Letter of Transmittal

13 December 2006
Dr. Diana Bauer and April Richards
National Center for Environmental Research
Environmental Protection Agency
Washington, D.C. 20005

Dear Dr. Bauer and Ms. Richards:

Enclosed is our report entitled *Improving Commercialization of Environmental Technologies through EPA's Small Business Innovation Research (SBIR) Program*. It was written at the Environmental Protection Agency during the period October 23 through December 13, 2006. Preliminary work was completed in Worcester, Massachusetts, prior to our arrival in Washington, D.C. Copies of this report are simultaneously being submitted to Professors Peter Hansen and David Lucht for evaluation. Upon faculty review, the original copy of this report will be cataloged in the Gordon Library at Worcester Polytechnic Institute (WPI). We appreciate the time that you have dedicated to us and wish you the best in all your future endeavors.

Sincerely,

Will Brooks
Lou Grillon
Marcus Lewis

Project Number: 41-IQP-DAL-DC03

Improving Commercialization of Environmental Technologies through EPA's Small Business Innovation Research (SBIR) Program

An Interactive Qualifying Project Report
submitted to the Faculty
of the
WORCESTER POLYTECHNIC INSTITUTE
in partial fulfillment of the requirements for the
Degree of Bachelor of Science
by

Will Brooks Lou Grillon Marcus Lewis

Submitted to:

WPI Project Advisors:
Professor Peter Hansen
Professor David Lucht

Environmental Protection Agency Project Liaisons:
Diana Bauer, PhD
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December 13, 2006

Abstract

This report was prepared for the National Center for Environmental Research (NCER), a division of the Environmental Protection Agency (EPA). NCER runs EPA's Small Business Innovation Research (SBIR) program. This report explores, through background research, interviews, and analysis, how environmental technology travels along the technology continuum to identify ways to be effectively commercialized. The major outcome for this project is recommendations for EPA on how to further develop their SBIR program to commercialize a greater percentage of technologies.

Executive Summary

The mission of the Environmental Protection Agency (EPA) is to protect human health and the environment. EPA has a variety of programs to help prevent, treat, and monitor pollution. The tragic magnitude of environmental pollution is driving the world to develop commercial technology products that will play an important role in mitigating pollution so we as mankind can live healthier lives. EPA's Small Business Innovation Research (SBIR) program looks to assist in the development of innovative environmental technology from an idea to commercialization. Technologies developed through this program provide EPA with a tool to use in their quest to save the planet.

The SBIR program was created by Congress to strengthen the role of small businesses in federally funded research and help develop a stronger national base for technical innovation. The SBIR program is supposed to help each agency achieve their mission through research. Companies receive funding from EPA or other SBIR agencies to do research which these agencies want them to do. The SBIR program is broken up into two parts or phases of funding. Phase I funding is for proving the feasibility of the technology. Once companies successfully complete Phase I they can apply for Phase II funding. Phase II funding is for further research and development of the technology, and hopefully bringing it to market.

Many SBIR supported technologies never make it to commercialization. Our project seeks to discover what can be done to improve the number of successful technologies. This project examines how these environmental technologies can be more effectively developed and brought to market to create a positive change for the environment. The mission is to identify ways to more effectively commercialize

environmental technology, to positively impact the environment. The objectives provided a framework for our project.

- Investigate the institutional context for the EPA SBIR program
- Collect and analyze company background information to interview program awardees for a perspective about technology commercialization
- Write case studies to create a summary analysis

Our major outcome for this project includes recommendations for EPA on how to further develop their SBIR program and work with other programs to commercialize a greater percentage of technologies that successfully complete the SBIR program. The overall greatest benefit to society and the environment represent the greatest success a company can have in the eyes of EPA.

It was determined that to collect the necessary data, interviews of EPA SBIR funded companies would have to be conducted. Qualitative information was collected from these companies through phone interviews. A cross section of EPA SBIR companies were contacted and interviewed. Grounded Theory was used in the development of the interview plan as was the key informant style of interview.

Case studies were written for each company compiling information from the background research, company specific research, and company interviews. These case studies provide a concise yet informative source of data concerning different companies that have participated in the EPA SBIR program. These case studies were then closely examined in the summary analysis to identify trends between the different companies. The summary analysis tries to highlight important similarities and differences and

provide an overview of all the information collected. The summary analysis provided the basis for the conclusions and recommendations.

Major recommendations for EPA's SBIR program include:

- Increase commercialization assistance after Phase II
- Reduce the time of the SBIR application process
- Increase communication efforts

First, after companies successfully complete Phase II of the SBIR program, the level of support and funding dramatically drops. Companies are on there own to find funding to finish developing the product and then market it to end-users. The WPI Team recommends EPA to offer more networking and commercialization support after Phase II. The WPI Team learned from the interviews with companies receiving EPA SBIR funding that there should be additional assistance available after the SBIR program is over. Lists of funding sources should be available to companies once they finish the program. EPA could also provide an opportunity for the small businesses to showcase their work to EPA and its many departments. Lists of technology specific conferences and tradeshows can also be made available to SBIR companies.

Second, as of now SBIR companies have to go through nine months of waiting during the review process to receive approval for funding. This is a major challenge for many companies because they depend on the SBIR funding to support the development of new technologies. During this waiting period companies usually do not have funding so no research is completed. The initial SBIR proposal review time of nine months between the proposal deadline and funding beginning needs to be decreased to six months or less. Companies developing new technology would not have to wait as long

for SBIR funding to begin if this change was made. This would allow companies to keep working on their project and not have to wait around during the decision making process. Reducing the amount of time between Phase I and Phase II from nine months to six months expedites the amount of time the technology ultimately takes to develop. It also keeps the momentum of the project going by shortening the time when companies are not working on the project due to a lack of funding.

Third, EPA does not seem to communicate up to its full potential. A lack of communication means that companies developing new technologies do not know about all the support EPA has to offer. It also means that one program/ department of EPA may be helping a company, but another program/ department could also help that technology if they only knew about it. Another effect is that EPA could be working to leverage their funds with another government agency to fund mutually beneficial projects. EPA lacks communication to technology users, which in turn means that companies developing new technologies do not have interested buyers. It would be of great assistance to SBIR companies and in turn the environment if EPA could publicize existing programs to the general public, small businesses and technology developers. EPA can provide information by creating a centralized database and electronic newsletter. The centralized database could include conferences, potential end-users for technologies, regulation changes, etc. EPA could also publish a quarterly electronic newsletter that would provide information on resources to commercialize environmental technologies along with a list of current SBIR technologies under development. This newsletter would be distributed to various EPA offices and made available on the EPA website. The results of this would be more collaboration and support between EPA offices and SBIR companies.

This report also helps EPA to see the context of other programs offered by EPA and other agencies. Our findings can help EPA SBIR to commercialize the majority of technologies that receive awards. The commercialization of these technologies will help EPA realize its mission of protecting human health and the environment by producing technologies that become implemented. These technologies therefore will benefit the environment. Our project team realizes that not every technology can be commercialized. With the suggested changes, we hope that the EPA SBIR program can become a model program for other government agencies' SBIR programs.

Authorship Page

We, the WPI EPA Project team, Will Brooks, Lou Grillon, and Marcus Lewis have equally distributed the authorship of the written sections incorporated into the report titled: *Improving Commercialization of Environmental Technologies through EPA's Small Business Innovation Research (SBIR) Program*.
Sincerely,

Will Brooks
Lou Grillon
Marcus Lewis

Acknowledgements

The Worcester Polytechnic Institute EPA Team: Will Brooks, Lou Grillon, and Marcus Lewis would like to thank Environmental Protection Agency for providing us with the opportunity to complete our Interactive Qualifying Project (IQP).

We appreciate the time out of their busy schedules that our liaisons at EPA, Diana Bauer and April Richards have dedicated to guide us in the right direction for the project. To our advisors from WPI, Professor David Lucht and Professor Peter Hansen, thank you for your support and guidance through the project.

We would like to express our gratitude to EPA representatives who have in some way, assisted us with providing pertinent information. Finally, we would like to thank all of the principal investigators who took time out of their busy schedules to be interviewed. We would also like to thank everyone that we talked to, be it an interview or a just passing word of encouragement. We could not have completed this project without the solid support provided to us by our university and fellow students DC06.

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List of Acronyms

ASME	American Society of Mechanical Engineers
ATP	Advanced Technology Program
BMES	Biomedical Engineering Society
CEIT	Center for Environmental Industry and Technology
CNS	Collaborative Science and Technology Network for Sustainability
CRADA	Cooperative Research and Development Agreement
DfE	Design for the Environment
DHS	Department of Homeland Security
DOD	Department of Defense
DOE	Department of Energy
EPA	Environmental Protection Agency
EPSCoR	Experimental Program to Stimulate Competitive Research
ETV	Environmental Technology Verification
FRTR	Federal Remediation Technologies Roundtable
FTTA	Federal Technology Transfer Act
GRO	Greater Research Opportunities
HDPE	High-Density Polyethylene
HQ	Head Quarters
HUD	Housing and Urban Development
JAMA	Japanese Automobile Manufacturers Association
IDIQ	Indefinite Delivery Indefinite Quantity
IEEE	Institute of Electrical and Electronics Engineers
IL	Ionic Liquids
IQP	Interactive Qualifying Project
LED	Light-Emitting Diode
MFES	Mercury-Free Electrical Switches
NACEPT	National Advisory Council for Environmental Policy and Technology
NASA	National Aeronautics and Space Administration
NAS/NRC	National Academy of Sciences for the National Research Council

NCER	National Center for Environmental Research
NEMC	National Environmental Monitoring Conference
NETC	National Environmental Technology Competition
NHEERL	National Health and Environmental Effects Research Laboratory
NHSRC	National Homeland Security Research Center
NIH	National Institute of Health
NIST	National Institute of Standards and Technology
NSF	National Science Foundation
OAQPS	Office of Air Quality Planning & Standards
OAR	Office of Air and Radiation
OEM	Original Equipment Manufacturer
OPEI	Office of Policy, Economics and Innovation
ORD	Office of Research and Development
P3	People, Prosperity and the Planet
PET	Polyethylene Terephthalate
PI	Principal Investigator
PRD	Peer Review Division
QA/QC	Quality Assurance and Quality Control
R&D	Research and Development
RTDF	Remediation Technologies Development Forum
SBA	Small Business Administration
SBIR	Small Business Innovation Research
SD	Surface Discharge
STAR	Science To Achieve Results
STTR	Small Business Technology Transfer
TTEP	Technology Testing and Evaluation Program
UV	Ultraviolet
VOC	Volatile Organic Compound

1.0 Introduction

According to a NASA study in 1992, the United States is one of the primary producers of airborne pollutants in the world (NASA, 1992). Pollutants affect our environment, from reducing the amount of ozone in the upper atmosphere, to making water unsafe to drink or swim in. The tragic magnitude of environmental pollution is driving the world to develop commercial technology products that will play an important role in mitigating pollution so we as mankind can live longer healthier lives.

The United States has tried to cut down on the by-products of pollution through systems of regulation and non-regulation. Systems of regulation are laws that the government uses to control environmental effects. An example of non-regulatory systems is the use of technologies that are beneficial to the environment. Many of these technologies and product ideas which could potentially help alleviate pollution never make it to commercialization.

Government organizations like The Environmental Protection Agency (EPA) provide funding programs to enhance the chances of environmental technologies making it to market applications. EPA was established in 1970 to combat this increase in pollution as technology boomed. EPA encourages compliance with these regulations through the application of environmentally beneficial technology. This is developed through research done by EPA and businesses from the private sector. EPA has a number of programs to assist the development of environmentally beneficial technology. One of these programs is the Small Business Innovation Research (SBIR) program. This program has helped some technologies make it to commercialization. The technologies that have made it successfully through the SBIR program have made a positive impact on

the environment and society. However, others have failed; the current SBIR program has a relatively low number of technologies successfully navigating it through completion.

EPA wants to know why many of the environmental technology products assisted by SBIR fail to become commercially successful. The National Advisory Council for Environmental Policy and Technology (NACEPT) Subcommittee on Environmental Technology was established in 2004 as a means for EPA to make recommendations about future direction of environmental technology programs. Recommendations cannot be made without a common set of criteria with which to measure current success levels. Therefore, the NACEPT subcommittee utilizes EPA's Technology Continuum. The continuum is a series of stages that correspond to different parts of the technological development process. It is through use of this continuum that evaluations of EPA's technology assistance programs are completed. An understanding of how technologies become commercialized through assistance from EPA has prompted the study of the programs currently available. Knowing how technologies with the assistance of the SBIR program make it to commercialization will allow EPA to better realize their mission of "protecting human health and the environment" (EPA, 2006). This process has already been started with the NACEPT analysis of EPA's technology programs; however, EPA would like a closer study of their SBIR program to answer a few questions such as: "How far along the technology continuum did the technology go? Has it been commercialized? What can EPA do to improve the rate of commercialization?" (EPA Project Description, 2006). These are questions that we explore throughout the paper.

This project traced the life of various technologies, some successful and some not. The technology continuum was used as the road map of steps from concept to

commercial success. We identified points along the way that aided success and those that caused failure. Our project deals mainly with providing EPA recommendations on how to improve environmental technology commercialize by strengthening their SBIR program. We accomplished this through identifying a target population of companies at various stages of development along the EPA defined technology continuum. We then interviewed the selected companies using interview strategies primarily based on The Discovery of Grounded Theory: Strategies for Qualitative Research by Glaser and Strauss (1967). Case studies were written about each interviewed company to document the success and failure of technology development companies that researched environmentally beneficial products. The case studies of those companies gave an understanding of the strengths and weaknesses of the programs that each technology participated in. To accomplish this, we used case study writing suggestions found in Case Study Research (Robert Yin, 1994). These case studies enabled us to create a summary analysis of trends displayed in the different interviewed companies. The highlighted trends may be used as a tool for EPA to better promote the development of environmental technology as well as public health benefits.

The mission of this project is to identify ways to more effectively commercialize environmental technology, to positively impact the environment. Technology can be very useful in helping solve environmental problems. When environmental technologies are developed and commercialized, they benefit the environment. And in doing this help EPA accomplish its mission of protecting human health and the environment. The objectives for the project are to

1. Investigate the institutional context for the EPA SBIR program

2. Collect and analyze company background information to interview program awardees for a perspective about technology commercialization
3. Write case studies to create a summary analysis

The final outcome presents EPA with, a series of case studies, a summary analysis, and a final report that includes recommendations on how to improve technology commercialization through the SBIR program. The deliverables from this project will help EPA find ways to enhance the success of environmental technology development, and in turn assist in protecting human health and the environment.

2.0 Background

Have you ever wondered why there is so much research being conducted but there are only a few end products that make it to market? A technology must go through many stages of development before it can be used. The progression or sequence of an idea to final commercialization is called a continuum. More specifically, a technological continuum is the label for the different stages of development a technology goes through to eventually benefit society through commercialization.

The Environmental Protection Agency (EPA), founded in 1970, is a federal agency that desires to fulfill the following mission, "to protect human health and the environment" (EPA, 2006). EPA sponsors many ideas for environmental technology projects, but unfortunately only a small amount of them actually make it to market and are utilized. The technology continuum provides a framework for analyzing the development of environmental technologies.

Furthermore, after the funded research has been conducted to support the new environmental technology, there lies another question; once the product has been put to use, is the new environmental technology benefiting the environment and public health?

Currently, EPA has already established programs, strategic plans and a continuum to develop technologies that prevent, monitor and control environmental problems related to air, water and waste. Some of these programs are federally mandated, like the SBIR program, which will be discussed in more detail in section 2.3. There are various types of environmental technologies that exist; such as drinking water treatment systems, pollution detectors, and waste reduction processes.

The main areas EPA wants explored are the development of environmental technologies and how to promote them. The mission of this project is to examine how environmental technologies can be more effectively commercialized to create positive change for the environment. This was accomplished by using the technology continuum to explore the process an environmental technology takes on the path from research to utilization, and by identifying challenges a technology faces on the road to commercialization. The final outcome presents EPA a number of recommendations to help companies overcome these challenges. The objectives that allowed us to successfully complete this project are as follows:

- Investigate the institutional context for the EPA SBIR program
- Collect and analyze company background information to interview program awardees for a perspective about technology commercialization
- Write case studies to create a summary analysis

A common definition of commercialization is needed in order to understand many of the concepts we worked with during our project. We defined commercialization as a product that is sold. It is assumed that if there are enough sales of the environmental technology, that it will have an impact on human health and the environment. If an end-user purchased the product, and there are enough sales for the company to constantly sustain production of the product, it has been commercialized.

Determining if a technology has been commercialized, or how far along it has come during development can be tricky. This is why EPA has outlined a continuum that technologies can be measured against, known as the technology continuum.

2.1 Technology Continuum

People have ideas every day for a new invention or a better way of doing something. These ideas are usually just brushed aside without further thought given to them. In some cases these ideas are developed to the point where they are used by a large part of the population. The technology continuum is a series of stages that an idea passes through as it is being refined to utilization. EPA breaks down this continuum into six phases as follows (EPA Environmental Technology Research & Development Continuum, 2006).

- Research/ Proof of Concept
- Development
- Demonstration
- Verification
- Commercialization
- Diffusion and Utilization

The technology under development will continue along the continuum until it no longer has a chance of becoming profitable, there is no more funding, or it becomes fully commercialized. These stages are not discrete, but make up a continuous process. An understanding of these stages will be crucial to presenting EPA with information about the development of technologies. We will use the technology continuum as a reference to determine where companies faltered and/or excelled during the commercialization process. The stages and graphic below outline what is categorized as the technology continuum by EPA.

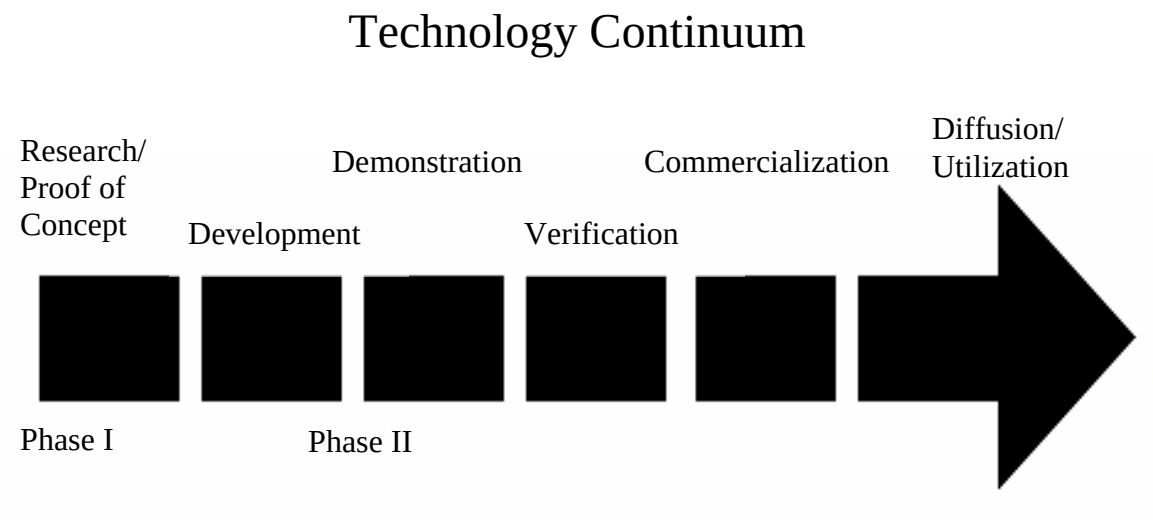

Figure 1 - Technology Continuum

2.1.1 Research/ Proof of Concept

Research/ proof of concept is the first stage along the technology continuum. This stage includes the idea being conceived and recognized as being viable. At this stage, bench top research of the technology takes place. At each one of these stages, the technology is assessed to make sure that it still appears to be viable. If the technology is recognized as being marketable, it will move on to the next stage, which is development.

2.1.2 Development

At the development stage, pilot tests of the technology are conducted. The pilot testing consists of a variety of tests to determine the product's overall functionality in an ideal environment. A prototype is used for testing. The minor kinks are worked out, and the technology moves into demonstration.

2.1.3 Demonstration

The demonstration stage involves full scale testing. This testing involves trying the technology out under a wide variety of conditions, not just the ideal ones. By testing

the technology over a wide range of conditions, the parameters can be optimized. The results of all the testing are examined to determine what the production costs will be.

2.1.4 Verification

The verification stage consists of tests by independent organizations. The technology is tested by other organizations at different sites to make sure that the technology is reproducible. They also test to make sure that the technology does everything that it is supposed to do. Safety tests are also very important. The findings from all these different tests are then publicly reported. For more information on environmental technology verification, please refer to section 2.4.4 Environmental Technology Verification (ETV) Program.

2.1.5 Commercialization

Commercialization by the private sector entails the technology be put into production. This includes manufacturing and distribution, along with a host of other tasks. The technology must be scaled up so that it can be manufactured on a large scale inexpensively. Then a proper distribution system needs to be implemented. If the technology is unlike any others, then a new distribution system may need to be created.

2.1.6 Diffusion and Utilization

Diffusion and utilization make up the last stage of the technology continuum. Diffusion is marketing the product to all of its potential users. The product must be distributed and available for consumer purchase. Utilization involves encouraging customers to purchase and use the new product or technology. The technology being developed is of little use until it reaches the end stage where it directly interacts with

peoples' lives. Before this stage, the technology is just being developed and not benefiting anyone.

These stages form the concept EPA terms the technology continuum. Each stage has its own unique pitfalls that small businesses encounter. Our project is aimed at discovering the main challenges along this continuum, and recommending to EPA how best to overcome these difficulties as they arise. A few general problems that a company can encounter are outlined in Appendix B.

2.2 Purpose of Environmental Protection Agency (EPA)

The Environmental Protection Agency (EPA) is a government organization headquartered in the Federal Triangle in Washington, DC working to improve the quality of life on the planet while reducing the negative impact of humanity on the environment. Since EPA was created in 1970, they have provided a means to consolidate programs to research and implement technologies designed to benefit the environment, to monitor and enforce environmental regulations, and to safeguard the environment and human health. The mission of EPA is "to protect human health and the environment" (EPA, 2006). To realize this mission, EPA has 18,000 engineers, scientists, policy analysts, legal, and public affairs employees working across the country. The organization internal to EPA can effectively break down any environmental problem so that no one office becomes overwhelmed with trying to solve the entire problem. EPA also works to attain their mission through a series of technology advancement programs that will be mentioned later.

The organization internal to EPA provides a solid framework for attempting to accomplish their goals and mission. EPA is broken down into 12 departments and 10

regional offices. Refer to Appendix A for a complete list. Each department is in charge of a different facet of protecting human health and the environment. Each of these offices has their own focus on advancing the goals of the Agency. The particular office associated with our project is the Office of Research and Development (ORD).

2.2.1 Office of Research and Development (ORD)

The focus of ORD is performing research to solve current and future environmental problems, providing technical support for EPA's mission, combining research and ideas from other scientific sources, and providing leadership for the advancement of environmental technology.

2.2.2 National Center for Environmental Research (NCER)

NCER is located within ORD and is the gateway for most EPA funded projects. The mission of this office is "to support high-quality research by the nation's leading scientists that will improve the scientific basis for decisions on national environmental issues and help EPA achieve its goals" (EPA about NCER, 2006). There are different programs that assistance in developing a socially beneficial technology that NCER runs. A few of these are called the Experimental Program to Stimulate Competitive Research (EPSCoR), People, Prosperity and the Planet (P3), Collaborative Science and Technology Network for Sustainability (CNS) and the Small Business Innovation Research (SBIR) program, which will be discussed later in the chapter.

2.3 Small Business Innovation Research (SBIR)

2.3.1 Federal SBIR

The Small Business Innovation Development Act of 1982 created the federal Small Business Innovation Research (SBIR) program as a means to "strengthen the role of small businesses in federally funded Research and Development (R&D) and help develop a stronger national base for technical innovation." The SBIR program was assigned four goals when it was created. These goals are

- Stimulate technological innovation
- Use small business to meet federal R&D needs
- Foster and encourage participation by minorities and disadvantaged persons in technological innovation
- Increase private-sector commercialization innovations derived from federal R&D (SBIR Facts, 2006).

This report focuses on the fourth goal, increasing private-sector commercialization innovations derived from federal R&D. The objective of this goal is to have private companies commercialize their innovative technologies with the help of the federal agencies.

