain documents. What you generate in the lab needs to be siphoned through, coming out with accurate data especially in the drug discovery process. Pharmaceutical companies do not have many drugs in the pipeline right now. It's drying up. That's why it's important for the wet lab data to be analyzed in a much quicker and cheaper way so we can get new drugs in the pipeline, and do it quicker and cheaper. When that is accomplished we can get more drugs in the pipeline. In the near future we will be able to take data out of the wet lab and compute it back to the lab within 72 hours, what would take two scientists one hundred years to do manually. So the computer will play an incredible role in advancing science, and advancing the wet lab efforts that are there right now.

What are some important current technologies being developed in the biomedical field?

This encyclical biology, its bioinformatics is the new wave of computer science and molecular biology. To me that's the most important technology that is being developed. The computer is taking public domains and all that information and making "sense" out of it. There is a company here called Sierra Informatics, which is creating desktop software that can download all the needed information and put it on a disk to, give it to the bench scientist to look at an enzyme or the cell, or to take a look at the pathways in the body to travel down and which ones not to. If there are 3000 pathways to be discovered, as you research that particular enzyme, if you know that only 30 pathways should be looked at and all the other one's should be rejected, based on the computer's research that will save you time and money in getting to the end of the line. There will

always be a new need for the wet lab side of technology because there will always be quicker and cheaper ways of experimentation than the bigger pharma's. All of these big companies like Pfizer, Merck, and Novartis are coming to the state because they are seeing all the small biotech companies creating all these wet lab experiments around certain technologies for the treatment and prevention of illness or disease. So that technology and the small cap biotech companies are really the wave of the future to watch. You will also see smarter, quicker, cheaper, more innovative ways to get to the drug discovery process like we've never seen it before. Ten years from now you won't even recognize drug discovery, it will happen so much quicker and cheaper, and more innovative. In the US this year there were four million prescriptions filled. In five years 5 billion will be filled. That tells you the acceleration of drug discovery that will be needed to keep people living longer and healthier.

Did the events of September 11th affect the biomedical field, and were there positive and/or negative effects?

On the positive side, it showed that more research dollars and work must go into the experimentation on things like anthrax, or other diseases that can be used against us in warfare. We are talking about a whole different nature. From that perspective, we are looking from a science side at doing more. September 11th rocked the economy in this country and they hit it hard. We are recovering, but the stock market is going to take a while. Our whole business is dependent on value in companies. Value equates how much money to levy for venture capital. Research and development has been hurt, but

we will survive. Our product is brain, and people will do it with more innovation in teams, and that's a whole new innovation. No matter what your business is, teams are the wave of the future. People will complement, coordinate, and produce a better product, whether it's on the hardware side, software side, or drug discovery. It woke us up to looking at science being a very important part in our make up, and the federal government is creating more dollars for development.

(No Tape Available)

Mayor Timothy P. Murray, *Mayor of Worcester*

Background

Timothy Murray is a graduate of Saint Johns High School in Shrewsbury Mass. He graduated from Fordham University with a BA in American Studies. He then went on to get his law degree the Western New England School of Law. He is currently serving his first term as Major, and his third two-year term as Councilor-At-Large, along with being a private practice attorney. He is married to the former Tammy L. Sullivan.

Synopses

Being the Mayor of the city, he knows the happenings of everything going on. We asked him the same exact questions as we asked the Congressman. We heard his point of view on these subjects. We wanted to obtain for information on major changes in the city's economy, the Brownfield problem, and the future economy.

Interview Questions and Answers

What have been the major changes in Worcester's economy since you've been in office?