At the beginning of the SBIR program, the amount of funding delegated by the Small Business Innovation Research Act of 1982 was 0.2% of the entire extramural research budget. That percentage has risen over the years to 2.5% of the extramural research budget for each agency participating in the program. The federal SBIR program approaches this mission through a uniformly competitive system in 12 federal agencies

with large enough budgets to support the program. The Small Business Administration (SBA) acts as the overseer for the federal SBIR programs.

The SBA imposes a number of guidelines on participating agencies. An example of these guidelines requires reporting to the SBA when a sponsoring agency feels that a contract recipient has not met the criteria set out for the awarded funding. This information will assist the SBA to perform their government function of regulating the SBIR program on a federal level. Agencies with SBIR budgets over $50 million must permit the National Academy of Sciences for the National Research Council (NAS/NRC) to conduct a review of their SBIR program. EPA's SBIR budget is under $50 million dollars, so they have not been reviewed by NAS/NRC. The government agencies which have SBIR programs are the Departments of

- Agriculture
- Commerce
- Defense
- Education
- Energy
- Human Health and Services
- Homeland Security
- Transportation
- National Aeronautics and Space Administration
- National Science Foundation
- Environmental Protection Agency

This program involves a federally mandated set of criteria for contract eligibility in addition to any other criteria set by the sponsoring agency. The criteria for being a candidate for SBIR funding are that the applicant company be a small for-profit business with under 500 employees, a minimum of 51% of stock shares held by U.S. Citizens, and the primary place of business located in the U.S. The specific criteria for contract eligibility vary from agency to agency based on specific research needs by the sponsoring agency. These criteria also vary from year to year within a given agency because of internal and external pressures to focus in particular areas of research. Internal pressures can come from different regional offices requesting a particular type of technology that will help compliance with regulations in their area. External pressures can come from taxpayers who want to see more progress made in a particular area of research.

2.3.1.1 Three Phase Plan for Money Disbursement

The federal system for SBIR contract disbursements is a three phase plan with criteria to meet at the start of each phase. The first phase (Phase I) contracts cannot exceed $100,000, though it may vary below that figure between sponsoring agencies. Phase I contracts between different agencies have different criteria for eligibility based on the requirements of that agency. The other non-federal standards are determined by the individual agency based on the type of research that would be most beneficial at that time. This stage is meant to assist a company with research and development of a desired technology.

The second phase, Phase II, contract cannot exceed $750,000, but can be any number up to this cap amount, as determined by the government agency. Acceptance into this second stage of funding requires the criteria of the first stage to be met. Phase I

must have also been completed successfully. Once accepted, there is another set of criteria determined by the agency that must be met. Phase II funding is intended to advance the previously researched technology to commercialization.

The third phase, Phase III, of the program does not involve more investment of capital from the sponsoring agency. Funding for this stage of the program comes from whatever sources the company can arrange for outside of the SBIR program of the government agency that sponsored their technology through Phases I and II. Phase III is the stage that takes the technology from the laboratory and moves it to the marketplace (Description of SBIR Program, 2006).

2.3.1.2 Department of Defense SBIR Program Evaluation

David Audretsch, Albert Link, and John Scott conducted a study of the effectiveness of the SBIR Program in 2000. This study focused on the Department of Defense (DOD) SBIR program. The DOD program is the largest government SBIR program, disbursing approximately $1.164 billion dollars in 2006 (Department of Defense: SBIR/STTR/Fast Track – Overview, 2006). The abstract from the study done by David Audretsch, Albert Link, and John Scott (2000) mentions that:

> … Based on alternative evaluation methods applicable to survey data and case studies, we conclude that there is ample evidence that the DOD's SBIR Program is stimulating R&D as well as efforts to commercialize that would not otherwise have taken place. Further, the evidence shows the SBIR R&D does lead to commercialization, and the net social benefits associated with the program's sponsored research are substantial.

This study shows that the largest SBIR program in the nation is assisting the production of technologies to commercialization, and benefiting society at the same time. However, there are some major differences between DOD program and EPA program in terms of financial backing and the type of research conducted. One difference is that

EPA primarily funds environmental technologies and DOD primarily funds military and security technologies. Examples of military and security technologies are defense applications such as information acquisition, military firepower and biological defenses. Also, DOD has a substantially larger budget that it can disburse through SBIR contracts than EPA.

DOD has a unique set of other programs that supplement their SBIR program. These programs include; DOD SBIR Fast Track and DOD SBIR Phase II Enhancement. DOD SBIR Fast Track is a program that expedites the process from Phase I to Phase II of SBIR funding. To qualify companies developing a new technology must have outside investors who will match phase II funding in cash, if they receive the Phase II SBIR funding. If the company qualifies then they will receive the following benefits from DOD for having a technology that looks promising and has outside interest:

- Receive interim funding of $30,000 to $50,000 between phases I and II where applicable
- Be evaluated for phase II award under a separate, expedited process
- Be selected for phase II award provided they meet or exceed a threshold of "technically sufficient" and have substantially met their Phase I technical goals

(Department of Defense: SBIR/STTR/Fast Track – Overview, 2006)

DOD SBIR Phase II Enhancement program is targeted at taking the technologies developed with SBIR funding and having them become commercialized by either DOD or the private sector. DOD goes about this by matching funding a company receives from outside investors during Phase II. DOD will match up to an additional half million

dollars of non- SBIR funds, and extend the contract for up to a year (Department of Defense: SBIR/STTR/Fast Track – Overview, 2006).

DOD SBIR website is very helpful for anyone interested in applying for SBIR funding or just trying to develop a new technology. They have a variety of links including resources to; Sources of Assistance in Technology Commercialization, Private Sector Sources of Early-Stage Technology Financing, and General Sources of SBIR/STTR/Small Business Assistance on the Internet. These sources offer a variety of different options that a small company can follow to help them develop their new technology. DOD also offers technology development and transfer resources by state. If a company is applying for SBIR funding for the first time, DOD even has an online tutorial that goes through how to follow the proper application process. The link to the tutorial can be found on the left hand side of DOD SBIR website www.acq.osd.mil/osbp/sbir/ (DOD SBIR & STTR Programs, 2006).

Another interesting fact about the DOD SBIR program is that DOD uses a lot of the technology that is developed within its SBIR program. For companies developing a technology under DOD SBIR funding, this means that once they have demonstrated and verified that their technology works, they probably have a customer willing to buy the product, DOD. This means that companies developing new technologies with DOD funding have to worry less about trying to find a market to sell their technology to, because DOD is there. This allows them to concentrate their efforts on quickly developing the new technology (DOD SBIR Success Stories, 2006).

After examining DOD SBIR program, it is concluded that it offers a wide variety of resources and options. DOD SBIR program is the largest SBIR program. This does

allow it to have a variety of different program offerings. The variety of programs, quick time between receiving proposals and awarding funding, along with a variety of resources, seems to allow DOD to run an effective SBIR program (DOD SBIR & STTR Programs, 2006).

2.3.2 EPA SBIR

The SBIR program in EPA annually solicits proposals from science and technology firms that meet the federally mandated criteria mentioned above. The goal of this program is to fulfill the missions of NCER, ORD and EPA while also strengthening the role of small businesses in the realm of federal contracting. The types of proposals that receive funding from EPA vary from year to year but maintain a theme of proposed environmental benefits. EPA's phasing system follows the guidelines determined by the SBA, which allows EPA to spend small amounts of their contract budget on a research idea in a high-risk study to determine if the research can be made technologically feasible. EPA's Phase I and II contracts are smaller than the previously mentioned federal limits for SBIR money disbursement as seen in section 2.3.1. "Under Phase I, the scientific merit and technical feasibility of the proposed concept is investigated. EPA awards firm-fixed-price Phase I contracts of up to $70,000 and the period of performance is typically six months" (EPA SBIR Description, 2006). Phase II contracts are awarded to companies that show promise during Phase I in amounts up to $225,000 for assisting in the development of the technology for commercialization over a typical period of two years. However, these contract award amounts can vary depending on the type of technology being sponsored and how central the research idea is to the mission of EPA at the time of the proposal.

Some previously funded projects through EPA's SBIR program include the development of an Arsenic Removal System for Point-of-Use/Point-of-Entry Drinking Water Systems by ADA Technologies, Inc., Nanoparticle-Anchored Plasticizers by TDA Research, Inc. and a Solid Scrubber for the Semiconductor Industry by ATMI, Inc. (EPA Small Business Innovation Research: Success Stories, 2006).

2.3.2.1 Option Funding

The objective of Phase II is "to continue the research or R&D initiated under Phase I and work toward commercialization of the technology" (Funding Opportunities, 2006). EPA does understand that Phase II may not "complete the total research and development required to satisfy commercial or federal needs beyond the SBIR program" and that in fact may end up being completed in Phase III, which EPA does not fund (Funding Opportunities, 2006). At the end of Phase II, EPA offers the Phase II awardees two options.

> For Phase II, the Agency is planning to require two Phase II Options: (1) Phase II Commercialization Option under which Phase II offerors shall submit a proposal for $70,000 additional funding to expand R&D efforts to accelerate the project from full scale testing and demonstration to full commercialization; and (2) Phase II Verification Testing Option under which Phase II offerors shall submit a proposal for up to $50,000 additional funding to facilitate third party research/ R&D verification testing that will improve the quality assurance and quality control (QA/QC) of the technology and accelerate the acceptance and use of improved and more cost-effective technologies (Funding Opportunities, 2006).

EPA changed the documentation requirements for receiving the additional option task funding about one to two years ago. This rule change only applies to the Phase II Commercialization Option, not the Phase II Verification Testing Option. Originally, companies had to prove that they were receiving a certain amount of in-kind donations

from sponsors, potential end-users, venture capitalists, universities, etc. In-kind donations are recognized as non-monetary donations, such as use of equipment or services.

> Documentation for the Phase II Commercialization Option are receipts showing that at least $100,000 was transferred to the contractor from one or more third party investors, such as venture capital firm, an individual "angel" investor, state or local funding source, or another company under a partnership, licensing or joint venture arrangement, or any combination of third parties. Documentation for the Verification Testing Option is the signed Commitment Letter with the third party testing organization (Funding Opportunities, 2006).

Similar to the Phase II SBIR program of the National Science Foundation, as of today, EPA requires companies to prove that they have received cash only donations/support from other sources. The question now is why EPA would want to do that. It is important to consider that changing the policy and procedure may have a larger than anticipated impact on the companies that are dependent on the EPA SBIR program. EPA changed the funding from cash donations to in-kind to increase the seriousness of companies receiving funding. It is very hard to track in-kind donations, or donations of services rather than monetary donations. This makes it difficult to prove how much in-kind donations SBIR Phase II awardees are actually receiving. EPA became reluctant to giving out the additional $70,000 for the Phase II Commercialization Option. EPA noticed that companies had a tendency to "fluff" up the amount of in-kind donations they received, to add up to $100,000. Again, in-kind donations are difficult to track, to know their true value, and how much the small businesses are actually receiving and using is even more difficult. EPA felt that they had to change the rule to only cash donations which amount to $100,000. The cash donations have to actually be in the small businesses' bank account in order to receive the $70,000. Doing so has diminished

EPA's reluctance to grant the additional funding since it is nearly impossible for small businesses to take advantage of the SBIR program this way.

2.3.2.2 Foresight Science and Technology

Foresight Science and Technology is an independent technology-market assessment company that EPA uses to provide marketing assistance to SBIR funded companies. EPA feels that it is important for companies developing a new technology to not only develop it but to also spend time on the marketing aspect of things. If a company develops a new technology, that is great. But unless the technology sells it doesn't beneficially impact the environment. Foresight helps companies developing new technologies consider potential markets for their technology. This allows the technology under development to take a path that will lead to a product that has a market.

Foresight provides something similar to what they call a Niche Construction Analysis™. "The Niche Construction Analysis™ discovers practical applications for scientific and engineering advances and identifies partners, positions the technology, and opens a dialog with champions in potential partners able to provide R&D funding and/or downstream commercialization support (Foresight NCA, 2006)." A niche study is provided to all EPA SBIR Phase I awardees. This market analysis is paid for by EPA out of the Phase I contract award. It provides the companies developing the new technology an idea of what different potential markets are. The study also provides a list of companies that may be interested in the technology. This list has specific contact names and numbers for the SBIR companies to contact at their convenience. By getting future technology buyers involved early, the SBIR funded companies will hopefully develop a

positive relationship with these future buyers. Down the road this will provide a valuable resource for the SBIR companies to use when they are trying to sell their technology.

2.4 EPA Programs for Technology Advancement

The Environmental Protection Agency is a large organization and has established five basic goals to accomplish its mission which are; Clean Air and Global Climate Change, Clean and Safe Water, Land Preservation and Restoration, Healthy Communities and Ecosystems, and Compliance and Environmental Stewardship (EPA's Goals, 2006). To achieve these goals EPA has many different programs in place. These programs include fellowships, grants, cooperative agreements, and other forms of financial assistance. Each one of these programs addresses a different issue. Some educate the people who will create the next generation of environmental technologies, while others help take these technologies from just ideas to product commercialization.

EPA offers a wide variety of fellowships, which are financial aid grants that allow students to study in a field of interest. These fellowships are available at the undergraduate, graduate, and professional levels (EPA Grants & Funding, 2006). Science to Achieve Results (STAR) graduate fellowships are for students working towards an advanced degree. The aim of this fellowship is for students to obtain an advanced degree in the environmental sciences field. With the expert knowledge these individuals learn, they will help to develop new environmental technologies. The Greater Research Opportunities (GRO) graduate fellowships awards grants to masters and graduate students studying environmental technologies at universities that do not have large research programs. This allows research to be completed by these talented students. There are also many other fellowship programs supported by EPA.

EPA offers financial assistance to non-profit organizations who are interested in sponsoring environmental conferences. One example of this financial assistance can be seen through EPA's support of the organization that sponsors the National Environmental Monitoring Conference (NEMC) (EPA Grants & Funding, 2006). EPA in addition, offers cooperative agreements for research about human health and ecosystems through the National Health and Environmental Effects Research Laboratory (NHEERL). Through these cooperative agreements, private companies are able to use EPA resources to research and develop environmental technologies.

EPA is a member of the Federal Remediation Technologies Roundtable (FRTR) and the Remediation Technologies Development Forum (RTDF). Both of these groups work between multiple agencies. The FRTR members consist of federal agencies, while the RTDF consists of both federal agencies and privately owned companies. The goal of these groups is to provide a broad overview on environmental clean up problems that reaches across many different agencies. The keys to these programs are that the different groups work together to reach a common goal of developing technologies that will positively affect the environment.

2.4.1 Federal Technology Transfer Act (FTTA)

The Federal Technology Transfer Act (FTTA) allows EPA to collaborate with non-federal agencies for research and development (EPA Research, 2006). This allows EPA to help companies develop technologies that EPA thinks are important. The FTTA program supports and improves US competitiveness, helps remove barriers to collaboration, and encourages cooperative R&D with a final goal of commercialization of the new technology (FTTA, 2006).

2.4.2 Small Business Technology Transfer (STTR) Program

The Small Business Technology Transfer (STTR) grant program combines the high-tech research being done in nonprofit research institution laboratories with small businesses wanting to develop these technologies for commercialization. These two groups combined can form a powerful partnership that is able to bring innovative technology to the market place in record time (SBA, STTR & SBIR, 2006). The companies participating in the STTR program must be small businesses, under 500 employees, that are American-owned and independently operated. Refer to Appendix B – Small Business Background for more information on small businesses. The nonprofit research institution or university must be located in the Unites States. These grants are awarded in a three-phase method. STTR Phase I provides funding for feasibility studies. Phase II can award up to $750,000 for further research and development. Phase III of the STTR program is the same as the SBIR program, in that no funding for final commercialization is not provided by the SBIR/STTR program.

2.4.3 Small Business Innovation Research (SBIR) Program

Refer to section 2.3.2 for information about EPA's SBIR program.

2.4.4 Environmental Technology Verification (ETV) Program

In October 1995, EPA developed a program to assist new technologies along the technology continuum to commercialization. The name of this program is the Environmental Technology Verification (ETV) Program. ETV develops testing protocol and verifies the performance of environmental technologies. ETV stands at the verification stage of the continuum.

After the verification stage of the technology continuum, comes the commercialization stage. It is important for environmental technologies to have the appropriate verification methods so that they can move along the technology continuum from verification to commercialization. If any technology is not verified a company is not likely to commercializing the new technology. There is just too much risk if a new technology has not yet been proven to work by a third party. This is why ETV is so important for the commercialization of environmental technologies. It allows environmental technologies to be verified by a trustworthy third party.

ETV is made up of a collection of public and private testing partnerships. These groups test the wide variety of environmental technologies that ETV deals with, from air, water, and soil, to pollution prevention and monitoring. ETV verifies the claims of environmental technologies up to both American and internationally accepted quality standards. This gives the companies that are developing new technology some credibility, and hopefully allows them to commercialize their technology as soon as possible (EPA ETV, 2006).

2.4.5 Office of Research and Development (ORD)

EPA's Office of Research and Development (ORD) performs in house technology research. The research performed here ranges from bench top research to full scale demonstration. ORD also tries to transfer the technology from basic research to everyday use so that it can benefit society. The areas of research are as broad as EPA's scope is. Some of the research media include air, water, and waste. ORD researches methods and means to combat pollution by focusing on pollution prevention, monitoring, and

treatment. ORD tries to use a multidisciplinary approach, including both engineers and scientists, skilled in a variety of different fields (EPA ORD, 2006).

2.4.6 National Environmental Technology Competition (NETC)

The National Environmental Technology Competition (NETC) was formed in 2003 to help environmental technologies from the private sector move along the technology continuum to commercialization. NETC achieves this by encouraging field demonstrations of new and innovative environmental technologies. In addition, NETC provides small grants to college students to compete in People, Prosperity and the Planet (P3) competition (EPA NETC, 2006).

2.4.7 People, Prosperity and the Planet (P3)

People, Prosperity and the Planet (P3) is a program begun in 2004 by EPA. This program focuses around a competition where college students design environmental technologies. EPA awards $10,000 to student teams to develop their environmental technology ideas. These ideas are then presented at the National Sustainable Design Expo. The expo is held on the National Mall in Washington, DC each spring. It displays available environmentally friendly products and the students' projects. The students' projects are entered into the Annual P3 Award Competition, where they have the chance to receive up to an additional $75,000 in funding to further develop their technology and bring it to commercialization or test it in the field (EPA P3, 2006).

2.4.8 Technology Testing and Evaluation Program (TTEP)

The Technology Testing and Evaluation Program (TTEP) is a program within the National Homeland Security Research Center (NHSRC). The TTEP program focuses on

protection of drinking water and the safety of the public in buildings. TTEP does this by testing, evaluating, and reporting on the performance of homeland security related technologies. TTEP grew out of EPA's ETV program and often uses ETV test plans, which have been modified to meet homeland security requirements. This program is aimed at the demonstration and verification stages of the technology continuum (EPA NHSRC TTEP, 2006).

2.4.9 Design for the Environment (DfE)

Design for the Environment (DfE) is a voluntary partnership program. The partnership consists of manufacturers, trade groups, and environmental organizations. The DfE program brings all these groups together for the good of the environment. All these groups have common objectives; the development of cleaner, safer, and cheaper processes and technologies. By looking at the costs, performances, and risks, decision makers are able to make informed decisions about environmental technologies. DfE provides companies with information, tools, and incentives to make informed decisions that will positively impact the environment. This program is aimed at the diffusion/ utilization stage of the technology continuum (EPA Environmental Technology Programs, 2006).

2.4.10 Center for Environmental Industry and Technology (CEIT)

The mission of the New England's Center for Environmental Industry and Technology (CEIT) is to serve New England's environmental technology industry as a window to resources, people, and programs. Its mission is also to promote the acceptance of innovative environmental technologies for solving environmental problems

in New England (EPA CEIT PDF, 2006). CEIT acts as an information center for developers of environmental technologies in the New England area. Companies can call CEIT to be referred to the appropriate organization, program, or agency, which can help them commercialize their environmental technology. This way companies can more easily overcoming regulatory and institutional barriers (EPA CEIT, 2006).

2.5 Grants

When ideas are not yet developed and there is little to no research to prove that the idea will work, it can be hard for small business developing the technology to secure funding. The most common sources of funding for small start up companies are personal savings, friends and relatives, banks and credit unions and possibly venture capital if certain profiles for the business are met (SBIR and STTR Programs and Awards, 2006). Personal savings and relatives are the best choices for securing funding because of their flexibility in repayment, but are limited in the amount of capital they can provide. Venture capital requires a national or international potential in addition to high growth potential. Other possible sources include "angel investors" who donate money to a particular company, idea, or programs, to secure federally funded grants to assist in the pursuit of research, or to take research and make it marketable.

This is where EPA and other government agencies come into play. The government can encourage the development of environmental technologies by giving phased contracts to companies that are researching technologies that deal with the environment. These federal contracts can be used for research that is not yet commercialized. This type of research is usually very risky and hard to secure funding for (Gutterman, 1997). Phased contracts reduce the risks associated with developing a

new technology. These contracts allow an initial inquiry into the problem by offering a small initial contract to see if the technology is marketable and works. Then the second phase contract gives a larger amount of funding to continue investigating the technology.

These contracts allow new technologies to be developed. Usually the high cost and low success rate of developing new technologies makes companies, especially small businesses, wary of investing their own money. However without significant personal investment from the business owners, most lending agencies will not support a business venture. These contracts allow the company to investigate a new technology with funding support, and still keep the intellectual property they develop. This is why the government can make a big difference by giving contracts to organizations that are at this stage of the development process.

2.6 Marketing

It is important for companies to not only develop their technology but also develop their business plan. A company can have a great product, but if this product cannot be sold then it has no concrete affects on the environment. SBIR companies developing new technologies need to concurrently proceed forward with their technology development and their business/ marketing development. These two separate yet connected avenues must both be followed for a company to successfully commercialize their technology.

It is very important that companies talk with the end-users early on in this process. Companies need to have an open dialogue with end-users from the start of their project. This makes sure that the company is developing a technology and product that end-users want and will purchase. If a company just develops their technology so that

they have widget, or gadget that no one wants to buy, they don't have anything. The widget is not worth anything and can't help save the environment if no one is willing to buy it. It will just sit around not being utilized and its potential will never be realized.

Companies developing new technologies should also talk with future manufacturing and distribution companies. These companies can help to shape the technology into a product which can be produced and marketed effectively. Companies cannot just develop a technology in the vacuum of their laboratory. They must realize that the goal is to develop a technology that can be marketed.

Companies must test early and often. Companies must test their technology/ product early and often. As a technology progresses along the technology continuum the cost to move it along increase quickly. If mistakes can be minimized in the beginning, companies can save a lot of money in the long run.

2.7 Social and Environmental Considerations when Developing Technology

In response to social, technological and environmental problems, research is practiced to find the answers. Environmental issues have a social effect on everyone. Mankind is using environmental resources at an enormous rate and figuring out a way for people to exist without exhausting our natural resources is an environmental issue that causes the need for the development of new technologies (The President's Council on Sustainable Development, 1999). When developing an environmental technology one must consider the socio-economic impact, environmental influence and the technical

need by society for the methodology of developing a new technology to be pursued. The benefits that an environmental technology ideally provides to society are the following,

- To ensure that every person enjoys the benefits of clean air, clean water and a clean living environment.
- To sustain a healthy economy that provides meaningful jobs, reduces poverty, and provides an opportunity for development.
- To ensure that the public can afford the equal opportunity for economic, environmental and therefore, social well-being.
- Encouragement of personal responsibility and community involvement. The people involved in developing new technologies, as well as the general public, may feel a need for them to take the cleanliness of their living environment into their own hands.
- Improvement in quality of life.
- An incentive for educational opportunities and rewards for the public from formal training that may be directly related to technological development, marketing, construction, etc. (The President's Council on Sustainable Development, 1999).

The ideal benefits for an environmental technology to provide for the environment are the as follows,

- Conservation of natural resources such as, air, water, natural minerals, oils, energy, and land. The conservation of our natural resources further promotes the long term supply of needed resources (The President's Council on Sustainable Development, 1999).

- Maintenance of the ecosystem to making sure that wild life – plants and animals – continues to survive.

To begin, when developing a new technology for the environment, one thing to consider is the social and/or socio-economic impact. One of the results from the development of a new environmental technology may be the creation of new jobs anywhere, from hiring researchers to the employment of temporary construction workers (Dey, 2006). Researchers also have to see if the public even wants to participate in what is being created. Members of the community may not want the new technology to be in their environment at that time. Riots, protests, and exercising the right to free speech are clear forms of expression if the public disagrees. More specifically, "the factors are conflicting, achieving of one factor may sacrifice others." (Dey, 2006) meaning the organization or business that is funding and developing the project will more than likely be faced with an ethical issue and may have to sacrifice one thing for another.

To conclude, there are many problems in regards to technology, the environment and social well being, which cause the need for new technologies to be developed. The methodology behind creating a new environmental technology is essential, because it determines if a project will make it through the continuum to final production; to be implemented into society, and help the environment while fulfill the technical need.

2.8 Summary

The previous sections of background information covered some of the basics about EPA, the federal SBIR program, the technology continuum as described by EPA, and some of technology's impacts on society. These ideas are important to our project

because we focused on performing an analysis of the EPA's SBIR program to provide recommendations for EPA on how to strengthen it.

The federal SBIR program was a source of information for the project because the SBIR program is the largest program of its kind in the United States. The technology continuum is a tool used by EPA to define a sponsored technology's progress toward commercialization/ utilization. For this reason we provide background information on the technology continuum because it can be used as a analysis tool of a technologies progression.

The methods section will describe how we collected the data that we used in order to analyze EPA's SBIR program. Our group first researched and interviewed companies that received SBIR contracts from EPA. Refer to Appendix D to see companies that were interviewed. Then we wrote up case studies on each one of these companies. A summarizing narrative was then written up, which pulls out trends from the case studies. This provided a concise written account of the information that we obtained. Refer to Figure 2 - Project Overview Graphic, located in section 3.0 for an overview of the different methodology steps.

3.0 Methodology

The mission of this project is to offer suggestions about how to improve the commercialization of environmental technologies through EPA's SBIR program. The project objectives provided a direction for our project.

- Investigate the institutional context for the EPA SBIR program
- Collect and analyze company background information to interview program awardees for a perspective about technology commercialization
- Write case studies to create a summary analysis

The first objective was created because EPA is concerned not only with their own program, but the overall goal of technology commercialization. EPA wanted to know what other programs, in addition to SBIR, are doing to assist the development of new technologies. EPA also wanted to know how their SBIR program compared to the SBIR programs of other federal agencies.

Collecting and analyzing company background information to prepare for an interview with program awardees was our second objective. The best source of information regarding what EPA can do to improve its SBIR program was determined to be information provided by the companies that participated in it. This information directly related to particular aspects of EPA programs that might need to be strengthened to increase the number of technologies that become commercialized. The interviews provided an outsider's perspective about EPA's SBIR program, which allowed EPA to see what could be improved, and what aspects are working well.

The written case studies were used to create a summary analysis. The case studies utilized the background research we did about each company and the actual

company interview. The content of the summary analysis consists of case studies combined with the information gathered from the institutional context for the EPA SBIR program.

These objectives provide a broad overview of our project goals. However, more specific tasks were outlined for each of these objectives to actually be completed. A basic list of steps that occurred can be found below in Figure 2 - Project Overview Graphic.

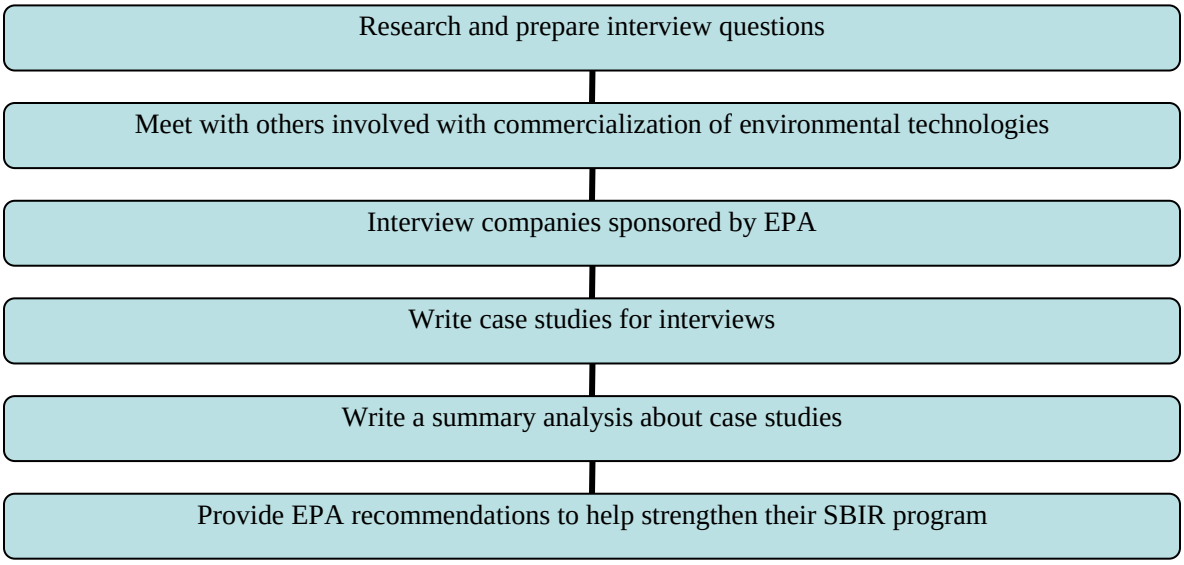

Figure 2 - Project Overview Graphic

3.1 Institutional Context of EPA's SBIR Program

Determining the institutional context of EPA's SBIR program involved reviewing the different EPA sponsored commercialization assistance programs and seeing how they could most effectively work together. It also involved interviewing the directors of EPA's SBIR program to understand the program's intended impact on technology development. The people we spoke with from these different programs provided solid

information which catalyzed some specific interview questions. Some of the other organizations we contacted include: Office of Air and Radiation (OAR), Design for the Environment (DfE), Environmental Technology Verification (ETV) program, New England's Center for Environmental Industry and Technology (CEIT), Peer Review Division (PRD), Department of Defense (DOD) Small Business Innovation Research program, and Foresight Science and Technology. Foresight is a marketing assistance company that EPA contracts with to provide specialized information to all SBIR awardees. It was useful to interview people at these programs and organizations because they identified what approaches they took to overcome different parts of the challenges of technology development. The institutional context of the SBIR program provided the basis for comparisons with what the other programs are doing differently and possibly more effectively.

To determine the institutional context of the program, we began by researching the SBIR program and others listed on the Environmental Technology Opportunities Portal (ETOP) website. We needed to understand what area of impact each technology assistance program could have on a technology. It was especially crucial information to have about the SBIR program because of the mission of our project. Some of the other programs included the Environmental Technology Verification (ETV) Program, Design for the Environment (DfE), and Center for Environmental Industry and Technology (CEIT). One program with particular impact to SBIR that is not listed on the ETOP website is the Peer Review Division (PRD). They were important to speak with because they set up the external review that every proposal for the SBIR program must pass to receive funding.

In addition to contacting EPA programs and centers, we also spoke with representatives from Foresight Science and Technology, and DOD's SBIR program. These interviews were conducted to determine each organization's impact on the development process. Foresight is a marketing assistance company contracted through EPA to provide a niche analysis to each SBIR awardee. DOD's SBIR program was important to contact because it represents approximately half of the entire federal SBIR budget. We thought it pertinent to compare what the largest SBIR program was doing differently than EPA so we could potentially make recommendations from the DOD's program. We used these other technology assistance programs as resources to better understand particular "bumps in the road" to commercialization.

3.2 Interviews with EPA SBIR Awarded Companies

We conducted interviews with companies who have received assistance from EPA to develop their technologies to provide the information we need to create case studies. We needed to obtain a perspective of the program from someone who had gone through it. The case studies in section 4.2 contain problem areas that were mentioned during our company interviews.

3.2.1 Selection Criteria for Companies

We conducted interviews with 11 companies that had navigated the EPA's SBIR program. We chose these companies based on a few factors. Our background research identified three strategies used when choosing a target population. The first one is choosing a group without pointing out difference, choosing a group with only one

comparative difference, or in a comparative study where there are no limits to the detail, time sensitivity and resources used to conduct the research (Glaser, 1967).

We decided to look at some SBIR success stories compiled by EPA to gain an initial target group of companies (EPA Small Business Innovation Research: Success Stories, 2006). These success stories were ideal because of the varying degrees of success each company had experienced. Within this target group, we also looked for technologies that operated in different media (air, water, or waste), and were related to pollution prevention, remediation, or monitoring. Another reason to use the companies from the SBIR Success Stories is because the contact information was already available, along with a description of the technology that progressed through the continuum. We also considered that having too many variables could have resulted in skewed data, but we countered this by asking more general commercialization questions.

> If we minimize the differences in groups but maximize similarity then we will generate basic properties. If we maximize the differences and maximize diversity, the scope of theory and a dense development of properties is then delimited (Glaser, 1967).

Challenges occurred when our team contacted some of the initial companies to schedule interviews. Sometimes no one was available to answer questions, no one was at the company who was knowledgeable about our target topic, and even a lack of contact information for the company. Those challenges were sidestepped by ensuring that there was a large enough initial sample of companies to contact in case any of those potential challenges arose so that we would have at least ten interviews to base case studies upon.

Once a sample of companies had been chosen the next steps were determined by unanswered questions that background research did not answer, "the sociologist does not know them [next steps] until he is guided by emerging gaps in his theory and by research questions suggested by previous answers" (Glaser, 1967).

3.2.2 Interview Development

We decided to use interviews as our primary source of current information about technology development through EPA's SBIR program, while information available from EPA's website would provide the majority of our background research. Other methods of data collection we considered were: conducting surveys, studying previously submitted documents, examining case studies, reading past research projects, and reading reports on the technological continuum. Surveys were discarded because of the potential time delay between sending them out and receiving responses, and because it is unlikely that busy people will take the time to fill out a detailed survey. We decided to combine the rest of the ideas into our project because some of the methods were more suited to uncovering background information, and others were more suited to collecting current perspectives.

To develop a proper interview we looked at dynamics such as who to ask and how many people at each company should be interviewed. We interviewed a person called the "Key Informant" for each company that we talked with. The key informant is "…a community resident who is in a position to know the community as a whole, or the particular portion you are interested in" (Key Informant Interview, 2006). Our ideal key informant was the principal investigator for the technology, because this person headed the development of the project. By interviewing the key informant, only one interview

had to be conducted for the necessary information to be drawn out, instead of multiple interviews with people that are less knowledgeable.

Keeping careful record of the responses to any questions asked to a company greatly aided us in determining more effective interview questions, and also in producing analyzable data for the end product.

Ethics were an important consideration when we interviewed companies and wrote this paper. The questions that were asked during the interviews were not meant to offend small businesses, disrespect EPA and their name, or misrepresent Worcester Polytechnic students. We also respected the confidentiality of some of our sources of information.

Once we determined who we wanted to contact, we created interview questions. We came up with an initial list of questions to ask these company representatives based on the institutional context we had for the SBIR program. The institutional context included the technology continuum (Figure 1 – Technology Continuum) which provided something concrete to base questions upon. We targeted our questions at particular stages of the continuum, so that we could ask appropriate questions to companies that had completed various phases of funding, and had therefore reached different stages along the continuum. Structuring the questions in that manner gave us an idea of where the company's technology is located on the continuum. It also allowed a detailed analysis of each company to be completed that included exactly where on the continuum the company reached.

Some of the additional categories for the questions that had evolved by the end of the project were external sources of funding, marketing skills of company, etc.

(Appendix E – Table of Analysis.) Asking our categorized questions assisted in determining if there were main reasons why companies had trouble bringing their technology to commercialization. To see if there is anything EPA can do to increase the success rate of developing a new technology we asked the companies what they would like to see from the program. The below (Table 1 – Questions for Companies) outlines some of the questions we asked companies that relate to particular areas of the continuum.

Questions for Companies

Technology Continuum Stages	Questions
Research/Proof of Concept	Whatever happened to the research? Does the technology have potential application outside the environmental field? Were there any particular problems that arose during the process of research and development? How did you initially get funding for your technology?
Development	Was the technology platform adopted by another entity? How did you prepare for the next stages in the process of making it to Phase II of SBIR funding?
Demonstration	Were you able to demonstrate the technology? How did you demonstrate that your technology works? What kind of procedures did you conduct? What were the challenges?
Verification	Explain the verification process and how you proved that your technology works? What were some of the key issues faced?
Commercialization	Has the technology been

	commercialized? What success did you have? Patents, partnerships, more funding, etc. Does it still have the potential to be commercialized? Are there sales?
Diffusion/Utilization	How long did it take to make it to the market? How did you plan on getting your product into the market? Have there been sales, revenue, and partnership offers? Is it impacting the environment? What did you learn from the problems you faced? What were those challenges?
Technology Transfer In General	What helped make the technology successful or unsuccessful? How long did it take? Was EPA support helpful? What were the primary sources of funding prior to and after involvement with the program, if any? What do you think EPA can do to improve the rate of commercialization? Did you commercialize your technology? What success did you have? What has happened since the patents and/or partnerships? What were the roadblocks?

Table 1 - Questions for Companies

3.3 Writing Case Studies

Conducting the interviews based on the guidelines above resulted in receiving a mass of information, so the next step for our project was to organize the information to make it easier to analyze. A case study is an information gathering and organizing tool used for an in-depth study of an individual or particular social group. The study is conducted so that the series of questions posed to the person or group being studied are the framework for the in-depth conclusions that can then be formed. We chose to utilize case studies because they lend themselves to in-depth analysis, and because they present data in a more organized format than a simple interview transcription.

There are a few approaches in the analysis of qualitative data. One way is to convert to quantitative data, another is writing memos on the properties to back up the conclusion drawn from data, and a third is to combine the two (Glaser, 1967). For the scope of our project, representing the qualitative data in the form of narratives from the case study was the strongest way to present the information because of the comparative nature of the data. Converting from qualitative data to quantitative data is very difficult and not as accurate since there are no numbers to present. Comparative analysis is the best method to use to generate reasons why some technologies are making it along the continuum and why some are not.

The various modes of comparative analysis used to create ideas for a theory from qualitative data are, “generation restricted to the search of regularities, generation by a combination of logic deductive theory and grounded inquiry, generation grounded in limited comparison groups, generation grounded in internal comparisons and insightful generation with minimal integration” (Glaser, 1967). This means that there are different

ways to create a theory from qualitative data. The method we have used is most like the comparative mode: generation by a combination of logic deductive theory and grounded inquiry. This applied most soundly because we asked questions designed to produce specific responses that could then be compared between interviewed companies.

According to Robert Yin, case studies are best suited to answering questions related to the "how" and "why" of the problem to be looked at. He defines a case study to be an empirical study that "investigates a contemporary phenomenon within its real-life context especially when boundaries between the phenomenon and context are not evident" (Yin, 1994). A case study is a study of something current that lacks definition. We wanted to know how the development process of an environmental technology progressed, and how EPA could improve their program.

The type of case study that is most applicable to our project is the explorative/ descriptive type. Yin (1994) claims that aspects that need to be determined for this type of case study are: the questions that need to be answered, the units of analysis for the information gathered in the case study to mean anything, and the criteria for interpreting the findings. Our team created questions described in section 3.2.2 – Interview Development. The units of analysis have also been provided in the stages of the technology continuum. Our interpretation of the findings was based on a comparison of the background data we had about the companies, and the specific company responses to our questions.

Other considerations that were addressed were suggested by Yin. He suggests that a typical case study has four major aspects that need to be addressed for the case study to be of usable quality. They are: construct validity, internal validity (only for

explanative or causal case studies), external validity, and reliability. Construct validity ensures that the information gathered will be about the topic intended to do the case study on. We addressed this by interviewing multiple companies that have experienced the technology advancement programs, and also sent a copy of our interview summary to the key informant for review. External validity deals with the relevance of the conclusions that are drawn from the case study. External validity can be increased through repetition of the questioning/ interview process to see if the similar results come from similar situations. This was addressed through the number of companies we interviewed for data about technology advancement and EPA. Reliability deals with the repeatability of the experiment/ process. This was established through a definite set of questions asked and an interview plan that was made up prior to the first interview. Our questions are outlined in section 3.2.2 – Interview Development, and have evolved through the project to the ones found in our Appendix C – Company Interview Plan.

3.3.1 Case Study Format

Once the interviews were conducted, the information was written in a case study format. More information was also collected in order to provide a detailed case study with all the pertinent information. To determine the format of the case studies a variety of resources were consulted. These resources included previous case studies written by EPA, such as ETV case studies, suggestions from EPA employees associated with the SBIR program and what they wanted to know, and our own knowledge of the data and how best to present it. The case studies in this report are easy to read and present the pertinent information collected from the interviewed companies.

The first thing that was important was that each case study could be identified easily at a glance. For this reason each case study has the name, address, phone number, and website of the company interviewed at the top. Next is listed who was interviewed and when. This allows for easy follow-up to our interviews. After that follows basic information on what technology the interview was focused around and what stage of the technology continuum the technology reached. This allowed us to see how far along the continuum each company reached for easy comparison and analysis.

The key areas, which include the impact of regulations, environmental impact, development challenges, and recommendations for EPA, follow. These are key areas that each individual company was asked about during the interview. These different areas were used in grouping the different companies and determining which recommendations would help the greatest number of companies. The case studies provided a valuable tool for grouping and evaluating the companies and their recommendations.

3.4 Summary Analysis

The next step of the project was to synthesize the objectives into a coherent review that can help EPA improve their assistance programs. We drew inferences based on information we obtained through our interviews when performing our analysis. Our summary analysis is a summary of all the information we collected about technology development. This information was collected by interviewing and researching companies that received EPA SBIR contracts. This data was then written up into separate case studies for each company interviewed. The summary analysis combined all of the case studies into one easily understandable piece of information and pulled out trends regarding businesses succeeding to commercialize. It highlights the similarities, or lack

there of, that exist between companies. This summary analysis was then used to analyze the EPA SBIR program and commercialization assistance in general. It shows where more assistance is needed or where enough support already exists for companies developing new technologies. This information can be extrapolated to other assistance programs inside EPA, and other SBIR programs outside EPA.

3.5 Summary

In summary, we have conducted interviews with companies that have gone through EPA's SBIR program for commercialization assistance, supplemented any questions raised with information from other programs and outside companies, then created case studies about the interviews, and evaluated them with a summary analysis. Through constant communication with our liaisons, we found an effective way to present the information to EPA. Our schedule for completing this project is shown below in Figure 3 – Schedule

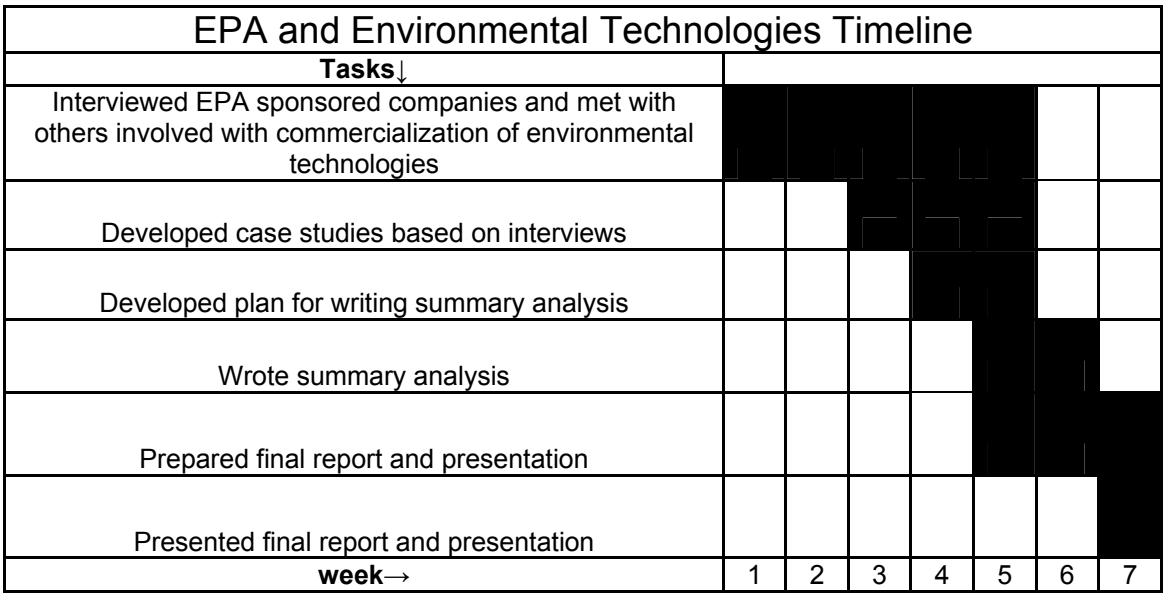

Figure 3 - Schedule

4.0 Results

This chapter is information gathered from our investigation of the SBIR program. We interviewed 11 companies and wrote case studies which contained information compiled from our background research on the company and what were their road blocks on the technology continuum. We also found the answers to our other questions by interviewing entities that interact with EPA and their SBIR program, Refer to Table 3-Other Investigated Programs in section 4.1.2. This investigation fulfilled our first objective of finding out the institutional context of EPA SBIR program, so that we could know who may have to play a bigger role in assisting environmental technologies make it from research to commercialization.

4.1 Institutional Context of SBIR Program

The SBIR program needs to be examined from a few steps back to be able to view the big picture. Our first objective was to investigate the institutional context for the EPA SBIR program, to get a broad overview of how the SBIR program functions as an entity. After meeting with the Deputy Director of the Program, April Richards, and meeting with the Director of the Peer Review Division, Barbara Levinson we found the details entailed in the proposal review process after solicitations close. A majority of the companies we interviewed wanted less solicitation time. The SBIR Application / Proposal Review Process goes as follows: First the proposals are submitted electronically or via mail to National Center for Environmental Research (NCER) and they are sorted and organized. Then the peer review experts have to be contacted, and waiting for their responses can take up to a month. The Peer Reviewers are experts in their fields that are contracted by

EPA to provide insight on the proposals. Three peer reviewers get a month to read the proposal, and write the write-up for the panel summary. A contract for each Peer Reviewer must be written to pay the peer reviewers, their airfare, hotel rooms, and for them to abide by their given budget from EPA. The contracts for the peer reviewers have to be written and approved by the Contracts Office at EPA, which takes 30 days. Once the peer reviewers agree to look at the proposals, they have a month to read the proposal and write up a summary for the panel discussion. The Peer Review panel consists of about 10-20 experts and three of them have to actually read the proposal and provide their thoughts to the panel. The panel uses the written summaries from those three people as a means to decide on which proposals should be funded. There is a lot of planning involved in setting up the panel. The third party peer review session is three days long, and is usually held in a hotel conference room. As you can see, it is not Peer Review that takes long; it is the actual process of setting up for it that is the issue.

Once the third party peer review session is complete, then the Internal Relevancy Review begins. Since no EPA employee is allowed to speak during the third party peer review session, the SBIR program has its own internal review to determine what proposals will solve the most important environmental problems that EPA needs to address.

After going through the external review, the proposals must pass a relevancy review where EPA decides if the projects are relevant to what they were asking for in their solicitation. EPA also prioritizes the projects according to importance to the agency if there are more than can be funded that are relevant. Then they are entered into a database and EPA finds someone within EPA (usually a program office and a lab) that

would be willing to review the proposal for technical merit and applicability to the agency. These usually take a month to review, though it is different for Phase I because there are so many proposals. The EPA personnel involved in relevancy review then meet with the internal reviewers to decide if the projects still qualify to receive funding. Once those proposals have been selected, the Director and Deputy Director of the SBIR program (Jim Gallup and April Richards) meet with the director of EERD, Steve Lingle and the center director of NCER, Gary Foley to receive final approval on funding. This process of meeting with the directors takes a few weeks. Then the proposals are sent to Marsha Johnson in the contracts office in Research Triangle Park, North Carolina. She sets up contracts with all the companies, makes sure that all the companies have been recommended or denied for good reasons. It takes approximately one month for companies to receive their contract and get the signed contracts back to EPA. The company then receives their first allotment of funding after their first month of work on the technology, and their first monthly submittal of a bill and progress report. For Phase I disbursements are fixed for each of the six months. For Phase II the companies bill EPA for the work they have done. Refer to Table 2- Timeline of Proposal Review Time for an illustrated timeline.