The biggest change in Worcester's economy since I've been in office, which is since January 2001, is the real estate market as it relates to residential values. Over the last two years Worcester has the second hottest real estate market in the country, which is very different than what has taken place over the last 15 years. It's interesting when you look at the 1990 census trends and real estate values for 1990-2000. The trend was very stagnant, but from 2000-2002 especially, the real estate market has gone through the roof, in large part because of the commuter rail. People in Boston and around 495 are getting priced out in terms of affordability, and they recognize the value they can get for a home in Worcester. We have a lot of good residential neighborhoods, and that nearly 90% of the people that can send their kids to public school still do. People are increasingly recognizing the value in the residential side, which has also initiated the debate if our future is that or a residential community with a city feel versus a heavy industrialized city, which has been a strong part of our historical past. The real estate market on the residential side is really the story. In terms of the commercial and industrial side, there haven't been significant changes, though the office vacancy rate has decreased. So there is a higher level of the number of people leasing in the office towers, which is a good sign.

How is Worcester dealing with the Brownfield problem?

I've said in my inaugural address, and I've said that as a member of the council; there is no single issue in Worcester that presents a bigger challenge, but also a great opportunity. The Brownfield issue is a complicated issue. It's in terms of how you finance the clean ups of Brownfield property, how you gain control of Brownfield property, and the legal aspects to it. There are a lot of obstacles, but the opportunity for expanding the tax base and job creation is huge. There are an estimated 600 + Brownfield sites in the city of Worcester. The State Department of Environmental Protection has confirmed 250. There was a study don't two or three years ago by the Economic Development Office here in the city, that if you take the 600 sites, there assessed value is $300 million. If you were to wave a magic wand and clean all of those sites up over night, the assessed value would go from $300 million, to $1 billion. That would bring an extra $30 million in revenue for the city, not to mention the number of jobs it would create, and in some cases new housing units. It's an issue that is a huge challenge, but there is no issue that has a bigger return or opportunity for the city in terms of its growth. Back in September I set up a group called the Brownfield's Roundtable. We got small business owners that owned contaminated sites and cleaned them up; we have small business owners that own Brownfield sites; and remember the definition of a Brownfield is confirmed contamination or perceived contamination. We have bankers, environmentalists, developers, licensed site professionals that work in the field, legislators, representatives from the congressman's office, the city administration, and we brain storm and strategize about what we can do to bring more attention to this issue. We are focusing on building up towards a forum in May where we will invite everyone who owns a suspected site to come, and we are going to have the legal professionals, banking

professionals, some of the academic departments from Clark and WPI will be involved, because in this economic climate, there won't be addition resources to go to clean up Brownfield's. Invariably, most people don't know of the existing resources that are currently available from the city, state, federal government, private lenders, and what licensed site professionals can do. When you get information about how a lot of property owners have cleaned up their sites without being shut down by the government, but in fact were assisted by them, I think we can spread the information and get the word out to accelerate the remediation of a lot of the sites. It's in the city's interest to facilitate the clean up of those properties because the assessed value goes up, your creating more jobs, and housing opportunities. As I said there is no single issue that is more important to the city. The Chamber of Commerce will tell you and the people of the city will tell you that everyday they get inquiries about these sites. In many incidences they might be a Brownfield site that is the size of a lot or a gas station, but in many cases they are multi acre spots, maybe three or four, maybe 20 acres. We really have to bring every resource to bear on it. One frustration that I have had with the city administration and the city manager is that we don't have a team of people working on this solely, on a day-to-day basis. I think you need to be literally knocking on the doors of everyone who owns a Brownfield site and tell them what we can do about their situation. Some have the perception that the city is going to come and shut them down, and that's not the case at all.

What is your view of Worcester's future industrial sector?