Time	Proposal Review Time
Solicitations Stay Open for 3 Months (May-August)	
Month 1	Organize Proposals
Month 2	Contact Peer Review Experts
Month 3	Peer Review Contracts Written
Month 4	Approval by the Contracts Office
3 Days	Peer Review is held
Month 5	Internal Relevancy Review
Month 6	"Decision Meetings"
Month 7	Proposals are in NC for Contract Prep
Month 8	Company Signs Contract
Month 9	Payment

Table 2 - Timeline of Proposal Review Time

During Phase I there is a two day networking workshop that is not required for companies to attend. At this workshop, there are presentations by Foresight and EPA about what they expect the companies to be able to do. EPA could look into doing something similar to DOE's opportunity forum through Dawn Breaker in Phase II, which allows companies and end users the opportunity to network. EPA could piggyback on that event, because there is not enough funding to run one solely for EPA companies. The third party peer review eliminates the question of whether or not EPA was being bias towards which proposals should receive funding. The EPA SBIR program is unique because they conduct a third part peer review panel, which is why their proposal review process takes nine months, but by appropriate pre - planning the process, the time it takes for a proposal to be reviewed can be reduced.

4.1.1 Time frame of other SBIR programs

Our first interview was with David Speser, Chairman of Foresight Science and Technology. See Appendix N for a summary of our conversation. The key issues highlighted by Mr. Speser as problem areas were the time frame to develop a new technology, reluctance by the company to follow up on the information provided, and a need to focus more on commercialization in addition to making the technology work. Mr. Speser's experience showed him that most technologies become obsolete after five years. This introduced the idea that EPA's SBIR program could be more effective if it had a shorter time from between the SBIR proposal and the actual award being given. Since some of these companies depend solely on SBIR funding to start their new technology, it is important that they receive the funding as soon as possible. This would allow the company developing the new and innovative technology a quicker start. They would not have to wait as long to see if they would receive funding to develop their technology, while their technology became obsolete.

To understand if EPA SBIR programs takes longer than other federal SBIR programs, between receiving proposals and awarding funding, our group investigated other federal SBIR programs. We looked at how many times a year SBIR proposals were accepted and the time between the proposal deadline and the awarding of funding. EPA's SBIR program takes nine months for proposal review time, beginning in August. Refer to Table 2- Timeline of Proposal Review Time for a timeline of this process. In this time the agency determines which proposals are deserving of funding and which proposals will have the greatest impact on human health and the environment. Due to the

nine month proposal review process, once a year, EPA chooses the top projects to fund with its budget.

Other government agencies do not have a third party peer review process. Other SBIR programs at other agencies only have an internal review process. Companies submit proposals of what their technology is and how they plan to develop it. After an internal review is conducted by the respected government agency, the decision is made what companies to fund. These companies are then awarded the funding. Out of the twelve federal agencies that have a SBIR program, we examined the four most commonly mentioned as being other sources of funding by companies we interviewed. These four are EPA, Department of Defense (DOD), National Institute of Health (NIH), and Department of Energy (DOE). Three of the four agencies are shorter because they do not have a third party external review process. Their review process is only internal and takes about three to five months. EPA has the longest time between the proposal deadline and awarding funding of agencies that we examined.

The Department of Defense, DOD, releases its internet solicitations at three times throughout the year. These times are November, May, and August 1st. Proposals are accepted in one and a half months from the solicitation date and are accepted for one month. Contracts are then awarded four months after the proposal deadline. This means that it takes only four months between the DOD receiving proposals and deciding who will be awarded the funding (DOD SBIR & STTR Programs, 2006).The Department of Energy, DOE, releases SBIR solicitations only once a year in September. They have a proposal submission deadline three months later in December. DOE awards its funding in June. This means that there are six months from the proposal deadline to awarding the

funding (DOE SBIR & STTR Power Point, 2006). The National Institute of Health, NIH, releases SBIR solicitations three times a year. NIH has proposal submission deadlines of April, August, and December 1. They award their funding seven months later in November, March, and July respectively (NIH SBIR, 2006). The Department of Homeland Security, DHS, releases solicitations for SBIR proposals twice a year. DHS is committed to having as fast as possible turnover from when the proposal deadline is to when companies receive their funding. For Phase I funding the DHS will review and award funding within approximately three months.

Phase II funding is made incrementally. The DHS tries to award Phase II funding as quickly as possible so that companies do not have to wait between Phase I and Phase II for funding to become available (DHS SBIR, 2006).

It will be beneficial to EPA's SBIR Program if the proposal review time, both internal and external was decreased to the four to six months range. Companies are comfortable with this time range. A shorter period of downtime permits companies to retain their development momentum. Once the technology is commercialized the companies will have a longer period of time during which they can market their technology, to stay within the five year time frame before the technology becomes obsolete. This in turn translates into a longer period of time during which the new environmental technology can benefit human health and the environment.

4.1.2 Other Investigated Programs

Along with timing, to determine the institutional context of the SBIR program, we spoke other companies, departments and program offices that relate or interact with EPA and the SBIR program. Refer to Table 3 - Other Investigated Programs.

Organization	Description
Foresight Science and Technology	Market Assistance Company
Environmental Technology Verification	EPA Verification Program
Design for the Environment	EPA Partnership Program
Center for Environmental Industry and Technology	EPA Information Center
Office of Air	EPA Office
Peer Review Division	EPA Division
EPA SBIR	EPA Technology Development Program
DOD SBIR	DOD Technology Development Program

Table 3 - Other Investigated Programs

4.1.2.1 Center for Environmental Industry Technology (CEIT)

The New England's Center for Environmental Industry and Technology (CEIT) serves the environmental technology industry and promotes the acceptance of environmental technologies. CEIT had a lot of good ideas provided by Maggie Theroux, one of the program runners has been working at CEIT for over seven years now.

There are ten different regions within EPA. The regional offices are the frontline of the EPA. They enforce environmental regulations by working with the states within their region. The regions delegate regulation enforcement to states. The regional offices also deal with regulations by giving out permits. It is important that the regions become involved in the process of technology commercialization. Region 1 is involved with technology commercialization through CEIT.

Companies involved with the regional offices during development and commercialization have a leg up over other companies developing new on their own. The regional offices can help companies developing technologies look ahead to the regulations which may apply to their technology later on. This allows the companies developing the technology the opportunity to make sure that their technology meets the regulations in the beginning of the design process rather than later on when it would be more costly to change the technology. CEIT can also help companies with new technologies receive regulation clearance so that they can market their new technologies. This leads to a smooth transition from R&D of the technology to marketing it.

Another idea that EPA could offer to companies is a searchable online database of all regulations that apply to a certain technology. This information would be easy to access and available from anywhere with internet access. Companies developing new technologies would get a look at all the different regulations that do/may apply to their technology. This would give companies a smooth transition from R&D to commercialization without having to worry about regulations.

The regional offices can lend a great deal of coordination to companies developing new technologies since they are the frontline and in direct contact with end-users. The regional offices can help companies find Cooperative Research and Development Agreements (CRADAs). The regional offices can also provide lists of programs and funding opportunities for environmental technologies. An example of this is “EnvirotechNews”, a low budget monthly news letter which provides a one stop place to find programs and funding opportunities applicable to environmental companies in the

area. This allows technology developers the ability to see what is out there and not waste time trying to find it.

Regional offices could also assist companies by matching technologies with interested parties. For example "Technology Connection" was a publication for companies looking for a certain environmental technology to be matched with a company that was developing, or developed that technology. This publication was run by CEIT, but is no longer being published. Having a system set up that matches companies with new technologies with companies that want to use those technologies could be very useful. This would allow the companies developing the new technology a buyer for their technology. This buyer might also be willing to help with the commercialization process.

Companies developing new technologies through the SBIR program may run into problems at different stages throughout the development process. It would be helpful to these companies to have quarterly check-ins from regional offices. These check-ins could be made through conference calls where the regional office would check the progress the company was making. The regional office could also see if the SBIR company was having any difficulties that they may be able to assist in solving or at least point the company in the right direction. These quarterly check-ins could also involve someone from EPA that was knowledgeable in that technology field. This would create a support team which wants to see the technology become successfully commercialized. For further information regarding CEIT please refer to Appendix I CIET Interview Summary.

4.1.2.2 EPA Air Programs

Ellen Brown from the Office of Air and Radiation (OAR), Robert J. Wayland from the Office of Air Quality Planning & Standards (OAQPS), and Ravi Srivasta also from OAQPS, were involved in a round table discussion of technology commercialization and the EPA SBIR program pertaining to the air field in general. This discussion brought up a variety of interesting points which are highlighted below. For further details please refer to Appendix T - Office of Air Summary.

It is important that the technology under development has an advocate within the company that wants the technology to reach commercialization. It takes passion to get a technology commercialized. You can't just sit around the lab doing R&D. There has to be someone within the company that really wants to see the technology reach the market. This person will take the business steps necessary to successful market the technology.

Some of the areas that companies have begun to network and market their technology include; conferences, trade shows, meetings, journals, and at demonstrations. EPA could help companies by providing a list of these different avenues of marketing specific to their technology. This would give SBIR companies some ideas of the right places to start their marketing.

Another thought to keep in mind is does this SBIR company really want to commercialize the technology. It would seem obvious that if a company applied for a SBIR contract that they would want to commercialize their technology, but this is not always true. Some companies just want the free money that SBIR offers. They are not concerned with commercializing their technology, they just want to get paid to do the research and write up a paper at the end. If a college professor is going to be the

principle investigator (PI), they may have to give up their teaching position because the PI has to be working for the company that is receiving the funding at least 50% of the time. It is important that the company genuinely wants to commercialize the technology and that they are willing and competent to do the required marketing leg work.

Many SBIR funded companies want an EPA stamp of approval for their technology. They want EPA to go to companies that may be interested in their product and promote it. SBIR companies are hoping that EPA will recommend their product because EPA helped sponsor the research and development of their technology. EPA can not do this. There are too many legal and ethical issues involved. What would happen if someone at EPA had a friend that was developing a technology and that technology was endorsed by EPA? This would put EPA in a bad situation. For similar reasons EPA has an outside peer review for the SBIR program.

It is also important that EPA tells companies this is what you get from the SBIR programs. Companies need to realize that SBIR only takes them so far. It is only one of many tools that can be used on the path to commercialization. Companies need to investigate other funding opportunities from the very beginning. EPA can help companies do this to a certain point, and then it is up the companies.

4.1.2.3 Environmental Technology Verification (ETV)

The Environmental Technology Verification (ETV) Program is a program run by EPA to verify environmental technologies. ETV functions as an independent source of credible test data about products. They then make that data available to end users of the technology, people who purchase it or regulate it. This third party verification provides companies with credibility so that they can commercialize their technologies. Abby

Waits from ETV provided some useful information during our interview with her. ETV not only verifies technologies that are brought to them, but they also go out and try to find technology to verify in fields that they feel are in need of more technologies verified and thus available to the market.

ETV does a lot of work with technology outreach. ETV outreach works toward the stakeholders and the organizations they represent. Each center has their own outreach program that involves going to local conferences and publishing in journals. The program publishes information, attends conferences, and hosts workshops at the regional level to advertise for the services offered. ETV also has a website (http://www.epa.gov/etv/) which is very popular by EPA standards, with approximately three million hits per year currently. All these different avenues allow ETV to get information out there about not only what they do, but what technologies they have verified.

ETV budget has decreased almost 50% from when it was initially started. This has caused fewer environmental technologies to be verified through ETV. ETV tries to find stakeholders in the technology being verified that are willing to help assist in funding the verification. ETV is no longer able to pay for all of the verification costs themselves. The program is still available to small companies that cannot afford the cost of verification though.

One of the positive things this decrease in budget has done is open up dialogue between ETV, companies developing the technologies, and stakeholders. In this case ETV helps bring together the company developing the new technology and the stakeholders involved with this technology. This example should be followed by other

EPA programs and perhaps regional offices. Solid communication is a key component of this concept. The more companies know during the development of their technology the better. EPA can help to connect companies developing new technologies with interested parties. This will allow the technology to pass through the technology continuum as quickly as possible to an awaiting market. Companies will know what the users want, and how to best market the technology, after talking with the stakeholders.

4.1.2.4 Foresight Science and Technology

Foresight S&T is a marketing consulting company that EPA ABIR program is contracted with to work with the awarded companies. Foresight receives $4,000 to provide the companies with advice on commercializing their technology. They give advice on what potential end users to contact and they provide the companies with the contacts. For further details on what Foresight does please refer to Appendix O – Foresight Science and Technology Summary. It may be even more challenging to commercialize environmental technologies due to the impact of regulatios and how quickly they can pass. From this discussion, it was highlighted that technologies are time sensitive and that in a five year timeframe technologies become obsolete. We then realized that timing is an issue.

4.1.2.5 Design for Environment (DfE)

See Appendix J for a summary of the convocation. The challenge we identified from this discussion is that EPA does not communicate and share information about what they are doing with their programs. DfE did not have a clear picture of who SBIR was funding and why, and the same goes for the SBIR program. Because of the obvious lack

of communication, we saw this issue as a window of opportunity for EPA SBIR program to improve upon.

4.1.2.6 Peer Review Division

Refer to Appendix W - Peer Review Division Summary for the detailed discussion. Speaking with the Director of the Peer Review Division, Barbara Levinson we found out the details on why it takes so long to review a proposal (Refer to Table 2-Timeline of Proposal Review Time). This gave us the knowledge to highlight the areas during the process that could be shortened.

4.1.2.7 Department of Defense (DOD) SBIR

Refer to Appendix K – DOD SBIR Program Director Summary for an overview of the interview. After speaking with the Director of the DOD SBIR program, Mike Caccuitto we realized that he was facing the same issues the EPA SBIR program was. The discussion reinforcement that even though a larger budget makes things easier, the same issues still exist such as communication (keeping track of company progress and commercialization success) and figuring out how to solve networking issues between the small businesses and end users. We found out that DOE SBIR program has an "Opportunity Forum", which is like a conference where the small businesses get a chance to expose their technologies to end users and venture capitalists. We concluded that if EPA leverages resources with other SBIR programs, and uses the strengths of other programs to add to theirs, EPA SBIR program will probably be more successful at assisting with the commercialization of their funded technologies.

4.2 Case Studies

The case studies that follow are from the SBIR funded companies that were interviewed. Basic information about the 11 companies that were interviewed can be found below in Table 4 – Interviewed Companies. A more detailed table of information and analysis topics can be found in Appendix E – Table for Analysis. Analyzing the company information we obtained through our interviews and then comparing the recommendations each company made with that information pulled out some particular reasoning each company had for making the recommendations they did. Each company had similar recommendations, though there were a few that were more specifically suited to the individual company. The recommendations and some possible reasoning for making those recommendations for each company are located at the end of each case study. To view the interview summaries for all the interviewed companies please refer to Appendices F, G, H, P, Q, R, S, T, V, X, and Y. These appendices have the interview summary for each one of the 11 interviewed companies in alphabetical order.

Interviewed Companies

Attribute →	Location	Stage	Technology
Company Name ↓			
ADA Technology, Inc.	Littleton, CO 80127	3 – Demonstration	Arsenic removal system for point of use/point of entry drinking water systems
Advanced Fuel Research, Inc.	East Hartford, CT	4 –Verification	Mercury sorbents and carbon black derived from waste tires
Aerodyne Research Inc.	Billerica, MA 01821	1- Proof of Concept	Monitor Acrolein, air pollutant
Infoscitex Corporation	Waltham, MA 02451	2 – Development	Mercury-free, electrical switches (MFES) and relays
Luna Innovations	Blacksburg, VA	4 – Verification	Magnetite nanoparticles for enhanced environmental remediation
Lynntech Inc.	Bryan, TX 77803	5 - Commercialization	New chemical process to create oxidizing agent potassium fer-rate
Mide Technology Corporation	Medford, MA 02155	2 – Development	Fuel injection to reduce pollution
National Recovery	Nashville, TN 37228	4 –Verification	High speed identification and sorting of plastic resin flake for recycling
Ophir Corporation	Littleton, CO 80127	2/3- Development/Demonstration	Novel liquid and gas pipeline leak detection system
Phoenix Science and Technology	Chelmsford, MA	4 – Verification	Innovative ultraviolet light source for disinfection of drinking water
US Infrastructure	Birmingham, AL 35209	6 - Diffusion/Utilization	Upflow Filter for Rapid and Effective Treatment of Stormwater

Table 4 - Interviewed Companies

4.2.1 ADA Technology, Inc.

ADA Technology, Inc.
Littleton, CO 80127
303-792-5615 x285
www.adatech.com

Interviewee: Craig Turchi, Principal Investigator

Time of phone interview: November 9, 2006

Technology: Arsenic removal system for point of source/ point of use drinking water
Technology Continuum Stage: Stage 3 - Demonstration
Media: water
EPA program(s): SBIR
Sources of funding: ADA has used EPA Phase I and II funding, but has also been able to repackage their idea enough to interest National Institute of Health (NIH) and Department of Defense (DOD) in funding this project under their SBIR programs as well. All three have funded Phase I and Phase II projects, and all three have been successfully completed by ADA. Approximately ¾ of all the company revenue comes through SBIR programs. Other sources include other non-SBIR government programs, state grants, royalties from previously developed technology that the company reinvests, and industrial contacts.

Regulation involvement: When asked about the impact of regulations on the technology, Mr. Turchi mentioned that uncertainty about a regulation is a problem. For example, when a regulation is being proposed by EPA, but it is unclear whether or not it will be approved shows the uncertainty that makes product development difficult. From Mr. Turchi's perspective, the time when a technology must begin to be developed is before the regulation is passed, so that when the regulation takes effect, the technology will be available for people to begin using it. The only problem with developing a technology in that gap is that companies are more reluctant to partner or contribute funding.

Environmental problem technology solves: Arsenic is a naturally occurring substance that is used primarily as a wood preservative, but can also be found in certain fertilizers and animal feeding operations. This substance can cause both short and long term effects. Over a long period of time arsenic has been shown to cause cancer. Short term exposure to high doses can have other health effects. This technology removes arsenic from drinking water before it can become ingested and lead to health complications.

Environmental impact: The lower the amount of arsenic you take into your body, the lower your chances of developing cancer because of arsenic levels. Since arsenic is found more commonly in ground water than surface water, most sources of drinking water are potentially at risk for containing too much of this substance.

Summary: ADA worked with EPA, DOD, and NIH SBIR programs to develop an arsenic removal system. Once the system was tested, it did not show any additional

benefit over existing technology in the US market, because the infrastructure here allows more permanent arsenic removal systems to be installed. Therefore, the company chose to look over in India as a potential market, because the technology is easy to make and easy to use. All the final product needs is to be mixed with drinking water before consumption. They are currently setting up a demonstration in India that will hopefully get more potential sponsors on board to fund the progress of the technology.

Challenges along the way (at what stage): At the demonstration stage, there were difficulties showing that their product provided an advantage over existing products. The company turned to an overseas market in India to show that in a place with fewer infrastructures, their product was more effective than existing products. The whole continuum has the problem that companies may not know where to turn to find the resources they need to commercialize their product. Also, Mr. Turchi felt EPA should be more understanding of this lack of resources when companies apply for multiple SBIR awards. Demonstration stage showed that ADA's product was not better than existing systems in US.

Solutions to the challenges (resources used): ADA created a core theme of research, and sold that idea to DOD, EPA, and NIH SBIR programs, so they were able to get much more funding than they might have otherwise. Because their product was not better than the existing US systems, they decided to take their technology overseas to a less developed country where the systems in the US are not practical. Infrastructure in the US allows the installation of beds of arsenic removal material. This solution is not practical in a developing country. Therefore, ADA's mix-and-use technology provides a better arsenic removal solution to India than it does in the US.

Interviewee's Suggestions to improve environmental technology commercialization: EPA should be more understanding toward this lack of money/ resources to completely develop a technology when companies apply for similar SBIR contracts. The amount of funding EPA provides is much better suited to augmenting an existing technology than creating a new one from scratch. Foresight was mostly useful, because there is only one man at ADA to help commercialize all the technologies that are developed.

Major conclusions: ADA has a pilot scale system for manufacturing their arsenic removal system components and is planning to test it in India sometime soon. EPA is not ADA's only source of funding. ADA uses other SBIR programs to help advance their technology. Regulations can have a significant impact on the process of developing a technology.

Analysis: Craig Turchi of ADA made the observation that uncertainty about whether or not a regulation will take effect is particularly harmful to developing a technology. The arsenic removal system is highly impacted by regulations about how much arsenic needs to be removed from the drinking water supply. Because of this regulatory impact, and the uncertainty about whether or not this technology would meet the regulation's requirements, funding opportunities were few and far between. No one wanted to fund a technology that might not be precise enough for the regulation, or might not even be

required, if the regulation was not approved. This lack of funding from interested parties led the company to use their core technology with a few modifications to apply for multiple SBIR awards from EPA, DOD and NIH. ADA felt that this was the only way to get enough money to develop their technology. They have made it to a pilot scale demonstration that is occurring now. ADA probably hopes that a pilot scale demonstration, even in the face of regulatory uncertainty, will create enough interest in companies that they will begin investing in furthering the development of ADA's technology.

4.2.2 Advanced Fuel Research, Inc.

Advanced Fuel Research, Inc.
87 Church Street
East Hartford, CT 06108
Tel: 860-528-9806
http://www.afrinc.com/

Interviewee: Marek Wojtowicz, Principal Investigator

Time of phone interview: Nov 7 @ 3pm

Technology: mercury sorbents and carbon black derived from waste tires
Technology Continuum Stage: Verification
Media: Air Treatment
EPA program(s): SBIR

Sources of funding: Only source of funding is the EPA SBIR program for the two technologies mercury sorbents and carbon black derived from waste tires.

Regulation involvement: AFR is facing federal and state elections, and depending on whom gets elected governor will determine demand for the technology. A utility company in Michigan that is big in the United States is looking at the tar technology to meet the regulations that may be passed. In AFR's case, the change in the EPA Option Task funding* dramatically slowed their development of the technology, because it was funding that AFR was depending on.

Environmental problem technology solves:

Air Pollution: Having clean air to breathe is vital for all life on planet earth to survive. There are toxins such as nitrogen oxide and sulfurous gases that are dangerous to inhale. Carbon black is made from oils derived from scrap tires. A pyrolysis process was developed for conversion of used tires into activated carbon, carbon black, and fuel gases.

Exhaustion of natural resources & Safer Tires: The most common usage of carbon black is as reinforcement in automobile tires. Carbon black also helps conduct heat away from the tread and belt area of the tire, reducing thermal damage and increasing tire life. Carbon black particles are also employed in some radar absorbent materials and in printer toner. We need fuel gases in order for our cars to run, exhaustion of our current gas and oil supply could result if we do not find another means for oil. The oils derived from the tires (before being processed into carbon black) can be used as an alternative to lower the increasing gas prices of today.

Poison Control: Mercury is highly toxic and in humans damages the nervous system, and if it gets into the environment, it poisons wildlife. AFR has developed a novel process (patent pending) for the removal and recovery of mercury from combustion flue gas. AFR creates tire-derived activated carbons for mercury control.

Environmental impact: Carbon absorption has numerous applications in removing pollutants from air or water streams both in the field and in industrial processes such as spill cleanups, groundwater remediation, drinking water filtration, volatile organic compound capture from painting, dry cleaning and other processes.

Activated carbon is used to treat poisonings and overdoses following oral ingestion. It prevents absorption of the poison by the gastrointestinal tract. In cases of suspected poisoning, medical personnel either administer activated carbon on the scene or at a hospital's emergency department. Activated carbon has become the treatment of choice for many poisonings (i.e. mercury). The use of activated charcoal is contraindicated when the ingested substance is an acid, an alkali, or a petroleum product. Filters with activated carbon are usually used in compressed air and gas purification to remove oil vapor, odor, and other hydrocarbons from compressed air and gas. Activated carbon air filters are also commonly used to purify the oxygen in aquariums.

Summary: Advanced Fuel Research, Inc. (AFR) celebrated its twentieth anniversary in early 2000.The Company currently has 14 full-time employees and 14,000 sq. ft. of office and laboratory space. The company has developed leading edge technologies in a number of areas. AFR has successfully developed, through government and industrial support, a number of innovative laboratory and process control instruments and software products that are today serving industrial and academic clients throughout the world. AFR also performs contract research and development for research institutes and private organizations. AFR often works on projects in collaboration with other small businesses, large companies, national laboratories, universities, and consultants. Many of these interactions have occurred through Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) projects.

AFR typically makes at least 10 presentations per year at national and international conferences. In addition, AFR scientists have been actively involved in organizing symposia, in the governance of professional societies, and in standards organizations. AFR has published more than 300 papers in conference proceedings, book chapters, encyclopedia chapters, and referred journals. AFR has considerable expertise in electronic materials and devices (EMD) and carbon materials (carbon fibers, fullerenes, diamond, and advanced carbon sorbents).

Challenges along the way (at what stage): It was quite challenging to spread the funds evenly through out time. The carbon black technology took from 1999 to 2005 to develop; it was intended to take only two years. It took so long partially due to the gaps in between Phase I and Phase II funding stages. As a contract R&D company, trying to commercialize technologies is time consuming and challenging, so they would rather stick to what they are good at: making technologies. The change in option task funding

also hindered their project; because they were depending on getting that funding, then the rule changed. AFR feels the rule changed because the EPA wanted to increase seriousness for companies to receive funding. Mainly because companies can easily inflate in-kind donations when providing proof to the EPA, and for a company to sponsor the small business with cash, means that the sponsor is serious.

Solutions to the challenges (resources used): AFR currently has no funding for this project and is unable to get the option funding, mainly because the rule was changed. It is difficult to get a straight cash donation, especially since they are not able to do pilot scale testing to give the technology more credibility.

Interviewee's Suggestions to improve environmental technology commercialization: Make a clear definition of deliverables (e.g., pilot scale testing data), and to consider each of them on a case by case basis, and to negotiate funding. The time it takes for the funding to be dispersed is also an issue. EPA has funded Foresight, and their assistance was wonderful. Most of the Foresight interactions pleased AFR. AFR has not heard of the ETV program when asked about it. It is possible that the ETV program would have helped give their technology more credibility to provide more funding from sponsors.

Major conclusions: It is always beneficial to rely on multiple sources of funding when moving a technology along the technology continuum. EPA may have tried to increase seriousness, or honesty for applying for more funding, but this effort may in fact he hurting companies and not helping them.

Nugget of knowledge, interesting fact: AFR has developed a successful strategy for commercialization of advanced technologies. The first step is to work closely with industrial strategic partners (often starting in Phase I of technology development) to develop technology based upon real customer needs. AFR may then seek additional development funding from industry or government. AFR then sells its first commercial units directly to its industrial partners and other industrial "early adopters". A comprehensive business plan is created, and when a technology/market combination demonstrates enough promise to exist profitably on its own, a free-standing spin off firm, to make and sell products. AFR will pursue this strategy based upon initial customer responses and business plan analysis. AFR technology is transferred or licensed to that spin-off company.
EPA has outperformed the other government agencies because a majority of AFR's leads comes from EPA's website. A business development person is hired as needed, but most of the advertising is word of mouth from the president, and primary investigator of the technology.

Analysis: Marek Wojtowicz of AFR commented that 75% of their funding comes from SBIR programs, so it would be particularly important for this company to have as small a break in the time to receive more funding as possible. He also mentioned that a more concrete definition of deliverables for the Phase I/Phase II project would be beneficial. Defining what results are expected from each Phase on a case by case basis would let the

companies pick a goal to be reached at the end of each Phase. He also wanted EPA's rules about what types of contributions are allowed to make companies eligible for EPA's option funding changed back to the way they were. He feels that his project is not one that can draw the cash contributions now required for the option funding, though they had no trouble finding in kind contributions to help develop the technology. This rule change would specifically affect AFR for the better, though EPA may have made this rule change because people were claiming to receive larger in-kind contributions than they actually had, making themselves eligible for the $70,000 available as option funding.

4.2.3 Aerodyne Research Inc.

Aerodyne Research Inc.
Billerica, MA 01821
(978) 663-9500
http://www.aerodyne.com/

Interviewee: Joanne Shorter, Principal Investigator

Time of phone interview: 10:30 AM November 6, 2006

Technology: Acrolein Monitor
Technology Continuum Stage: Stage 1 – Proof of Concept
Media: Monitor Air
EPA program(s): SBIR
Sources of funding: EPA SBIR Program provided approximately $70,000 (EPA Aerodyne SBIR, 2006). Aerodyne applied for SBIR Phase II, if awarded, they will receive an additional $225,000 in funding. JAMA (Japanese Automobile Manufacturers Association) provided some demonstration assistance through comparison of their current monitoring methods to Aerodyne's, and have expressed an interest in purchasing one of the instruments once they are completed and ready for sale. No cash donations were mentioned in the interview.

Regulation involvement: There are no regulations prohibiting Aerodyne from developing this technology.

Environmental problem technology solves: This monitor for Acrolein, a Volatile Organic Compound (VOC) created by combustion of organic material, can be used to test things that produce Acrolein as a byproduct. Testing the level of Acrolein allows the manufacturer of something that produces Acrolein to see if their device produces an acceptable amount of pollution.

Environmental impact: According to EPA's website, Acrolein is created through the combustion of organic material, used in industry to create other chemicals, and as a pesticide to control algae, weeds, and mollusks. "Acrolein inhalation may cause irritation to the eyes, nose, throat and lungs and exposure to higher levels may cause death. Based on laboratory animal studies, Acrolein is regarded as extremely toxic." (EPA Air Toxics, 2006)

Problems along the way (at what stage): Aerodyne currently has no marketing division; their only sales are based on word of mouth and the business that being advertised as a success story on EPA's webpage brings them.

Solutions to the problems (resources used): Aerodyne hasn't encountered a major problem yet, but if they want to sell more units, they will need to look for some market guidance so they can successfully expand their product to newer markets.

Interviewee's Suggestions to improve environmental technology commercialization:

Ms. Shorter suggested that EPA speed up the approval process between Phase I and II so the technology isn't sitting dead for a year while there is no funding to keep people working on it.

Summary: Phase I Acrolein monitoring technology developed by Aerodyne utilizes previously existing research and products to accomplish this new task of measuring Acrolein using IR spectroscopy. Aerodyne has no marketing division at the present, and does not feel that one is required because they are making sales simply through word of mouth. They would like to see the SBIR process quickened so there are fewer gaps between phases of funding, to minimize down time in the development of the technology. The technology is well supported technically, though with no market division, sales may not be as high as they could be. Aerodyne also felt that the assistance from Foresight was helpful to a limited extent.

Analysis: Joanne Shorter of Aerodyne commented that it has been hard so far to find interested parties to assist the development of the technology. This technology is still in Phase I, so there is not much data to back up the assertions of the company that their technology is worth investing in. Because of this lack of outside funding, Joanne felt that shortening the time gap between Phase I and Phase II was particularly important. Another reason for shortening the gap is that the people developing the technology lose momentum when they have to stop working on a technology for six to nine months. Aerodyne would like to circumvent that through more continuous funding.

4.2.4 Infoscitex Corporation

Infoscitex Corporation
303 Bear Hill Road
Waltham, MA 02451
781-890-1338
http://www.infoscitex.com/

Interviewee: Robert Kovar, Principal Investigator

Time of phone interview: 3:30PM October 31, 2006

Technology: Low-Cost, Mercury-Free Electrical Switches (MFES) and Relays
Technology Continuum Stage: Stage 2- Development
Media: air prevention
EPA program(s): SBIR
Sources of funding: The only source of funding for this project at the time of the interview was the EPA SBIR Phase I funding of $69,966 (EPA Infoscitex SBIR, 2006). Phase II funding from EPA was applied for, if Infoscitex receives Phase II funding they will match that amount with their own resources.

Regulation involvement: There are currently no laws or regulations prohibiting the use of mercury in electronic switches that Infoscitex knows of. Infoscitex feels that the idea of going mercury free is recognized by switch manufacturing companies and automobile Original Equipment Manufacture (OEM) companies. Infoscitex feels that the switch manufacturing companies are looking to non-mercury alternatives for their switches.

Environmental problem technology solves: Mercury is a toxin that is released into the environment through a variety of different ways. One of these ways is when electrical switches and relays containing mercury are incinerated. By using mercury-free electrical switches (MFES) and relays the amount of mercury released into the environment will decrease.

Environmental impact: If mercury is not used in switches, then no mercury will be released into the environment when these switches are incinerated. This in turn means that our environment will have less mercury in it. Mercury is a known mutagen and carcinogen. It can be very toxic to all kinds of animals, especially when it accumulates in them. Mercury is known to accumulate in fish, and then animals that eat fish suffer adverse health affects. By reducing mercury in the environment, these health problems can be mitigated.

Summary: EPA made Infoscitex aware of the issues with mercury through a published solicitation requesting companies to solve the problem. To help identify possible markets and solutions, Infoscitex talked with switch manufactures and automobile OEMs, since cars can have a few dozen of these switches in them. Infoscitex came up with the idea of using organic ionic liquids, ILs, instead of mercury. They worked on R&D and have developed a proof-of-concept that works. The proof-of-concept uses an IL and a novel

switch board. In testing the design light up an LED when tilted in one direction and turned off when tilted in the other direction, proving that the idea works.

Challenges along the way (at what stage): After EPA SBIR Phase I funding was used, there were no other funding resources available. This means that the research on this topic is at a stand still until other funding can be secured.

Solutions to the challenges (resources used): Infoscitex is waiting to see if they receive Phase II funding from EPA. If funding is granted, then they will match that with their own resources. This will allow for further continuation of the project.

Interviewee's Suggestions to improve environmental technology commercialization: EPA can offer incentives for new environmental technologies. Incentives that would help a technology reach commercialization quickly include; tax breaks, a timeline for change, and the fact that the new technology can be even cheaper than the existing technology. The reasoning behind incentives given by the interviewee is as follows. The price of implementing a new technology can be expensive. The cost of implementing a new technology will initially make the price of the product go up. Then competitors that did not implement the new technology can still sell their product for less. To help companies that want to implement a new technology, incentives can be given to help offset the initial cost of changing over to the new technology. This will allow companies to implement new environmental technologies and still be able to be competitive.

Major conclusions: Infoscitex has begun research and proof of concept work concerning Mercury-Free Electrical Switches (MFES) and Relays with EPA SBIR Phase I funding. The proof-of-concept testing went well. Infoscitex looks forward to hopefully receiving Phase II funding to allow them to create a prototype, which is considered to be the development stage. They will also see if they can apply the technology for other uses.

Nugget of knowledge, interesting fact: Infoscitex is a contract R&D company. They only do research under contract to companies or the government. Infoscitex does not intend to initiate a new manufacturing company at this time, even for a very promising product. It is much too expensive, time consuming, and risky. To reduce risk Infoscitex tries to partner up, or sell their technology to other companies. They do not directly commercialize any technologies themselves.

Analysis: Infoscitex's only source of funding for this project was EPA's SBIR program. This means that during the funding gap between Phase I and Phase II no work was being done on this project at all. The only thing happening was that the researchers were forgetting what they had learned and where they were headed relevant to this project. For this reason speeding up access to Phase II funding from this program would be extremely helpful in this particular case. Other suggestions for the program would help this company greatly, because they are trying to take a market away from an existing product. Therefore, it would be greatly beneficial to Infoscitex for EPA to provide incentives for people to switch to a more environmentally friendly product in this particular application.

4.2.5 Luna Innovations Inc

Luna Innovations Inc
3157 State St.
Blacksburg, VA 24060
540-552-5128
http://www.lunainnovations.com/

Interviewee: Matthew Hull, Principal Investigator in Life Sciences Group

Time of phone interview: 10:30AM November 14, 2006

Technology: Magnetite Nanoparticles for Enhanced Environmental Remediation
Technology Continuum Stage: Stage 4- Verification
Media: water treatment
EPA program(s): SBIR
Sources of funding: Luna received EPA SBIR Phase I funding of $69,939 (NCER SBIR Luna, 2006). Luna is now in Phase II and will receive another $224,963 from April 2006 to June 2007 (NCER SBIR Luna, 2006). This project has also received internal funding.

Regulation involvement: This technology is used for remediation, which is a regulatory driven sector. Luna's technology can be used to treat arsenic in drinking water. The lowering of arsenic in drinking water standards has definitely helped drive this technology. Companies need technology, like Luna's, that can effectively remove arsenic from drinking water to meet these new regulations. There is no way to predict the regulatory climate for the next few years, but Mr. Hull does not see regulations adversely affecting this technology.

Environmental problem technology solves: There can be a variety of contaminants in our drinking water. These include; chlorinated ethylenes, hexavalent chromium, arsenic, and perchlorate (NCER SBIR Luna PI, 2006). These containments lead to adverse health effects. Remediation of these contaminants can be achieved through a variety of different ways, one these ways is using magnetite nanoparticles.

Environmental impact: Clean water that is safe to drink is very important for human health. If magnetite nanoparticles can provide an effective way to eliminate contaminants from drinking water then people will live healthier lives. This is because the adverse effects of these contaminants will not be a factor.

Summary: Luna filed an initial disclosure for the synthesis of one particle. They will decide later this year if they wish to file for a patent or not, after an extensive review of other technologies and patents. Foresight was very helpful in understanding what aspects of this technology could be expanded on. Luna does not have enough personnel on the business side to give as much attention to marketing as they would like, so Foresight is useful. Luna is working with an OEM type company to license their technology. This will allow them to use the existing sales network of the partnered company. Luna would like to verify this technology through Environmental Technology Verification (ETV)

program. Luna plans to do some testing internally before they go to ETV so they know their technology will become verified. Luna is working in collaboration with a researcher at Virginia Polytechnic Institute and State University (Virginia Tech) on this project.

Challenges along the way (at what stage): After EPA SBIR Phase I funding was completed, there were no other outside funding resources available. Internal funding requires buy in like external funding, and consequently was also unavailable. This means that the research on this topic was put on hold.

Solutions to the challenges (resources used): To achieve buy in, either internally or externally, you need results. Luna ended up just waiting until Phase II funding to continue research. During Phase II Luna hopes to have enough promising results to acquire funds from both internal and external sources.

Interviewee's Suggestions to improve environmental technology commercialization:

EPA SBIR program should increase the amounts of their awards. EPA could possibly make fewer awards at a higher level of funding. This will allow companies to develop technology further so that once they are finished with Phase II funding they can find support to help pay for the commercialization process.

EPA should expedite the length of time it takes for reviews on Phase I proposals. A good time period would be to award contracts in six months or less. This means the time between the proposal deadline and the award funding starting would be six months or less.

Luna recommends that EPA offer bridge funding between Phase I and Phase II. This will allow companies to continue working on the project, and not have to wait to continue work until Phase II funding starts. This bridge funding could be worked in as option funding perhaps.

Another idea is to make option funding based on an internal audit of the proposals instead of using the peer review system. This could reduce the amount of time it takes to receive this funding.

There is a lack of understanding concerning how options work together. There needs to be more understanding. It is important that people know the option for verification money goes to ETV, and not directly to the SBIR company to be used in further development of their technology. The technical people may understand, but the business people don't. It would be helpful if EPA created a model of funding that business people could understand as well as technical people.

Major conclusions: Overall EPA SBIR program was helpful to Luna. The EPA SBIR program helped get the technology started. Funding came at the right time, so an initial partnership with the Virginia Tech researcher could be established. The technology just recently entered into Phase II funding and has some time to go until commercialization could occur. Luna has a commercial partner who has tested small quantities of their product. Now they have to scale up the production process and make sure it still works properly.

Nugget of knowledge, interesting fact: Know going into Phase I that you (company) need industrial partners to scale up the production.

Analysis: Internal funding from Luna is the only source of money for this project besides the EPA's SBIR program. As a result, the technology is sitting dead while there is no external support between Phase I and Phase II. If there was more external support for the technology, then Luna's internal support could assist with funding at this stage. Speeding up the transition from Phase I to Phase II would greatly assist this company because it would enable them to return to work on the project that much sooner, and hopefully commercialize their product that much sooner. Another suggestion was for EPA to provide fewer awards, but increase the dollar amounts awarded. This would allow Luna to advance their product along the continuum farther, so that it would become more attractive for commercialization.

4.2.6 Lynntech Inc.

Lynntech Inc.
7607 Eastmark Drive, Ste. 102
College Station, Texas 77840
979-693-0017
http://www.lynntech.com/

Interviewee: Oliver Murphy, President and Founder

Time of phone interview: 3:00PM November 14, 2006

Technology: A New Chemical Process to Create Oxidizing Agent Potassium Fer-rate
Technology Continuum Stage: Stage 5- Commercialization
Media: waste prevention
EPA program(s): SBIR
Sources of funding: Lynntech received EPA SBIR funding totaling $295,000 (NCER SBIR Lynntech, 2006).

Regulation involvement: No regulation obstacles were mentioned in the interview. Regulations of oxidizing agents used for environmentally-friendly remediation would only help this technology.

Environmental problem technology solves: Right now there are no cheap and environmentally friendly oxidizing agents on the market. Oxidizing agents are used for industrial waste control, disinfection, and water treatment (NCER SBIR Lynntech PI, 2006). Potassium fer-rate is an environmentally-friendly and effective oxidizing agent.

Environmental impact: Potassium fer-rate is environmentally-friendly and does not have the adverse effects of other oxidizing agents. It replaces other oxidizing agents, therefore those agents adverse effects will no longer be a problem. The process that Lynntech uses to produce potassium fer-rate is also very environmentally-friendly. Lynntech developed an environmentally benign process for the production of potassium fer-rate that uses low-cost starting materials, most of which are recyclable (NCER SBIR Lynntech PI, 2006). So not only is the end product good for the environment, the production process is too.

Summary: Lynntech has one or two US patents issued on this technology. Lynntech currently has an agreement with a potential supplier of their product. The potential supplier is considering becoming the sole licenser of the technology. Their name was not mentioned because of a mutual non-disclosure agreement. Lynntech has heard of the Environmental Technology Verification (ETV) program, but does not believe that it is suited to this particular technology. Lynntech has no designated marketing department. Researchers and senior management do the marketing by attending exhibitions and tradeshows where they network.

Challenges along the way (at what stage): A challenge Lynntech faces is with the commercialization process. They have developed a process to manufacture potassium fer-rate, but only laboratory scale quantities. Now that there is an interested company wanting to license the technology they need to find the resources to scale up the product method.

Solutions to the challenges (resources used): Lynntech is looking for ways to fund the scale up of potassium fer-rate production. Lynntech is using their own resources to begin the process, but is waiting for support from the interested company.

Interviewee's Suggestions to improve environmental technology commercialization:

No funding gap between Phase I ending and Phase II beginning is ideal. This is impossible, though a reasonable goal would be three to five months between Phase I ending and Phase II beginning. The reason to shorten the period of no funding is as follows. If there is a stoppage in funding between Phases I and II, companies lose momentum on their project. Most companies do not have the resources to fund the project themselves and at this early stage others are not willing to invest. Therefore the developers have to begin working on some other project. Companies then have to start back up on the project in nine months when Phase II funding starts. It is hard to switch your mind from one project to another, it takes time to remember and become reacquainted with the material. You lose momentum on the project.

The one thing to make sure of is that Phase II proposals are only submitted after Phase I is completely done. Asking for Phase II proposals before Phase I is complete would effectively shorten Phase I. Six months for Phase I is already too short.

The government (EPA) should offer more support after Phase II. The area of little to no funding after Phase II is known to many as "the valley of death". This is because SBIR funding of technologies usually ends after Phase II and the technology dies, or progresses no further. If a technology has market pull, then the government needs to get involved with Phase III. Even if the market pull is three years down the line, the government should support the company. This would provide a resource to overcome "the valley of death" and thus aid in commercializing technology.

Major conclusions: EPA SBIR program was helpful to Lynntech. It helped get the technology going. Right now Lynntech is trying to commercialize their product. They know of a company that is interested in licensing their technology. This company verified their product and is passing along samples to end users. Lynntech is now just waiting to hear the word from the interested company to start scaled-up production.

Nugget of knowledge, interesting fact: "There is not (a) one size fits all means for technology commercialization." You have to find your company's niche. Commercialization is going to be done by people that are good at it, not scientists and engineers.

A myth is that you receive two or three SBIR awards, manufacture and sell the product. This is not true 90% of the time. There is a continuum of companies that are good at a specific stage of the technology continuum. Companies are static; the

technology is dynamic and moves from one company to another along the technology continuum. Each company fits into a certain spot on the continuum.

Analysis: Oliver Murphy of Lynntech has had success commercializing technologies in the past. This technology has a company interested in it, who wants to become the sole license holder for the technology. The interested company is currently trying to make sure that the market is ready for this product. Since Lynntech is currently running production at a laboratory scale, even though they have a commercially interested party, government support for after Phase III to assist with the scale up would have a greatly beneficial impact. The assistance would help to push the product into the market sooner than if they have to wait for their interested company to provide the funding to create a full scale production apparatus.

Oliver thinks that it would be beneficial to companies if EPA did not have such a large gap in funding between Phase I and Phase II. Currently there is a large gap between EPA SBIR Phase I and Phase II funding. During this gap researchers usually work on a different project. When Phase II funding begins, the researchers start working on the initial project again. The problem with this is that the researchers lose momentum because they have to switch from one project to another. One thing Oliver points out for consideration is how DOD runs their SBIR program.

DOD's program cuts the time of funding between Phase I and Phase II down substantially. They do it by requiring Phase II proposals four months in to Phase I, when the technology is not as developed as it could be before putting it up for judging and acceptance into Phase II. It is a tricky situation, because if a company does get accepted to Phase II based on the work that they have done, then they will be receiving their Phase II money much sooner than they would have otherwise. However, the downside is that if they are denied for Phase II funding because their technology was not developed enough at four months, but at six months, they had a product that would be accepted, then they have no chance to go back and try again without waiting much longer and re-applying during the next round of proposals.

4.2.7 Mide Technology Corporation

Mide Technology Corporation
200 Boston Ave, Suite 1000
Medford, MA 02155
781- 306-0609
http://www.mide.com/

Interviewee: Attila Lengyel – Chief Operating Officer

Time of phone interview: 10:00 AM November 20, 2006

Technology: Fuel Injection to Reduce Pollution
Technology Continuum Stage: Stage 2 - Development
Media: air treatment
EPA program(s): SBIR
Sources of funding: Mide received EPA SBIR funding totaling approximately $295,000 (NCER SBIR Mide., 2006).

Regulation involvement: No regulatory impacts were mentioned in the interview.

Environmental problem technology solves: A cleaner method of fuel injection reduces the amount of pollution created by an internal combustion engine. This would primarily be applied to Humvees or tanks employed by the military.

Environmental impact: Pollution reduction from a diesel engine is extremely important. Though diesel combustion produces less CO than gasoline combustion, it does release other harmful pollutants into the air. Lowering those emissions will protect the atmosphere and thereby protect all human health.

Summary: Mide has worked with EPA and DOD Army SBIR programs to develop a more efficient fuel injection system to reduce pollution. The technology has stopped being developed. The funding ended from the SBIR programs, and the development process for this particular project is extremely costly. There is a market for the technology, though Mide does not have the resources to pursue development and commercialization on their own.

Challenges along the way (at what stage): Finding commercial partners has been difficult for Mide, particularly because the fuel injection system is mostly designed to be installed in high value vehicles such as Humvees and tanks, not for the much larger commercial vehicle market.

Solutions to the challenges (resources used): Mide has not been successful at finding another source of funding to develop their system because of the specialized market for the technology.

Interviewee's Suggestions to improve environmental technology commercialization:
EPA should offer more support after Phase II, such as finding commercial partners who would be interested in the technology, and providing a contact within the company that EPA has worked with in the past would be a substantial help. EPA should keep its ear to the ground to better direct companies to potential markets. Offering market assistance would also help further the development of the technology. If EPA had a personal interest in a developing a technology (for example, if they were the end user), it would be much easier to commercialize the products.

Major conclusions: EPA SBIR was helpful, though not as much as Army SBIR. Development has stopped because of a lack of funding. The technology was demonstrated in a laboratory setting.

Nugget of knowledge, interesting fact: Mr. Lengyel had never heard of Foresight, the marketing assistance company contracted through EPA to help companies in the SBIR program. Mr. Lengyel did not work directly with this project during the entire development period, so this could explain why he did not hear of Foresight.

4.2.8 National Recovery Technologies, Inc.

National Recovery Technologies, Inc.
566 Mainstream Drive
Nashville, TN 37228-1223
615-734-6400
http://www.nrt-inc.com/

Interviewee: Robby Perrish, Technical Products Manager

Time of phone interview: 10:30 AM November 7, 2006

Technology: High speed identification and sorting of plastic resin flake for recycling
Technology Continuum Stage: Stage 4-Verification
Media: Waste Prevention
EPA program(s): SBIR

Sources of funding: National Recovery contributed their own money for R&D. Government labs and Fisk University in Nashville, TN provided instruments and analysis. Plastics Council and plastics institutions also helped out with coming up with ideas and defining the market. National Recovery works with the DOE.

Regulation involvement: National Recovery Technologies manufactures and sells their product; therefore there are no licenses.

Environmental problem technology solves: People produce a lot of waste each day. Only 5% of the plastics in the world are being recycled. Having to constantly create new plastics can ultimately exhaust the environment's natural resource that plastics are made from: petroleum. One of the biggest challenges within the recycling industry is grouping the selected recycled products together in an easy, convenient and cost effective manner. National Recovery Technologies provides sorting solutions of materials such as cans, plastics, papers, glass and wood for recycling to the recycling industry. They create sensing technologies to identify plastics (by colors, tints, transparencies and polymer (PET and HDPE polymers) flakes or pellets) and separate plastic products i.e. plastic bottles and flakes so that recycling is easier and more effective.