Not unlike the industrial manufacturing community around the country, there are serious challenges of slave labor in China and parts of Central America where they pay people fifty cents an hour. It's tough to compete given that we have a standard of living hear, OCEA, and people should get a wage that they can support themselves and their families. Ideally you have healthcare benefits, but when you ship a lot of this stuff offshore, most of these countries don't have any of those basic standards of living. That being said, where we can remain competitive in brainpower. What is the cutting edge manufacturing, how we can integrate it with biomedical research, and there is a convergence with cellular technology, computer technology with manufacturing, and that's where we can stay ahead of the game, and Worcester is well situated in that regard. We've got WPI, that is a primer engineering school, well known for its research, manufacturing and other ones, and it's one of the reasons why a lot of business and industry has spawned in Worcester. If we can couple that with the medical and health communities, there is a convergence with a lot of those life sciences, so we can stay ahead of the curve. I hope we do because the manufacturing industry has been a very important part of what Worcester and central Massachusetts is all about. In terms of the economic side, when people manufacture things they have to buy products, goods and services. They pay people good wages, so it's an important part of what we are all about so hopefully we can take that cluster concept, which is being advocated for and networked between existing small and mid sized manufacturers by the manufacturing advocacy center on Prescott St. so we can strengthen that bond and prevent the erosion on manufacturing in Worcester.

Tape 5: Timothy Gerrity, Ph.D

Timothy P. Gerrity, *Director of the Bioengineering Institute*

Background

Ph. D Timothy Gerrity received is B.S., M.S., and Ph.D from the University of Illinois at Chicago. He then received his post-doctoral training in pulmonary physiology in the Department of Medicine at the University of Illinois where he later became a member of the faculty. Before coming to WPI he was the Executive Director of the Georgetown Chronic Pain and Fatigue Research Center (1999-2002) in the Georgetown University School of Medicine. He was appointed director of the newly established Bioengineering Institute in 2002.

Synopses

This interview was our first one. We wanted to learn about the present and future technology of bioengineering. We talked to the right person. He knew everything that was going on in this field with specific and detailed examples. Interviewing Gerrity opened our eyes to the vastness of technology in the city.

Interview Questions and Answers

Before you came to WPI, what advances have you seen in the fields you have been studying?

One is imaging, more specifically, magnetic residence imaging. It has come a long way in the past years, giving you the ability to create three-dimensional images in a body without the use of radioactive material. An example of this is cross sections of the brain that can be viewed in incredible detail. It enables researchers to probe into bodily functions to see how things really work, and gives us an improved ability to treat disorders and anything involved with it.

What is your role in the WPI Bioengineering Institute?

My role is to run an organization whose purpose is to serve as a bridge between the research bench and the commercial sector. We call the space under the bridge the valley of death, because getting from the academic side, in the lab, and turning it into a product is a difficult process. You may have a new idea, but it's very possible that many people have already thought of it already, and you have to figure out if it's usable, or if there is demand for the product. Then it comes to the practical side of marketing, because after that you need investors, someone to make it, and a whole other set of issues to deal with concerning clinical trials and the FDA.

What have been some of the major advancements in the biomedical field in the past ten years? How has Worcester played a role?

Let me expand that to out just a little bit further, for lets say 20-25 years. It has clearly been in the arena of molecular biology. DNA was identified 50 years ago and it

was an amazing accomplishment of basic research and although everybody knew from that point forward that the key to disease was in that genetic code. It was not just a matter of cracking that genetic code; it became a matter of understanding how it actually worked. How did that DNA miraculously form a human body? What processes were being regulated by the DNA to make sure a liver was a liver, a heart is a heart, a brain is a brain, and everything is in the spot it's supposed to be. The same is true with the respect to the disease process. The disease process is embedded in the body, an integral part of the body and often reflects something gone wrong in the instructions of the genetic material. So, molecular biology and the advances in it began to take hold about twenty years ago. Provided techniques and capabilities to begin to understand the real function of the DNA and the human genome in everything from forming an organ, to causing disease. There is a consequence now. Molecular biologist has discovered genes responsible for the cause of some diseases, especially very heritable diseases. Huntington's Disease is one that has a clear link, and long before molecular biologists came along, it was clear the link was there, but only recently was the gene actually identified, that was responsible and present in the mother and father, and resulted in the offspring. One of the things that are really fascinating about this, is that disease is an interaction of the DNA you inherit, and the environment, which you live in. For example, you may have a gene that makes you susceptible to lung cancer, but the lung cancer only occurs if you are exposed to cigarette smoke. Although you have the gene, you may not necessarily get lung cancer, but it explains why not everyone who smokes gets lung cancer. So, these are remarkable things where we are moving forward to a day where we will be able to speak literally about the cure for disease because we will be able

to go in and if there is a deregulation in the process of the body causing disease; we will be able to go into the body and the cells to die, literally, because was will be able to go into the cell and manipulate the genetic material.