Environmental impact: Recycling is the reduction and reuse of waste. Recycling waste helps the environment and saves money, too. This is an example of how recycling can help the environment. In NRT's case, let's take a look at plastics and why they need to be sorted.

> Plastic is made of petroleum, a non-renewable resource. It makes up almost 10 percent of waste stream's weight, but takes up almost 20 percent of its space (or volume). About half of plastic waste comes from packaging. The rest comes from all kinds of goods, such as computers, radios, disposable razors, and toys. A piece of plastic that is

> thrown away will stay the same for many, many years. Today, only about five percent of plastic is being recycled, primarily plastic soft drink bottles and milk jugs. In your house, you can find two types of easily recyclable plastics. The plastics from soft drink containers (Plastic #1, known as polyethylene terephthalate, or PET, for short) are used to make fiber, structural molding, and more containers. Milk jug plastics (Plastic #2, called high-density polyethylene, or HDPE) can make bottles, toys, pipes, crates, and other products. A mixture of these plastics goes into making garbage cans, park benches, plastic "lumber," manhole covers, and even railroad ties.
>
> Separating plastic by type for recycling helps manufacturers produce higher quality recycled product. To be recycled; plastics are either shredded or melted down and then used to make new plastic products. Although #1 and #2 plastics are the easiest ones to recycle, there are other types of plastics as well that will be more commonly recycled in the future. (EPA Recycling City)

Summary: NRT has been making high speed identification and sorting of plastic resin flake for recycling technologies since 1981. This is an industry they know, so they are capable of applying general knowledge from previous projects to newer technologies.

Challenges along the way (at what stage): It took approximately three years to develop this technology due to the gaps in funding.

Solutions to the challenges (resources used): National Recovery started working with a company (name withheld) to test their prototype technology at no cost to National Recovery. This helped get kinks out and debug. They were able to test in an industrial setting. Company still has working prototype. They took that information to improve design. Alliances within industry and working agreements exist. They shared research and results with alliances. Alliances are more helpful with a specific contact person who is a decision maker.

Interviewee's Suggestions to improve environmental technology commercialization: EPA offered funding is low compared with other agencies SBIR funding. NRT funded a large percentage of research from own budget. NRT feels that allocating the funds over a nine month period instead of six months would be better. NRT could use cross industry marketing help. NRT is always looking for a new market. Foresight has been a help/ benefit with finding a new market for other applications. If EPA could supply specific contacts for other industries and where to go, it would be helpful. Access to basic research at national laboratories would be good. NRT wants EPA to provide a list of labs at companies, universities, and government that can help with testing and analysis. NRT would like EPA to make standard agreements between EPA and resources that companies can use, as well as providing information of how much it will cost to utilize these resources.

Major conclusions: NRT does not have a marketing department. They do not seem to have a problem with developing technologies; the challenge is getting their products on the market. Their current marketing strategies include; attending trade shows, web presence, and occasional advertising in trade journals. Recycle sorting is a fairly small industry; National Recovery feels that lots of marketing is not necessary. They want to be provided with contact information so that they know who the big decision–makers are of potential partners. Commercializing a technology is all about what networking relationships the companies are pursuing and how to get those leads. The pursued relationships they have created should be maintained in order for those relationships to grow in trust to assist with finding and/or providing resources, funding, and potential end-users.

Analysis: Robby Perrish of NRT commented that EPA's awards for SBIR were substantially smaller than those for other agency's SBIR programs. He also commented that cross industry help connecting to new markets would be a great service for EPA to provide, because they have only sold eight units of their sorting technology, and they would like to sell more. The fact that NRT does not have marketing personnel also impacts this desire for EPA assistance networking. Another suggestion made was to create a database of testing facilities/labs that EPA knows of and can make standing arrangements with. This database would allow a company to check in their region to see what other places they could turn to for assistance developing their technology, and how much that assistance might cost them. This suggestion also stems out of the lack of marketing personnel who could otherwise look for potential collaborators for the project.

4.2.9 Ophir Corporation

Ophir Corporation
10184 W. Belleview Avenue, Suite 200
Littleton, Colorado 80127
303-933-2200
http://www.ophir.com/

Interviewee: Martin O'Brien, Vice President Ophir Corporation

Time of phone interview: 11:00AM November 21, 2006

Technology: Novel Liquid and Gas Pipeline Leak Detection System
Technology Continuum Stage: Stage 2- Development and Stage 3- Demonstration
Media: monitor air/water
EPA program(s): SBIR
Sources of funding: EPA SBIR Phase I ($69,958) and Phase II ($224,999) funding. Ophir also funded some of the expenses internally (NCER SBIR Ophir, 2006) and (NCER SBIR Ophir II, 2006).

Regulation involvement: There are no direct regulations involved with this technology. Mr. O'Brien said that the regulations regarding pipeline inspection changed about five years ago. The rules changed so that utility companies no longer had to follow a specified inspection plan, but could come up with their own risk management approach. Ophir thought that utility companies would no longer want to walk the pipelines, but instead would adopt their new pipeline monitoring technology.

Environmental problem technology solves: Pipelines carrying natural gas or oil may have leaks that release a variety of greenhouse gases including; carbon dioxide, ethane, and methane (NCER SBIR Ophir, 2006). The technology monitors such leaks so that they can be detected quickly and the situation corrected as soon as possible. This will lead to the reduction of greenhouse gases emitted from leaks in gas and oil pipelines. It also will reduce the amount of fuel lost due to the leak and therefore decrease the risk of dangerous explosions.

Environmental impact: The reduction of greenhouse gases will help to keep global warming in check. The environment will also be safer since the leaks will be detected sooner with this technology. This will result in fewer destructive explosions caused by leaks in the pipelines.

Summary: Ophir developed this technology using EPA SBIR funding. Once EPA funding ran out after Phase II, Ophir looked to other sources. They were unable to find a commercial partner or other source of funding. The technology filled too small a niche to have the potential to make a large amount of money. Ophir thought about going through the ETV program, but decided that they would wait until they had customers. The project has been significantly scaled back because there does not appear to be the market that was initially hoped for. Ophir still has a company (Alyeska) that is interested in the

technology, but not immediately. Foresight only provided marginally helpful advice to Ophir; this could be because Ophir has a marketing and business development division. Mr. O'Brien said that in the right context, Foresight can be a huge help to a company. (The right context would be a small company that is not thinking about marketing their product.)

Challenges along the way (at what stage): A commercialization stumbling block was finding someone who would pay to package the technology. Most companies only want to purchase a finished product, not actually pay to design the working prototype into a saleable model. After the completion of Phase II, Ophir still needed funding to package the product, so that it was ready to be sold.

Solutions to the challenges (resources used): Ophir is looking for sources of funding. They are staying in touch with Alyeska, a pipeline company, which is interested in their technology. Now Ophir is waiting to see how interested Alyeska is, and if they are willing to help support the commercialization costs.

Interviewee's Suggestions to improve environmental technology commercialization: Mr. O'Brien thinks that EPA can improve their programs by making more of an effort to get the technology commercialized. Some form of support to industry, perhaps as simple as an endorsement to look at technologies developed by the EPA's SBIR program. He recommends that EPA implement a top down approach to getting the industry involved. This would mean getting the industry interested in change from top management down.

Mr. O'Brien also commented that EPA investigations into the real needs and cost-drivers of the marketplace would be an important step. Mr. O'Brien feels that EPA needs a reality check to see how the industry will actually react. EPA should find out what the industry will actually spend on a technology, and then focus on funding projects that aim for that price range.

EPA could also meet with executives, as an independent broker. They could encourage companies to invest in EPA sponsored companies/technologies, but they need to understand what the industry will buy.

Major conclusions: The EPA SBIR program was helpful in developing this technology. The funding helped provide the resources necessary to build and test a working prototype. The market was not what was anticipated at the beginning of this project. Therefore, the technology turned out to be tougher to market/ commercialize than originally planned.

Nugget of knowledge, interesting fact: There is a huge gap between a working prototype at the end of Phase II to an end product that companies can actually purchase. Finding the funding to make that last jump is extremely difficult. For environmentally-driven technology development efforts, some method of bridging the "product development gap" would be a huge step forward.

Analysis: Mr. O'Brien's suggestion to have EPA provide a greater push for commercialization stems from his company's struggles to convince the power industry to

consider a technology change. His product would provide a much more innovative way for the utility companies to monitor their pipelines, if the companies were willing to consider it. If the technology were able to gain more market pull, it would be able to commercialize because companies would want to use it. Without the market pull, the technology will remain in a state of dormancy because of a lack of funding interest. Mr. O'Brien also mentioned that EPA could try to figure out the actual drivers of industrial technological change and only fund projects that are aiming to meet those goals at a price that industry will be willing to pay. He did not believe that if EPA were following this practice that Ophir's technology would have been funded.

4.2.10 Phoenix Science & Technology, Inc.

Phoenix Science & Technology, Inc.
27 Industrial Avenue
Chelmsford, MA 01824
978-367-0232
http://www.phoenixsandt.com/

Interviewee: Raymond Schaefer, Principal Investigator

Time of phone interview: 2:00PM November 3, 2006

Technology: Innovative Ultraviolet Light Source for Disinfection of Drinking Water
Technology Continuum Stage: Stage 4- Verification
Media: water treatment
EPA program(s): SBIR
Sources of funding: Phoenix Science and Technology (PS&T), Inc., started out with EPA SBIR Phase I and II funding. Funding from the EPA SBIR program was $295k (NCER SBIR PS&T, 2006). As the technology developed they received funding from Advanced Technology Program (ATP), National Science Foundation (NSF), National Institute of Standards and Technology (NIST), and U.S. Department of Housing and Urban Development (HUD) (PS&T SD Lamps, 2006). These funding opportunities came about when PS&T found other applications for their ultraviolet light technology. They also have a hand shake agreement with Trojan, a water treatment company, to lend testing equipment and facilities, advice, etc. This agreement is directly related to the water treatment application of their lamp.

Regulation involvement: In January there were two new rulings issued. The first, and relevant one, is that ultraviolet (UV) treatment of drinking water is not only approved, it is recommended. This means that the market for UV technology is increasing, and will grow for the next ten years Raymond Schaefer estimates. PS&T technology uses pulse UV, which has not been proven effective yet. This means that while UV technology is recommended, pulse UV technology is not recommended because it is a new technology.

Environmental problem technology solves: Drinking water treatment is very important so that people do not get sick. Many organisms exist in untreated water that are harmful to people. Right now chlorine is frequently used to treat drinking water. EPA recommends the use of UV light to treat drinking water. EPA feels that UV light has far fewer side effects than chlorine because nothing is added to the water. PS&T's UV surface discharge (SD) lamps use much less electricity than mercury-based UV lamps that are used now. Since electricity is the main cost of operating these lamps PS&T's SD lamps cost less to operate than currently used mercury-based UV lamps.

Environmental impact: PS&T's UV SD lamps use less electricity; this means they are more likely to be used to treat water, because they will cost less to operate. For this reason their application will be wider and their benefit over chlorine treatment will be

realized. They will also save energy over mercury-based UV lamps because they use less electricity.

Summary: PS&T currently has two patents and a third one pending. They also have a license agreement with Kyzer Systems Inc. Foresight was not really helpful when it came to considering alternate paths to take the technology to, mainly because PS&T already researched alternative routes and applications for the technology. It would be appreciated if Foresight assisted with making the deals between the technology developers and companies that would use the technology, just like a broker does.

Challenges along the way (at what stage): PS&T needed to gain credibility for their technology. To do this they wanted to have their technology verified by a third party. This verification would prove to companies interested in buying their technology that it actually met its claims. PS&T considered using Environmental Technology Verification (ETV) Program. This program is designed to verify new environmental technologies. The one downside to using ETV to verify their technology was that EPA only funds about half of the total cost of verification for this expensive program.

Solutions to the challenges (resources used): PS&T has instead partnered up with colleges and universities, such as Duke University, to test in their facilities. Another cheaper way to receive verification that PS&T has used is to hire expert independent researchers.

Interviewee's Suggestions to improve environmental technology commercialization:

Have an Indefinite Delivery, Indefinite Quality (IDIQ) contract like Department of Defense (DOD). This allows a company an easier way to receive funding from other government agencies. Funding can be directly transferred from one government agency to another, making funding easier to secure.

Another thing EPA can do is shift around funding, or move money around to another agency, this may take away from the administrative work. This way EPA still supports the development and commercialization of environmental technologies, but the administrative costs are not felt by EPA. This is because another agency deals with the distribution paper work.

During this interview it was also recommended that EPA consider a funds matching program, where EPA might match 50 cents on the dollar for commercialization funding received from outside companies. This would give companies developing technologies a boost with the commercialization process.

Another suggestion was that there be more support after Phase II funding. The SBIR program can act as a broker to bridge the gap between Phase II SBIR funding and Phase III non-government funding, i.e. venture capital.

EPA SBIR program should reconsider the amounts awarded and increase them to what they used to be worth, taking into consideration inflation, when EPA first established their SBIR award amounts. Inflation has increased the cost of developing a new technology. Therefore the support for that development and commercialization should also increase.

Major conclusions: Overall EPA SBIR program was helpful in technology development. As technology progresses along the continuum the price to move further along increases. For this reason EPA funding was helpful in the beginning when research could be done on a small budget. As the technology progressed more funding was needed. This funding was received from a variety of sources mentioned earlier. EPA SBIR program helped get the technology started, but left off after it began Phase II. More support for verification and commercialization would help technologies reach the market.

Nugget of knowledge, interesting fact: EPA SBIR program application requires the most paper compared with other SBIR programs that PS&T has experience with. EPA could use Grants.gov for their SBIR application process. This would dramatically reduce the amount of required paper during EPA SBIR application process.

Analysis: Raymond Schaefer of PS&T commented that he had worked with multiple sources of SBIR funding to develop his SD technology. Therefore he had to go through multiple application processes and wait for acceptance to each program. One of his suggestions was to allow transfer of funds from one government agency to another, to be injected to the company through one agency's program. This way, if a company was enrolled in an EPA program, but DOD and NIH liked the technology being developed, they could just give money to EPA, who could filter it down to the company without having to go through more application processes. Another suggestion for assisting the company to obtain funding was to use the idea of fund matching. This would mean that if a SBIR company could secure funds from an outside company, EPA would match 50 cents for every dollar given by the outside company to fund the project.

Since they are in the process of verifying their technology, which is leaving the realm of SBIR support, more information about some suggested ways to proceed would be useful. With a small amount of marketing experience and no federal program to turn to, being able to get your technology commercialized is extremely difficult. More financial support for verification would directly benefit this technology, because current funding options available through EPA only cover half the testing cost.

4.2.11 USInfrastructure

USInfrastructure, Inc.
651 Beacon Pkwy W Ste 214
Birmingham, AL 35209
205-945-0098
www.usinfrastructure.com

Interviewee: Ramjee Raghavan, Principle Investigator

Time of phone interview: 11:30AM November 29, 2006

Technology: Upflow Filter for Rapid and Effective Treatment of Stormwater
Technology Continuum Stage: Stage 6- Diffusion and Utilization
Media: water treatment
EPA program(s): SBIR and ETV
Sources of funding: This project by USInfrastructure, Inc.(USI) was funded by internal money along with EPA SBIR Phase I funding of $99,926, and Phase II funding of $225,000 (NCER SBIR USI, 2006) (NCER SBIR USI II, 2006).

Regulation involvement: Storm water regulations have positively impacted this technology. Business owners are being required to investigate the potential of having to treat the runoff from their sites before it enters the drainage system (NCER SBIR USI, 2006). Without these regulations the technology would not be as nearly successful as it is today.

Environmental problem technology solves: Storm water contains a wide variety of contaminants that are harmful to the environment. These can include heavy metals, such as mercury. Storm water is collected in storm drains that can empty directly into our natural water system untreated. If the storm water enters into ponds or streams untreated, the storm water brings with it all the contaminants.

Environmental impact: Using filters to treat storm water before it enters our natural water supply would help to mitigate this problem. The contaminants would be filtered out of the storm water and would not reach our water supply. This would in turn keep our water clean and safe to drink.

Summary: One of the researchers working with USI is an expert in this field and had many contacts in industry. USI attended conferences where some companies were interested. Hydro Compliance was one of these companies that were interested and also a contact. They bought the technology/ patent from USI. Hydro Compliance then came to a selling agreement with Hydro International, an international company trying to grow in the United States. Hydro International gave USI $100K for commercialization funding, which allowed USI to go through the ETV program. The results for ETV are not officially out as of the interview date, 11-29-06; even though USI began the verification process two years prior. Development was successful. While waiting for

ETV, pilot tests were conducted. Hydro International handled the packaging and marketing of the technology and did a good job of it. The technology is now available for purchase and a large number have been sold.

USI found Foresight helpful and thought they were a good idea for small businesses.

Challenges along the way (at what stage): USI did not have any major challenges along the way to commercialization. They were in the right place at the right time.

Solutions to the challenges (resources used): N/A

Interviewee's Suggestions to improve environmental technology commercialization: Quality Assurance/ Quality Control (QA/QC) is important. It is good that EPA SBIR program requires these, because when a company tries to commercialize their technology after going through the SBIR program it is helpful. QA/QC gives merit to the data produced.

Mr. Raghavan agrees with the Commercialization Option at the end of Phase II being awarded by cash donations instead of in-kind. Cash donations from an outside company show that the SBIR company is serious about commercialization. It also shows that the outside company is invested and will work to help get the technology commercialized so that they can see a return on their investment. This also makes sure that small businesses do not try to take advantage of the SBIR program by "creating" in-kind donations that may not exist.

Major conclusions: The EPA SBIR program was helpful in developing this technology. The funding helped provide the resources necessary to develop this technology. The technology was at the right place at the right time. Once USI developed it far enough along, it was passed off to Hydro International who did a good job of marketing and selling the technology.

Nugget of knowledge, interesting fact: Make sure you know your market! You, the small business should also know when a new set of regulations are coming in and how they will affect the market and consequently your technology.

Mr. Raghavan says "Jim Gallup is an excellent project officer and is running a good program."

Analysis: QA/QC helped this technology because they were fortunate enough to have been working on a technology that met a current demand in the market, and therefore had companies willing to assist with development, packaging and marketing. Therefore, they were working with companies that had access to information about what the end customer wants. The cash requirement also did not affect this company because they were in the right place at the right time with their technology. Companies were pulling this technology out into the marketplace, which made things much easier for USI.

5.0 Summary Analysis

The EPA SBIR program helps to commercialize environmental technologies. These environmental technologies have a variety of different positive effects on human health and the environment. These new and innovative technologies help to prevent, treat, and monitor pollution. The more environmental technologies become commercialized, the greater the potential impact on the environment. For example, this impact may be the removal of arsenic from our drinking water, or the implementation of a new manufacturing process for an environmentally friendly oxidizing agent. The EPA SBIR program fosters an environment that is conducive to technology development and commercialization in all the areas of the environment.

The information gathering process for this project has been informative and iterative. We began with background research and from there designed an interview plan. This interview plan was used to interview EPA SBIR funded companies. From these interviews we wrote up case studies highlighting what we thought was important to EPA concerning their SBIR program. Analysis of these case studies was then performed to condense the important information down to a few key points. These key points consist of both things EPA is doing right concerning their SBIR program, and where there is room for improvement.

5.1 Identified Challenges

Through the analysis of our 11 case studies we have identified 23 different suggestions made by the companies we interviewed that EPA can make to improve technology commercialization within the SBIR program. Some of the suggestions had

some potential impact beyond the company making the suggestion and are mentioned below. These suggestions came directly from the representatives of the companies we spoke to regarding the numbers suggested for decreasing review time and the amount of funding that were specific to each person making the suggestion. The suggestions are listed in the order they are discussed in the following sections.

These suggestions include the following:

Time Consumed by the Proposal Review process:

- The time between phases should be three to five months instead of the present nine months
- Simplify the application process, use electronic means to reduce the amount of paper used
- Extend the amount of time Phase I covers from six to nine months
- Make option funding based on an internal audit of the proposals instead of using the peer review system.

Funding:

- Increase the dollar amount of SBIR awards
- Create funding between Phase I and Phase II
- Have a funding match program
- Boost verification funding to the total cost of verification
- Change option funding back to in kind donations instead of cash
- EPA can help fund projects through other agencies to reduce EPA administrative costs

Commercialization Assistance:

- Tailor Foresight assistance to companies depending on marketing personnel
- Cross industry marketing help
- Help by brokering deals between SBIR companies and Venture Capitalists or other commercialization funding
- Post technology specific conference information on EPA web site.
- Provide incentives for companies to switch to more environmentally friendly products even if they aren't required by regulation
- Offer more support after Phase II (valley of death between SBIR Phase II and Venture Capital or other commercialization funding)
- Consider using Indefinite Delivery Indefinite Quantity (IDIQ) contracts

EPA program and office communication / awareness:

- Publicize existing programs to the public and technology developers
- Publish environmental journals, EnvirotechNews and Technology Connection, from CEIT monthly
- Database of resources available at government labs, universities, etc and approximate costs
- Searchable database of regulations that affect "My Technology"
- EPA should create a model of option funding that business people could understand as well as technical people.
- Post technology specific conference information on EPA web site

A number of different recommendations mentioned above were only mentioned by one or two companies. Others were mentioned by almost all the companies. To

examine the validity of these suggestions, the proposed suggestions by the various interviewed companies were reviewed based on the impact that they would have, not on just one company, but the wide variety of companies that the EPA SBIR program helps to support. EPA constraints such as, staff and budget were also taken into consideration. Following are the company recommendations analyzed.

5.1.1 Time of Application Process

The time between Phase I and Phase II should be three to five months instead of the present nine months. As of today, the time between Phase I and Phase II is nine months. It would be ideal for companies to receive funding three to five months, as requested, so that there is not as much down time. A large amount of companies, mainly the Scientists, cannot continue their research without SBIR funding because most of them depend on SBIR moneys. These companies are forced to stop research during the nine month period between the end of Phase I and at the beginning of Phase II. It is very difficult to shut down a project while waiting for funding, then nine months later, pick back up where the company left off. Companies lose momentum on the project which is expensive and time consuming to start the project up again.

This process takes so long because there are a variety of tasks that must be completed. These are described in full detail in Section 3.1- Institutional Context of SBIR Program. The SBIR review process is a lengthy one. The Peer Review Division (PRD) requires approximately four months to fully evaluate all of the proposals. Because of the number of proposals (300) in Phase I, approximately one month is required to actually sort and organize all the proposals. After the “Third Party Peer Review” or external review, comes the “Relevancy Review” or internal review. The SBIR program

labs that do the internal evaluating require around one month. After this, write ups for each proposal are done; relevancy reviews are conducted, as well as procurement requests, which take two to three months. Then the contract writers get to begin work crafting the contracts between EPA and the company. This also takes between two to three months. The "Third Party Peer Review" is what makes EPA's SBIR program so unique. The National Science Foundation is the only other government agency that does this. Having an external review eliminates bias towards the proposals. Other SBIR programs only have an internal review, which is why their proposal review process is only three to five months.

Phoenix S&T recommended simplifying the application process via use electronic means to reduce the amount of paper used. The EPA SBIR program does accept electronic copies on the NCER website. Right now the EPA SBIR application process is paper intensive. The SBIR proposals which are at least 25 pages long for Phase I and much loner for Phase II, must be submitted to EPA in multiply paper copies. These copies are then distributed to the appropriate people for review. This creates a large amount of paper that could be eliminated if the proposals were submitted electronically. Seeing as EPA is working towards protecting human health and the environment this would be a great example of reducing the amount of paper waste. Many other SBIR agencies have their proposals submitted electronically through www.grants.gov, but due to many layers of bureaucracy EPA is not allowed to use this service. We do agree that submitting the proposals electronically eliminates all the excess paper copies of the proposals which end up in the best case being recycled and otherwise thrown away. It also makes the application process easier for applying companies because they do not

have to make a bunch of paper copies, only submit the proposal electronically. Our group recommends that EPA continues to use electronically submitted copies because it is a faster streamline into the application and review process.