What do you see as the future of your industry? What will Worcester's role-play in that?

My industry is the medical device industry. It is more broadly the products for human health that are engineered. An example of a medical device is a cardiac pacemaker or an artificial heart. The one artificial heart that is licensed by the FDA for clinical trials, not yet approved for wide use, is a device that is made by Abiomed in Danvers, Ma. There you see, Abiomed is just an example of many firms that are developing and manufacturing medical devices. Although, there is a lot more encompassed by medical devices than just the very obvious examples. There is application of engineering principles to problems of just being able to provide ordinary clinical care, for particularly the elderly. It is expensive to have people go to hospitals and clinics to receive medical care when that medical care maybe is getting blood pressure checked, a few other vital signs, or talking briefly to a physician about how you feel. That is actually not an inexpensive proposition. We are looking for better ways we could do that from remote locations, so we won't have to move a person from their home to the hospital. That is something that we are working on right now in the institute and the Center for Untethered Health Care. They are developing ways a patient can interact with a health care provider at a distance. These would include the ability to monitor physiological signs such as heart rate, blood pressure, and even things like oxygen

saturation in the blood and hemoglobin count. That if we can measure them on the person themselves, and transmit that information either over a wireless network or high speed Internet, then that can go to the health care provider where those readings can be monitored. In addition to that, it provides a window for the patient to have passively their data sent to the health care provider, and allows the patient to interact with the health care system in a way that empowers them to take charge of their own health, and to learn about their condition because now you can set up opportunities for the patient to learn more about their disease, and find out through an interactive process what they can do to improve their health instead of just taking medicine. There are lots of things people can do. It's managing your diet, exercise, and other things that all play a role in your health. Diet and exercise are hard. The doctor can say eat less fat, but if you have a means to use a piece of software that is working over the Internet that allows you to keep track of what your fat intake is and exercise for the day, then you can actually see on a graph the results. Let's say I took in so many grams of fat today, so I'm going to try to do better tomorrow because there is positive feedback. These are things that we can do today. All the technology is there, and that is important to know that the technology and the science to do many of the things in the development of biomedical devices exist. It's just a matter of taking advantage of them. So for the application I just told you about, the impact could be potentially billions of dollars in health care costs because you can make people less dependent on the health care system. Having people live with a higher quality of life, and not need to go to say an emergency room, and for the elderly this will be very important. If we can have a means of monitoring the status of an elderly person who would otherwise have to be in a nursing home, or some other health care facility,

they can be at home. So not only can the physiological status be monitored, but something like their position. Bill Michaelson, the director for the Center of Unfettered Healthcare, and also a professor in the ECE department at WPI, is one of the leading experts in Global Positioning Systems, and what he is doing is developing systems where we can actually locate someone with in one foot of their actual location and see if suppose, it was mid-day and someone hasn't moved for two hours, or they are doing something outside of their usual pattern. You could accumulate that data over a period of time and find that on the average the person moves so many hours a day, their not, why? So, maybe a phone call or something to see if the person is ok.

How has computer technology helped in the advancement of the biotech industry?

The advancement in computing power is essential. The development of new and better techniques to decode the human genome was made possible by technology, and in the future it will become increasingly important. Bioinformatics refers to the application of computers and software to search the human genome to identify specific sequences for producing something like a key protein responsible for causing disease. The ability to search that enormous database is only possible by computers. Pharmaceutical companies and biotechnology rely on supercomputing to produce their products. Bioinformatics also has other extremely useful applications, like the ability to store huge databases, so things like healthcare records could be accessed and cross-referenced, and we will begin to find out what are real effective treatment for diseases.