Extend the amount of time Phase I covers from six to nine months (Lynntech and NRT). Lynntech and National Recovery Technologies want the Phase I contract to be extended to nine months because this would allow them more time to develop their product before having to apply for Phase II. If a technology is more fully developed at the end of Phase I, it is more likely to receive a Phase II award. Extending the time for Phase I by three months would give companies more time to work on their technology, but would then require spreading the $70,000 award out over nine months instead of six. This could be a benefit to companies with internal research funding, or other sources of funding outside EPA's SBIR program. Extending the time of Phase I could potentially hinder companies relying solely upon EPA funds to develop the technology, because they could use up the award before the time for application for the next round of funding. This recommendation could be useful, but does not show an immediately apparent benefit to most SBIR companies.

Another recommendation is to make option funding based on an internal audit of the proposals instead of using the peer review system. The peer review system is not active in the application for option funding. Option funding must be applied for with the submission of a Phase II proposal. The option funding is then made available at the end of Phase II, if the company requests it and remains eligible. The reason that the funding is applied for so early in the process is that EPA cannot disburse money without a legal contractual agreement, which would end with the end of Phase II. If companies were

applying after Phase II when they need the money, they would be required to enter another contractual agreement with EPA in order to receive the funds. This recommendation appears to be based on a misunderstanding of how EPA's funding system works. The option funding is ultimately decided by EPA SBIR personnel, not the peer review division. A recommendation that more clearly explains how EPA's application and funding system works to the program awardees would be useful here. A more concise explanation could be useful in clearing up any uncertainty about how the system works and when to apply for the different aspects of the program.

5.1.2 Funding

A majority of the companies requested the EPA's SBIR program to increase the dollar amount of SBIR awards. EPA would like to give out more money, but there are not enough funds in the EPA SBIR program's budget to give out a larger amount of money for Phase III: technology commercialization. EPA could give out fewer awards, but more in dollar amount. Doing this may not be the best way of solving the issue of funding because, the EPA SBIR budget is approximately five million dollars, so drastically reducing the amount of awards to slightly increase the dollar amount of awards is not efficient. This would only allow a few companies a chance to develop their technology.

Companies also want EPA to create funding between Phase I and Phase II. Providing funding between Phase I and Phase II would be a major change to EPA's SBIR program. When a company is in the transition period between Phase I and Phase II, there is little to no development of the technology if the company does not have non- EPA funding to support the project. The developers must move on to another project in the

down time, so they lose their working knowledge of the technology. They must then regain it before making further progress. This could be alleviated by providing funding between Phase I and Phase II that would provide a more continuous development process. A problem with this suggestion is that EPA would not like to fund a company between Phase I and Phase II that would not end up receiving a Phase II award. There is no good way to determine whether a technology would be approved or not before it goes through the approval process. This recommendation would be of great help to the companies, but would be extremely difficult to implement for EPA. An easier solution to this challenge would be to shorten the time between Phase I and Phase II. This was discussed previous in section 5.1.1 Time of Application Process.

Boost verification funding to the total cost of verification. EPA has a verification program called the Environmental Technology Verification (ETV) program. This program verifies environmental technologies so that they have an independent third party verification, to give their technology credibility. More information on this program can be found in section 2.4.4 – Environmental Technology Verification Program. As of now companies in the SBIR program have two options after they complete Phase II. Refer to section 2.3.2.1 – Option Funding for more information on the two options. One of these options is to verify the technology through ETV. This option pays $50k towards the cost of verification. The one thing is that verification can cost upwards of a $100k. This means the funded SBIR small business has to come up with the remaining cost.

A company suggested that EPA could cover the total cost of verification. This would mean that companies would not have to pay any money towards the cost of verification. By doing this fewer companies would have their technology verified

because EPA has a limited budget. For example, EPA can fund ten projects completely or half of 20 projects. There is a good side to having companies supply funding for half of the verification cost. This shows that the small business or a third party is truly interested and wants to commercialize the technology. When EPA funds half of the verification cost, it also allows more companies to have their technology verified. For this reason having EPA fund half the cost of verification seems reasonable at this point in time. No change is recommended by the group at this time.

Have a funding match program. There is a difference between option funding and match funding. As discussed earlier in section 2.3.2.1 – Option Funding, option funding is just when a program offers different options, possibly at different levels of funding to those that may want to choose an alternate route. Match funding, is when an agreement is made between two sponsors, to fund this one project, and as the first sponsor increases its awardees money, the second sponsor tries to match that amount of the first one. For example, for every dollar that Department of Defense offers a small business, the EPA SBIR program could maybe offer fifty cents. The small business is now receiving an extra fifty cents to the dollar from the EPA, depending on how much the DOD program offers.

One of the SBIR awarded companies ran into a problem when SBIR program changed option funding. Advanced Fuel Research wants EPA to change option funding back to in kind donations instead of cash. AFR is heavily dependant on EPA SBIR funding, and since the rule recently changed, they no longer have any other funding. This has dramatically slowed down the development of their carbon black technology. The reason why EPA changed the rule from documenting in-kind donations to cash donations

is because companies were taking advantage of the EPA commercialization option by making their in-kind donations seem to be worth more than what the company was really receiving. Cash donations are easier to verify. Requiring cash donations lets EPA know that companies are serious about commercialization. EPA believes that this pushes companies to work harder, and to get out there into the market and get funding that amounts to $100k.

The recommendation that EPA can help fund projects through other agencies to reduce EPA administrative costs was investigated by the team. One company suggested that EPA could maximize their budget by funding projects that other agencies were sponsoring, instead of having their own pool of funded technologies. The suggestion was intended to show that EPA can fund a project directly without having to pay for any of the administrative costs. This would mean that companies would receive more money for R&D, and money would not be exhausted on the administrative tasks of allocating the funding. There are two problems with this. The first is that EPA is the only agency that funds certain environmental projects. These projects are not being conducted at any other agency. This means that EPA could not fund some of the projects that they would like if they only funded through other agencies. EPA would also not be able to fund new projects, only pre-existing ones. The other problem is that if EPA, with its small budget, started funding other agency's projects it would lose control over what environmental projects ended up receiving funding in the first place. Some environmental projects might not get off the ground. This would be a huge loss to the environment. EPA should not make it a practice to fund environmental technologies through other agency's SBIR programs.

5.1.3 Commercialization Assistance

Post technology specific conference information on EPA web site. It can be difficult for companies developing new technologies to find a buyer. After SBIR companies have completed Phase II there is not that much support available to commercialize their technology. Conferences are a great way to network and meet potential buyers. EPA could provide a list of technology specific conferences on their website. This would allow companies to see what conferences they can network at.

Tailor Foresight assistance to companies depending on marketing personnel. Foresight provides marketing assistance to EPA SBIR funded companies. This assistance comes in the form of a niche study discussed earlier in the paper in section 2.3.2.2-Foresight Science and Technology. This report provides the same information regardless of the company, the only difference between reports is the technology being investigated. The report is not tailored to each company depending on their marketing expertise, or lack there of. Companies that have marketing people working for them usually have all the information that Foresight provides them with. Companies that have all scientists and engineers seem to be unsure of how to best use the information they receive.

The company recommendation is to custom tailor Foresight assistance to a company's marketing expertise. This could prove challenging for Foresight and the SBIR companies, since each company is different. It might be challenging for Foresight to know what to provide them with. That is why our group believes that having a few more option available besides the niche study would be valuable. A second option would be for companies that have marketing people and already know the information that Foresight is going to provide them with. This second option would be focused at the later

stages of marketing, instead of focusing on target markets and target companies, which the SBIR company already knows of. This option would focus on what the end users want and laying the ground work for potential deals.

Having two or more separate options for companies to choose from allows them to maximize Foresight's marketing ability. A company will be able to pick which option will work the best for them. This will lead to companies receive more pertinent marketing information from Foresight. Limiting the choices to two or three options makes it easy to choose what option would work the best, and also does not put an unneeded burden on Foresight to develop different study layouts.

Cross industry marketing help is useful for companies so that they can see more markets that they could apply their technology to. Providing contacts at potentially interested companies would be of great use to technology developers. If EPA were to provide these contacts, it could be said that they were showing favoritism. The knowledge that technology developers could gain from EPA implementing this system of referral would be very valuable to them. Ethics issues prevent EPA from doing this.

EPA does provide marketing assistance through the services provided by the marketing consulting company Foresight Science and Technology. Foresight provides contact information to potential end users and partners for developing the technology to the small businesses. When this information is provided, the company must then follow up with the information to develop those contacts. A majority of the time, a company does not know what to do with the information and does not know where they can advertise their product. The small businesses wanted EPA to serve as a liaison or broker for the companies between the small businesses and the end-users. It is the company's

responsibility to know their market and create relationships with end-users so that they can have commercialization success. A possible recommendation would be for EPA to provide information about conferences that would be useful places to network at to develop business contacts that could help find another outlet for a technology.

Help by brokering deals between SBIR companies and Venture Capitalists or other commercialization funding. Most companies interviewed mentioned that they had difficulty finding funding after Phase II ended. A few companies used the term the "Valley of Death" for the area between the end of Phase II and actual commercialization. If EPA were to broker deals for their SBIR companies, they could be playing favorites. Ethics issues prevent EPA from doing this. Foresight Science and Technology is a company EPA contracts with to provide marketing assistance to SBIR awardees. One of the services they provide is a list of contacts that could be interested in developing the product. If the contacts wanted the end result, they would be more likely to assist with the development once Phase II ended. EPA can not directly broker deals for SBIR companies. EPA can help set up work shops and conferences where technology developers and technology buyer can network.

Consider using Indefinite Delivery Indefinite Quantity (IDIQ) contracts. It can be challenging for companies to secure funding after Phase II is complete. IDIQ contracts can be a tool to help companies secure funding after the completion of Phase II, or during other parts of their technology development. These contracts allow government agencies to directly transfer money from one agency to another. By using these contracts one agency can help fund a SBIR technology at another agency relatively easily. This allows

a company to receive funds that they may otherwise not receive from other government agencies. This in turn allows the technology to be developed further.

The DOD SBIR program uses these IDIQ contracts. At this time it is recommended by the group that EPA take a look into using IDIQ contracts. If these contracts can be set up easily it is advised that all Phase II companies have this option made available to them. If IDIQ contracts are tough to set up, then the group recommends not implementing them. There is a limited number of Phase II companies and an even small number that would potentially use IDIQ contracts. It may not be worth the effort to set up these contracts for a SBIR program as small as EPA's.

A common phrase companies used to describe the gap between the end of Phase II and commercialization the "valley of death." This gap typically occurs when a company has developed their technology to the end of Phase II and there is no more SBIR funding. EPA does offer $70,000 for their Commercialization Option at the end of Phase II. It would be helpful for small business – especially the ones without strong business people –to be provided with information and leads to venture capital and other commercial funding. It is understood that companies should know their field, and think about how they plan to maximize how far along the technology continuum they are able to go with the provided resources, but some do not think that far ahead, or have the business practice to do so. If EPA could provide their SBIR awardees with information on conferences, networking events and other places to go to sell their technology, it would be a tremendous help. A simple web page with links to conferences and networking events, and a place for companies and others to post up something they heard word of mouth may be efficient. It can be difficult to find out where to go to sell a

technology. Having a centralized location of the best places to go from EPA will help both EPA and the small business achieve their common objective: to commercialize environmental technology.

Provide incentives for companies to switch to more environmentally friendly products even if they aren't required by regulation. Companies currently have no motivation to switch to a more environmentally friendly product if it is not mandated by a regulation. There are many environmental products that are not being used to the greatest benefit because of a reluctance to spend money to replace a product that probably works fine for one that is "green". Developers can try to entice companies to purchase their product by providing a higher quality product at a lower price than the non-environmentally friendly versions. Providing incentives for companies to switch to more environmentally friendly technologies would be a very effective method to help protect the environment. EPA cannot effect a change in this area because they are a regulatory agency and do not have the power to provide tax breaks or other financial incentives for over-compliance with regulations.

5.1.4 EPA Programs and Office Communication / Awareness

Publicize existing programs to the public and technology developers. After interviewing the OAR and DfE – both EPA programs/departments – it has come to our attention that EPA does not communicate to the level they can. Increasing the level of communication between different EPA departments will allow increased support for environmental technologies under development. Publicizing existing programs to the public, technology developers, Original Equipment Manufacturers (OEM), and interdepartmentally, will create an awareness of what opportunities and resources are

available. For example, Advanced Fuel Research (AFR) did not know that EPA had an Environmental Technology Verification (ETV) program. If AFR was aware, could the ETV program given it more creditability to move further its technology along the continuum? Granted that the ETV program is about five years old, the other departments within EPA were not aware of the program. If EPA advertises its own programs to the other departments within EPA and publicize existing programs to the public, technology developers, and end users, the SBIR program will assist more companies to commercialization.

On that note, making people aware of regulations that may influence their technology is another way that awareness can keep the technology going smoothly along the continuum. A searchable database of regulations, called "My Technology" will prove to be beneficial. If a creating an online searchable database is not feasible, again, centralizing the new regulations being passed regarding the environment could be done by the Environmental Protection Agency. Regulations have a large enough impact on a technology's development that they should be easily accessible. If a technology is in the right place, at the right time, and is being developed when a regulation is on the verge of being passed this can increase the industry's interest in buying the technology. Consequently a higher commercialization rate will occur due to the new regulations.

Publish environmental journals, EnvirotechNews and Technology Connection, from CEIT monthly. Some interviewed companies have commented that they do not know where to network with potential partners for their technology. The suggestion by Maggie Theroux of CEIT to publish an environmental journal could help companies learn who else is interested in their product. The journal provides contact information about

companies that are facing a specific environmental problem. Other companies reading the journal could see an application for a technology they have, contact the company requiring a solution, and make a connection. This would be beneficial for both companies, because it would provide a sale for one company, and would provide a solution to the other's environmental problem. However, this is currently only in place in EPA's Region 1. If this suggestion were carried out in all regions of EPA, it would greatly facilitate the development of technologies by connecting companies with others that could be interested in helping the technology get to a the final product so they could use it.

Database of resources available at government labs, universities, etc and approximate costs. Resources are not widely available, or in one place, that list places that a company can have work on their technology done at. Companies that are looking to have a certain part manufactured or tested, do not always know where to go. A database of all the different resources available to SBIR companies would be helpful. This database should be in one easily assessable location and contain the different resources available at different government and university labs, along with approximate prices.

This database would allow companies to easily find the locations that offered the assistance they needed. The SBIR company could then contact these different locations and find out which had the best prices and would be able to do the requested work. This would allow companies to develop their technology quickly and make outside help easy to find. The group does not recommend that this suggestion be implemented. A company should know where to find these resources in its field of study. It would be too

challenging for EPA to organize a list of all the different resources available for all the different environmental technologies that there are.

EPA should create a model of option funding that business people could understand as well as technical people. EPA has two different options for additional funding after Phase II is complete. More information on these different options can be found in section 2.3.2.1- Option Funding. These options for additional funding have models associated with them. These models are there to help companies understand how the option funding works. These option funding models can be difficult for business people to understand. It was suggested by an interviewed company that EPA create a model that both the scientist and engineers can understand along with the business people. This way the business people can understand how the option funding works and will be able to help their company use it to help commercialize the technology underdevelopment.

It would be beneficial if EPA revised the option funding model and wording. Considering EPA's budget it is not recommended at this time. Only one company that was interviewed mentioned this. This company also said that the scientists and engineers could understand the option funding fine; it was just that the business people did not. The option funding wording and model are fine as is for now.

5.2 Company Scenarios

Our group feels that EPA will get the most use out of recommendations that provide the greatest amount of assistance to the most companies. There is not one type of company that applies for an SBIR award; there are many. We classified the companies we interviewed into two different company types, referred to as the Entrepreneurs and the

Scientists. We were able to do this classification based on a binary (yes/no) set of categories that were applied to each company. Figure 4 – Common Aspects of Interviewed Companies shows this matrix that compared the different categories. The categories we used for classification were based on the slightly broader topics of who the end user is for the technology, how far along the development process the company takes a technology, whether or not there were commercial partners, whether the technology was a re-application of an existing technology, and whether the company had obtained other sources of funding outside of EPA's SBIR program. We were initially considering using company size and regulation impact as variables. Company size was disregarded because of a lack of personnel data for each company. Regulation impact was disregarded because any environmental technology can be impacted by a regulation, regardless of what type of company chooses to pursue developing it.

Once the categories were chosen, it was a simple matter to use our table containing data about all the companies Appendix to answer the questions asked by the matrix categories. Once the matrix was filled out, the two types found in Figure 5 – the Entrepreneurs and the Scientists were constructed with the results. No company fit perfectly into either category, but were matched up based on the overall number of similar characteristics. The types are discussed in sections 5.2.1 and 5.2.2.

Common Aspects of Interviewed Companies											
	ADA	Aerodyne	AFR	NRT	Ophir	Phoenix	Infoscitex	Luna	Lynntech	Mide	USI
End User is OEM							yes	yes	yes	yes	yes
Contract R&D							yes	yes	yes	yes	yes
Partnerships	yes	yes		yes		yes		yes			yes
Non EPA SBIR Funding	yes			yes		yes		yes		yes	yes
Re-application of existing technology	yes	yes		yes	yes	yes					

Figure 4 - Common Aspects of Interviewed Companies

"Entrepreneurs"	"Scientists"
ADA, Aerodyne, AFR, NRT, Ophir, Phoenix	Infoscitex, Luna, Lynntech, Mide, USI
Market is a large group	Market is an OEM
Develop the technology through commercialization	Contract R&D
Have commercial partners	Have commercial partners
Technology is a re-application of an existing technology	Creates Original Technologies
Obtained other sources of funding outside EPA's SBIR	Funding mostly from EPA SBIR

Figure 5 - The Entrepreneurs and Scientists

5.2.1 The Entrepreneurs

There is no right or wrong way to commercializing an environmental technology. Even though there is not a one size fits all way of doing so, there are some ideal characteristics that small businesses could replicate. The technology is applicable to a large scaled market. For example, Ophir Corporation is responsible for developing a new pipeline inspection system, to meet the mandated regulation passed by the Department of Transportation. Ophir saw this as an opportunity to a new market that they could apply to an existing technology they already have. Another example is ADA technologies, which have an agreement to sell their technologies in India. India has a problem with their drinking water systems and ADA's Technology on arsenic removal system for point of use/point of entry drinking water systems will have a huge impact on India and its drinking water systems.

These five companies have also carried their technologies beginning at Stage 1 of the continuum, R&D, all the way up to the final stages on the technology continuum, commercialization. Contract R&D companies prefer to do the research and some development, at least up to lap bench testing, and sell off or license their product to a larger company that is good at commercializing.

They also have commercial partners that are willing to assist them with putting the product onto the market. EPA does provide commercialization consulting from Foresight, Inc. but that take place in earlier stages of the continuum rather than near the end – when it is most beneficial. The technologies that each of these Entrepreneurs are pursuing is a re-application of an existing technology that they have previously

developed. These companies feel that they should stick to what they are good at, since getting to know the market or industry your company is involved with is time consuming.

The main reason why many of these companies are able to carry their technologies all the way to commercialization is because they have obtained other sources of funding outside EPA's SBIR. Money does not solve everything, but it does for the most part, at least through the first four stages of the technology continuum. The commercialization stage of the technology continuum requires knowledge of the market the technology is being sold in. Successful commercialization requires the small business to be able to identify potential end-users, conferences to attend and networking events to publicize the technologies.

Just because a small business fits into “the Entrepreneurs” does not necessarily mean that that is the way to commercializing a technology. Some of these companies do have weaknesses along different points on the technology continuum, and the following recommendations will help them.

The Entrepreneurs may not need Foresight, Inc. help at all. EPA should tailor Foresight assistance to companies depending on marketing personnel and offer an option to the company on whether or not to receive Foresight help at a given time or at all. The time between phases should be three to five months instead of the present nine months. This would help both company types because the amount of funding is more lucrative, therefore more project work can be performed at a constant rate. Offer more support after Phase II. Remember that EPA is funding small businesses, and the hardest thing for small businesses to do it to get their foot into the door. EPA can help by brokering deals between SBIR companies and venture capitalists or other commercialization funding

resources. This would present an opportunity to the small business to take full advantage of.

Even though some of these companies have marketing departments, a searchable database of regulations that affect their technology is always helpful. The same goes for a centralized location for resources available at government labs, universities, etc. and approximate costs of using each of those resources. Knowing what conferences and networking events helps both company types. Cross industry marketing help from EPA would also greatly assist small businesses because the technology could then be applied to numerous markets and industries. Marketing an environmental technology to another industry may be difficult, and having EPA vouch for the small business could have a positive impact. Some of these technologies are not regulation driven, so if the EPA could provide incentives for companies to switch to more environmentally friendly products even if they aren't required by regulation then this will assist "the Entrepreneurs" tremendously. This would create a market that is willing to invest in the environmental technology.

5.2.2 The Scientists

The Scientist companies are usually research and development companies. These companies usually are developing a new and innovative technology which will be sold or licensed to a manufacturing company or OEM. These companies usually form commercial partners with the companies that they will license or sell their technology to. These companies' technologies are funded by the EPA SBIR program almost exclusively.

Infoscitex Corporation is a research and development company. They did not have any outside funding other then EPA SBIR funding for this technology. The end

users for this technology are car OEMs and switch manufactures. This technology is new and is not a reapplication of any existing technology. For these reasons Infoscitex Corporation fits perfectly into the Scientist description.

Luna Innovations is a research and development company. They did not have any outside funding other then EPA SBIR funding for this technology. The end user for this technology would be an OEM type company. Luna is trying to license their technology to this OEM. This technology is relatively new but does borrow slightly prove previous work done by this company and research partner. Luna fits into the description of the Scientists.

Lynntech Inc. Innovations is a research and development company. The only funding for this project was EPA SBIR funding. The end user for this technology is a chemical manufacturing company. This technology is new, and is not a reapplication other technologies. For these reasons Lynntech Inc. fits perfectly into the Scientists company description.

Mide Technology Corporation Innovations is a research and development company. Mide did receive DOD Army SBIR funding besides EPA SBIR funding. The end users for this technology would be army vehicle manufactures. It is not clear if this is a reapplication of an existing technology or not. Mide fits into the description of the Scientist company because it agrees in most of the categories.

Research and development (R&D) companies have certain needs specific to the first two stages of the technology continuum. Since these companies concentrate working on a technology during Stage 1- Research/ Proof of Concept and Stage 2- Development, they need different support from companies that develop a technology all

the way to commercialization themselves. These companies need less time without funding and more time with funding. They also need contacts which will turn into partners to license and sell their technologies to.

R&D companies need there to be less time when there is no funding. This means either decrease the time between Phase I funding ending and Phase II funding starting, or have bridge funding in that gap. This allows the R&D companies to concentrate on developing the technology being funded. They do not have to wait until the funding starts again if there is no gap between Phase I and Phase II. This allows the research and development process to flow quicker and the product reach the end user faster.

These companies are looking for a company to take over the technology and commercialize it, so they need contacts to license or sell the technology to. Cross industry marketing help would also assist these companies in finding potential companies to sell their technology to. Further support after Phase II in marketing their technologies to OEM companies would help R&D companies. R&D companies are not going to manufacture and sell their own technology. They are instead going to license or sell it to a manufacturing company to do that. That is why so much support is needed in this area. Incentives to use new technology would assist R&D companies in selling off their technology to manufacturing companies.

Increased funding is always helpful to companies. This allows the companies to take their work further along to a place where another company is will to invest in the technology. Extending Phase I would help R&D companies develop their technology because they would have more to time to work on the research part.

6.0 Conclusions

The project had three objectives at its outset. The first was to understand the institutional context of EPA's SBIR program. This has been accomplished through interviews with: EPA's SBIR program managers, Jim Gallup and April Richards; Abby Waits from the Environmental Technology Verification (ETV) program, Maggie Theroux of Region 1's Center for Environmental Industry and Technology (CEIT), a group from EPA's Design for the Environment (DfE) program, a group from EPA's Office of Air and Radiation (OAR), Barbara Levinson from NCER's Peer Review Division (PRD), David Speser from Foresight Science and Technology, and Mike Caccuitto, DOD's SBIR director. We also attended a Phase I relevancy review to see some of the process that goes on within EPA to determine which proposals receive funding. A confidential Phase II external peer review session also had some valuable information for us. Mike Caccuitto from DOD's SBIR was interviewed to provide a comparison for EPA's program. There is a great difference in scale between the two programs, but the mechanics for running each were found to be similar. They also had similar commercialization challenges despite the differences in scale and the unique scenario of DOD being the market for some of the technologies that it funds. Refer to Appendix K for more information. The other EPA programs (ETV, CEIT, and DfE) were contacted to gain an understanding of what other programs do to assist commercialization. We then compared this information with our understanding of the SBIR program to see how they could work together most efficiently. Interviewing EPA's SBIR program managers allowed us to understand the specifics of how they assist commercialization, and what changes they would be willing to consider for their program.