How are computers helping with your present work?

In a number of areas at the Bioengineering institute they really do play an essential role. At the Center for Untethered Health Care, we are also moving into the area of bioinformatics. We are trying to work a relationship also with the army on doing a trial using bioinformatics approaches to search large medical records. We also use computers in the Center for Comparative Neuroimaging, which emphasizes magnetic residence neuroimaging technology to explore the function of the human body, the brain, to use it as a diagnostic tool for anything ranging from brain cancer, breast cancer, bone cancer; but the ability to create these images from the raw data that is collected from the device itself with M.R.I. devices to create those images in three dimensions requires incredible computing power and complex algorithms that constantly being improved everyday. So, the Center for Comparative Neuroimaging looks at issues, the hardware and the software. It is important to develop new hardware to view higher resolution images using computer software that can take the raw data and produce an image.

What are some important technologies being developed in your field?

Nanotechnology is one of them, and there is a lot of work going on at WPI with nanotechnology, especially in the Bioengineering Institute, which is the center for molecular engineering, in other words, nanotechnology. Let me say briefly what nanotechnology is because it's said a lot, but it's hard for people to understand who don't know about it. When you think of making something, anything, you start with some raw

material, and you start doing something to that raw material. Say you want to make a statue, you start with a piece of rock and chip away at it. So you start off with a large number of molecules interacting together, and you're just doing stuff to the large aggregate. Nanotechnology is about going at it from another direction. It is to build literally atom by atom that exists at the microscopic scale. So, the promise of nanotechnology is that you can create a machine, or large collection of machines, called nanobots, that for a diagnostic purpose, these machines can do something to go in and measure something directly inside a human's body. They do it in a way that cannot be done externally, so you would inject these little machines in to go to a target organ, tissue, or cell and take some measurements, and they would come out either through excretion or are withdrawn from the blood. They then report back on what was there, what they found. It sounds futuristic, but it's not that far off. There are currently some interesting applications of nanotechnology, for example, to deliver a drug very precisely to a tumor. These are in the experimental stage, but they exist. It's not too far off in the distant future. Related to that is a technology called tissue engineering. Tissue engineering is studying the way one can manipulate tissue cells to grow into an organ. It is very much related to stem cell work, where you take an undifferentiated cell that has the potential to be any kind of cell, but has to be directed in the right way, so you could tell it to start making skin. It has the possibility of treating burns and other wounds with real skin, very rapidly, with no problem of rejection if it's transplanted from a foreign individual, a xenograph. This technology has tremendous promise. Another example is the integration of tissue and inanimate materials such as metals and plastics. So an artificial organ might be some combination of tissue and hardware. It is a very exciting

area. We are also doing work on tissue engineering. These are technologies that did not exist ten years ago, but they do now. The idea behind nanotechnology is surprisingly fifty years old. A physicist by the name of Richard Fineman, who is probably the greatest genius of the 20th Century next to Albert Einstein, had a lecture once called, "There's a lot of room at the bottom," meaning once you get down to the atomic level, there is a lot of room to build things. The bridge from research and basic research to an application can be very long. Where the limitations sometimes are, are just having the technologies available to actually carry out the idea. On the other hand there are areas where the timeline is extremely short between research and product application. That is in the area of biotech. Someone in a lab can discover something today, and almost literally tomorrow, they are on the road to producing it pretty quickly. Actually biotech companies themselves are the rapid outgrowth of that and usually are started as small startup companies by scientists who made the discovery that this could really do something. So, They start up this company where what they are doing is developing further the technology and to a point where they can make something, and at that point a big pharmaceutical company comes along, and purchases the intellectual property by that company.