The second objective of the project was to use an outsider's perspective to scrutinize what the program's strong points are, and where the outsiders would have appreciated more support. To complete this, we contacted 11 companies for interviews and asked specific questions related to the SBIR program. We also asked company related questions to see if some of the points were not weaknesses in the program, but in the company. The interview summaries for each company and program we contacted while realizing our first and second objectives may be found in Appendices F through Y.

Our case studies and summary analysis of the data we gathered for the third objective are the most important parts of the report. The case studies provided the information gathered from each company in an organized format with topical organization replicated for each company. This made the development of the summary analysis straightforward. The summary analysis examined each of the recommendations that a company made for a particular benefit each company would gain from EPA adopting their suggestion. This allowed us to see which recommendations could have an effect on more companies than only the one suggesting it. We also looked for common themes of suggestions to arise. We identified four primary themes pertaining to the application process, amount and timing of funding disbursements, commercialization assistance, and intra-agency program coordination/awareness. These categories enabled us to focus on a specific area of the program to make a recommendation about it.

These categories aligned themselves well with the general areas of difficulty of the development process that we identified. A major problem companies encountered was that after EPA support in Phase II ended, there were no other available sources of funding for further development and commercialization of the technology. Another

challenge we identified is that some technology developers are not familiar with the range of different technology development programs available through EPA, which we described as a communication challenge. Another challenge that arose was that of the length of downtime during the re-application process between Phase I and Phase II.

Our specific recommendations to EPA about these three main challenges take into consideration the limited budget and personnel available to the program and strike a balance between what the companies are requesting, and what EPA feels they can provide. More research can always be done into the implementation of these recommendations.

7.0 Recommendations

When considering these recommendations, understand that no matter how much assistance and resources EPA provide, the companies have to put in the effort, funding, resources and man power to get the job done. The company is responsible for developing the environmental technology and taking it to commercialization, not the EPA. Jim Gallup's thoughts about EPA's perspective are that they are there to assist these small businesses to achieve their common goal which is to create a cleaner environment (Appendix M – EPA SBIR Director Summary). Many companies were recommending that EPA provide funding beyond what their resources will allow. We agree that an increase in funding would greatly assist companies with commercialization, but there are other important factors to consider. This was made very clear after speaking with Mike Caccuitto, the program director of the DOD SBIR program that has a billion dollar budget. He faces some of the same commercialization problems that EPA SBIR does with a five million dollar budget.

Working through our three objectives has provided enough information for us to make some feasible recommendations to EPA that require little additional effort to implement. The following recommendations were suggested because they would have a beneficial effect on any environmental technology progressing through EPA's SBIR program towards commercialization.

Major recommendations for EPA's SBIR program include the following;

- Increase commercialization assistance after Phase II
- Reduce the amount of time between phases of funding

- Increase publicity and communication efforts amongst EPA departments, between Federal agencies, and to the environmental technology development industry

7.1 Commercialization Assistance after Phase II

Post-Phase II commercialization assistance from EPA would greatly help technologies become commercialized. EPA already provides assistance in the form of Foresight Science and Technology during Phase I and II. If Foresight assistance were tailored to companies depending on their marketing personnel and expertise, individual companies would see enhanced benefits from their interactions. Most companies find the commercialization information Foresight provides them with is useful. Most of these SBIR companies are composed of almost all scientists and engineers. They do not have people familiar with marketing, so the commercialization/ marketing information Foresight provides them with can be very helpful. One problem for companies that do not have marketing personnel, such as the scientists, is that some of them do not know what to do with the marketing information. Some SBIR companies that do have a marketing department find that they already know what Foresight tells them. For these companies an alternative use of the funds is more appropriate.

EPA currently provides a niche study for each company through Foresight. It would be extremely valuable to the companies to offer a few different levels of assistance to choose from, and still receive the same dollar worth of Foresight assistance. Companies would be able to pick which option would work the best for them. This will lead to companies receiving the most pertinent marketing information from Foresight based on market research already performed by the company. Companies with marketing personnel, like the entrepreneurs, could focus Foresight assistance on more specific

marketing challenges that they faced instead of the basics that are provided now by the niche study.

EPA could also provide an opportunity for the small businesses to showcase their work to EPA and its many departments. EPA now has a two day workshop that they hold every year for all Phase I companies. This workshop presents to the SBIR Phase I awardees what EPA expects of them, and how to complete all the necessary paperwork. At the workshop EPA and Foresight also make presentations concerning the importance of thinking about commercialization early on. Our group recommends that EPA have a speaker come in and give a presentation on networking and its importance. Throughout the various interviews it came up that networking is how a lot of companies found funding or commercial partners. Networking should be the focus of one of the two days. EPA should also invite agency people that are interested in the technologies being developed so that a relationship can be established between the SBIR companies and contacts within EPA, which could help in the development of the technology.

Along the lines of conferences, EPA can look to use conferences to bring together the SBIR technology developers and end users. DOE currently holds an opportunity forum through Dawn Breaker, a marketing company similar to Foresight, in Phase II. This forum allows companies and end users the opportunity to network. EPA formerly used to have some of their SBIR Phase II companies attend, but no longer does. Our group recommends that EPA try to join DOE's effort and have EPA SBIR Phase II companies attend this forum. EPA should try and generate interest in environmental companies to attend so that there are environmental technology end users present.

Opportunity forums like the one mentioned above will allow EPA SBIR companies a chance to network and possibly find end users that will buy their technology.

Making existing technology specific conferences and tradeshows better publicized to EPA awardees would provide the awardees the opportunity to network with potential end users or collaborators. Companies would be able to form business contacts which could help them commercialize their technology. Publicizing existing conferences and trade shows would be easy for EPA to do if there was already a newsletter being sent out with other important information for technology developers such as the one proposed in section 7.2. These conferences could also be listed on EPA's website by technology area, along with links to the specific conferences and tradeshows. This additional assistance will help more technologies become commercialized and have an impact in EPA's mission of protecting human health and the environment.

The last recommendation that our group would like to make is that of a technology incubator. Technology incubators can be a powerful resource to help a technology become commercialized, and they can help companies bridge the "Valley of Death". These incubators provide assistance in the form of guidance and monetary support. They offer a tool that can be used to develop a technology to commercialization. Our group recommends that EPA create a program that encourages the development and support of technology incubators. EPA could provide information on conferences, regulations, and the SBIR process to these incubators. These incubators could then be a local source for companies to turn towards when developing environmental technologies.

7.2 Reduce Time between Funding

Reducing the amount of time between Phase I and Phase II from the present nine months expedites the amount of time the technology ultimately takes to develop. It is crucial at this time because it is very difficult for companies to stop conducting research and then pick it back up nine months later. It is important to decrease proposal review time because technologies, especially environmental technologies are very time sensitive. In other words, as Foresight S&T claims, the technology becomes obsolete after 5 years. Making the application process shorter would allow companies to retain development momentum more easily because people would retain working knowledge of the project. This would benefit EPA as well as the companies, because then EPA would be getting more productivity out of their funding. Keeping the momentum of the project going is ideal for the effective development for commercializing environmental technologies.

As of today, once solicitations close, EPA SBIR programs proposal review process is nine months. Refer to the table below for the reasons that the process currently takes nine months. Refer to Table 5 - Timeline of Proposal Review Time for more information.

EPA's SBIR program is unique because they have a two tier review process, the external third party (peer) review, and the internal relevancy review. The external review process requires that each member of a review panel be under contract to EPA before they can be paid. This process is the most lengthy, because initial draft contracts must be mailed out to each panel member for signatures. Then the draft contracts are sent through EPA's contracting office, which requires approximately a month to process all of the contracts. Then each member is given a month to review the proposals for funding. If

the contracting process could be simplified, the time could be significantly reduced. The contracting process also comes into play after the external and internal reviews. Before each company can receive funding, they must be under contract with EPA. This means that after the review panels decide who will receive funding; it is still another few months before the company will receive any money.

The proposal review process is the same for both Phase I and Phase II. For Phase I, EPA ABIR program receives 300 proposals, so it can be understood why EPA would need nine months to sort and organize. It is not as important to reduce the time at the beginning of Phase I because the small businesses have not began research or development yet, so it is not at critical to have expedite the process for the companies to receive funding. For Phase II, EPA SBIR program receives a lot less proposals. It is important to reduce the proposal review time for this phase because it is very difficult for small businesses to stop developing their technology, and then nine months later pick up where they left off. This becomes expensive and extends the amount of time it takes for development.

The following suggestions on how to reduce proposal review time can be applied to both Phase I and Phase II proposal review, except Suggestion 2. Please not that these suggestions are in chronological order of the application process.

Suggestion 1 - Close Solicitations Earlier

One of the biggest ways the SBIR programs can shorten their review time is by shortening deadlines. Solicitations are open for three months, and a majority of those proposals come in on the last day the solicitations are open. Shortening the time from three months to two month saves a month of time the technology has to get out into the

market. This does not reduce the nine month review process, but it does save a month of time from the entire one year process (Solicitation time, three months plus the proposal review time, nine months makes it a one year process). Once the solicitations close, the nine month review process time begins.

Suggestion 2 – "Guess" the incoming proposals for Phase II:

The EPA SBIR program requires their companies to submit monthly reports on their technology development progress. By carefully looking at the monthly reports, one of the SBIR program runners could take their best educated guess on what proposals from Phase I will come in for Phase II. Doing this will allow the Peer Review Division, to begin contacting the third party peer reviewers a month in advance; because it takes a few weeks for the experts to agree on reading their assigned proposal. Then the peer review experts get a month to read their proposals. Presuming which proposal will come in for Phase II has been done for the first time in 2006 by Don Tang and it saved them about two months of time. The WPI EPA team suggests that the SBIR program continues to do so.

Suggestion 3 – Company Signs their Contract

The companies that receive funding have a month to sign their contract and return it to the EPA in order for them to receive their first piece of the funding. Reducing that time to about two to three weeks saves additional time. Even though it only save about a week or so, every day, week, or month saved counts and begins to add up.

Suggestion 4 – Set up "Decision Meetings" in advance

By pre – planning important meetings just like a deadline or appointment would save another month of time. The "Decision Meetings" are meetings with the Director of

NCER and the Department Head of something? Meeting with those two people can be very difficult since they are directors of large departments. Right before the contracts go to the company their signature is needed by the both of them The “Decision Meetings” is a time where the people running the SBIR program have to explain why the proposal should be funded and to receive a signature on the contract so the small businesses can begin receive funding. Setting up the meetings with the respected people is what is time consuming, not the actual meeting. Right now, it takes about a month to set up those meetings. If those meetings are a pre set date, just like all the other deadlines for the proposal review process, it would save a month of time. The Director of Blah, Gary Foley is willing to set up those meetings well in advance to shorten this review process.

The total amount of time that would be saved off the entire one year application process would be reduced from 12 months to about eight months. The total amount of time saved off the entire nine month proposal review process would be reduced from nine months to about six months. These suggestions are the beginning to reducing the proposal review time for EPA SBIR program.

7.3 Increase Communication

During our interviews with different companies and programs, we noticed that there were many cases of companies or programs being unaware of what the function of the SBIR or other technology development programs were. It would be of great assistance if EPA could increase communication about its programs for technology development to other agency’s SBIR programs, within EPA departments, and to technology developers. This publicity would let more companies understand how EPA’s assistance programs fit together. It would also provide information to companies

wondering about how the individual programs function to produce a commercialize-able environmental technology. Communicating with other SBIR programs would allow for possible leveraging of funds between the programs to maximize the effectiveness of each program.

A quarterly electronic newsletter would be the most appropriate for publicizing existing programs because it would require the least maintenance and could reach the largest number of people. It would also require the least amount of work to create articles for. It would also be easy to add new subscribers to.

Another option for publicity would be the publication of technology descriptions in appropriate trade journals. The reader base is immense and directly focused on the topic of a technology that would be highlighted there.

Practical information to distribute in a newsletter or journal would be a brief description of EPA's technology development programs. This description would allow technology developers to determine what sources of funding are available for their product. If all of EPA knew about other technology advancement programs, individual programs could point out the next program to apply to.

Other information EPA should consider distributing is a brief description of the technologies currently in a technology advancement program such as SBIR. This would allow both technology developers and potential end users to see what projects are currently under development. If an end user saw a technology description they liked, they would be able to contact the company to offer assistance for the development of the technology. If this information were distributed within EPA as well, then different

departments that have a particular interest in a technology currently being developed would be able to assist as much as they could.

7.4 Future Research Recommendations

The research and recommendations provided in this report were limited by the amount of time that we were able to spend on this project. We have a list of recommendations that those researching this topic or related topics may find helpful as a starting point for their new research. These include researching; what makes some technology easier to commercialize than other technology, how to distribute funding between high risk high payoff and low risk low payoff projects, support available after Phase II, how to measure successful commercialization of technology, and comparing all the different SBIR programs. These issues were all highlighted during the course of our project as being important considerations, but we did not have enough time to completely address them.

7.5 Summary

The information provided in this report details both positives and negatives about the EPA SBIR program. This information will allow EPA to implement changes to their SBIR program as they see fit to help commercialize environmental technologies. We expect that this information provided to EPA can help to create a SBIR program that commercializes the majority of technologies that enter it.

Our project team does realize that not every technology can be commercialized, but we feel that more technologies can become commercialized after entering the program. With the suggested changes we anticipate that EPA SBIR program can become

a model program for other government agencies to emulate. We know that the EPA SBIR program is, and will continue to be, an innovator in the field of environmental funding.

Appendix A – EPA Background

Mission and Background of Environmental Protection Agency

The Environmental Protection Agency (EPA) is a government organization headquartered in the Federal Triangle in Washington, DC working to improve the quality of life on the planet while reducing the negative impact of humanity on the environment. Since EPA was created in 1970, they have provided a means to consolidate programs to research and implement technologies designed to benefit the environment, to monitor and enforce environmental regulations, and to safeguard the environment and human health. The mission of EPA is "to protect human health and the environment." (EPA, 2006). To realize this mission, EPA has 18,000 engineers, scientists, policy analysts, legal, and public affairs employees working across the country. The organization internal to EPA can effectively break down any environmental problem so that no one office becomes overwhelmed with trying to solve the entire problem. EPA also works to realize their mission through a series of technology advancement programs.

The organization internal to EPA provides a solid framework for attempting to realize their goals and missions. EPA can be broken down into 12 departments and 10 regional offices, see Table 5- Departments and Regions of EPA below. Each department is in charge of a different facet of protecting human health and the environment. The 10 regions and 12 Offices are listed below in Table 4 – Departments and Regions of EPA.

Offices Within EPA

- Administration and Resources Management
- Air and Radiation
- Compliance and Enforcement
- Chief Financial Officer
- General Council
- Inspector General
- International Affairs
- Environmental Information
- Prevention
- Pesticides and Toxic Substances
- Solid Waste and Emergency Response
- Water
- Research and Development

Regions of EPA

- Region 1: New England (Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont, and 9 Tribal Nations)
  - HQ in Boston
- Region 2: New Jersey, New York, Puerto Rico, US Virgin Islands, and 7 Tribal Nations
  - HQ in New York
- Region 3: Mid-Atlantic (Delaware, District of Columbia, Maryland, Pennsylvania, Virginia, and West Virginia)
  - HQ in Philadelphia
- Region 4: Southeast (Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, Tennessee, and 6 Tribes)
  - HQ in Atlanta
- Region 5: Illinois, Indiana, Michigan, Minnesota, Ohio, Wisconsin, and 35 Tribes
  - HQ in Chicago
- Region 6: Louisiana, Arkansas, Oklahoma, New Mexico, Texas, and 65 Tribes
  - HQ in Dallas
- Region 7: Iowa, Kansas, Missouri, Nebraska, and 9 Tribal Nations
  - HQ in Kansas City
- Region 8: Colorado, Montana, North Dakota, South Dakota, Utah, Wyoming, and 27 Tribal Nations
  - HQ in Denver
- Region 9: Pacific Southwest (Arizona, California, Hawaii, Nevada, the Pacific Islands, and Tribal Nations)
  - HQ in San Francisco
- Region 10: Pacific Northwest (Alaska, Idaho, Oregon, Washington, and Native Tribes)
  - HQ in Seattle

Table 5 - Departments and Regions of EPA

Each of these offices has their own focus on advancing the goals of the Agency. One office not listed here is the Office of the Administrator, which is directed by the administrator of the entire EPA, Stephen L. Johnson. This office provides "executive and logistical support for EPA Administrator and the staff offices that directly support the Administrator. The Administrator is responsible to the President, and is assisted by the Deputy Administrator, Marcus Peacock and (13) staff offices. The Office of the Administrator supports the leadership of EPA's programs and activities to protect human health and safeguard the air, water, and land upon which life depends. (EPA Administrator, 2006).

The Office of the Administrator within EPA has within it an Office of Policy, Economics and Innovation (OPEI). This office is very important to EPA when policy decisions need to be made. OPEI also provides suggestions about how to promote innovations that reach higher standards of environmental and health protection with fewer resources than before. OPEI also plays a major role in making regulatory decisions as the business world evolves, and EPA needs to adapt to ensure their regulations stay up to date. The office also strengthens "…analytic foundation of the Agency's decision making processes…" (EPA OPEI, 2006). The regional offices enforce the regulations handed down by EPA. Regional offices also have a strong say in what types of proposals for technology assistance receive funding, because they actually deal with enforcing the regulations. Therefore they are in the best position to see what technologies might actually be useful to EPA and their region.

Recent EPA Budget Trends

The regions require funding in order to effectively regulate the area they oversee. Looking at the past budgets for the agency to see how the amount of funding has changed over the past 10 years has shown that the amount of funding for trust funds has remained fairly constant around 1.4 billion dollars. The amount of funding for Operating Programs took a sharp increase in 2004, when the budget jumped from its previous level of approximately 2.6 billion dollars up to 4.3 billion dollars, an increase of 1.7 billion dollars. Infrastructure funding reached a peak in 2003 of 3.9 billion dollars, however has been steadily decreasing over the past years down to 1.7 billion in the President's Budget of 2007. The percentages of funding from the past two year's proposed budgets have remained the same, though the dollar amounts have changed.

Current EPA Goals Mission, Policies, and Objectives

EPA's budget needs to be used effectively for the agency to best realize their mission of "protecting human health and the environment" (EPA, 2006). To ensure that funds are applied most efficiently, every year EPA creates a document called the strategic plan that they use as a road map for effecting environmental change over the next 5 years from when the plan was created. The most recent copy of the strategic plan redefined the goals/objectives of the agency, which are shown here:

Goal 1: Clean Air and Global Climate Change

Protect and improve the air so it is healthy to breathe and risks to human health and the environment are reduced. Reduce greenhouse gas intensity by enhancing partnerships with businesses and other sectors.

Goal 2: Clean and Safe Water
Ensure drinking water is safe. Restore and maintain oceans, watersheds, and their aquatic ecosystems to protect human health, support economic and recreational activities, and provide healthy habitat for fish, plants, and wildlife.

Goal 3: Land Preservation and Restoration
Preserve and restore the land by using innovative waste management practices and cleaning up contaminated properties to reduce risks posed by releases of harmful substances.

Goal 4: Healthy Communities and Ecosystems
Protect, sustain, or restore the health of people, communities, and ecosystems using integrated and comprehensive approaches and partnerships.

Goal 5: Compliance and Environmental Stewardship
Improve environmental performance through compliance with environmental requirements, preventing pollution, and promoting environmental stewardship. Protect human health and the environment by encouraging innovation and providing incentives for governments, businesses, and the public that promote environmental stewardship. (EPA 2006-2011 Strategic Plan, 2006)

EPA uses these goals to keep their progress advancing as efficiently as possible, and as overall funding umbrellas to decide how funding is broken down between divisions of EPA. Specific goals are set for the end of each year, and accountability measures are created based upon the strategic plan from which each of these goals comes. The entire document may be downloaded from EPA's webpage by following the reference above.

Worcester Polytechnic Institute (WPI) Project with EPA

Working knowledge of this background will provide a foundation for us (WPI Students) to complete a project requirement to graduate called the Interactive Qualifying Project (IQP). There are many different options for completing this requirement, however our group chose to travel to Washington DC and work with the Environmental Protection Agency. The project description provided to our team is shown below as Figure 6.

The project we are working on focuses on providing information about the commercialization of environmental technology to EPA through an analysis of companies in EPA's SBIR program; supplemented with information from outside sources and other EPA programs. This process of commercialization is important to EPA because the mission of the agency is to "protect human health and the environment." Therefore, if EPA can assist more technologies through to commercialization, those technologies will have an impact on making the environment a cleaner and healthier place to live in.

Many of the ways that EPA can assist commercialization are programs that are operated out of the National Center for Environmental Research (NCER) within the Office of Research and Development (ORD) (Figure 7). One of the major programs in

NCER is the Small Business Innovation Research (SBIR) program. The director of this program is Jim Gallup, and the deputy director is April Richards, one of our liaisons. Our other liaison is Diana Bauer, program manager for Collaborative Science and Technology Network for Sustainability (CNS).

At the head of NCER is the Office of the Director, Gary Foley. Underneath that office is the Office of the Deputy Director, headed by Chris Zarba. Below those two offices at the head of NCER are three different divisions. They are the: Environmental Engineering Division, headed by Stephen Lingle; Environmental Science Division, led by Becki Clark; and Peer Review Division which has Barbara Levinson as its Acting Director. Our project team is a part of the Environmental Engineering Division. Refer to Figure 7.

This project will provide information to many of our associates about the technological advancement programs they work with every day. If there are issues with one particular program or stage of commercialization, our project will highlight them. Once the issues are illuminated, we will look in more depth at what programs for assistance EPA offers that correspond to that stage of the continuum. Our project will also highlight the sections of the continuum (the road map of technology development, beginning from the basic concept up through to successful commercialization) where EPA offers the most support for commercialization, so that EPA can see what aspects of their assistance programs are the most effective. Through this illumination, we will provide an outsider's overview perspective to EPA employees who have been working with aspects of these programs for years. This will allow EPA to improve upon existing technology commercialization programs, or create new programs if necessary.

WPI Student Team Project

Environmental Protection Agency
Development of Environmental Technologies
August 10, 2006

The mission of the Environmental Protection Agency (EPA) is to "protect human health and the environment." EPA's National Center for Environmental Research (NCER) in the Office of Research and Development (ORD) will be hosting the WPI student team. ORD is the part of EPA that supports research and development that is useful for environmental protection. NCER is the part of ORD that supports research at universities, non-profits, and small businesses.

There are many EPA programs that support the development of environmental technologies (http://www.epa.gov/etop/) needed to prevent, monitor and control environmental problems related to air, water and waste. There are many different types of environmental technologies. A few examples include a drinking water treatment system to remove arsenic, a monitor to detect particulate matter in air, and a process that replaces lead in the manufacture of tire weights.

One of EPA's main vehicles for funding technology development is the Small Business Innovation Research (SBIR) Program which is managed by NCER. EPA is one of 11 federal agencies that has an SBIR program that funds small businesses to research and develop technologies needed to support the mission of the agency. Information about the program including an example research solicitation, project success stories, and links to other agencies SBIR programs can be found at www.epa.gov/ncer/sbir.

A technology must go through several stages from research through commercialization before it can ultimately be used for environmental benefit. These stages are depicted on EPA Environmental Technology Research and Development Continuum (http://www.epa.gov/etop/continuum/index.html). While ideas abound for environmental technologies, a small percentage of these actually make it to market. Through this project, the WPI Student team will investigate how a technology moves along the continuum from research to utilization, what makes the technology successful and what EPA can do to promote the successful development of environmental technologies.

Part 1. Technology Development. The WPI student team will select several successful projects supported by EPA's SBIR (and possibly other technology) program(s). Through research including interviews with principal investigators (PI's), EPA staff and others, the student team will explore the following questions. Whatever happened to the research? How far along the technology continuum did it go? Has the technology been commercialized? Does it still have the potential to? Are there sales? Was the technology platform adopted by another entity? Does the technology have potential application outside the environmental field? What helped make the technology successful or unsuccessful? How long did it take? What can EPA do to improve the rate of commercialization?

Part 2. Environmental Benefit. For some of the projects examined in part 1, the WPI student team will examine the potential and actual environmental benefits of the technologies when utilized. The student team will use data provided by the companies, EPA staff and other resources. Who is using the technology? How is it being used? What are the environmental benefits? What are the public health benefits? Does the technology have potential for other applications? What other agencies are funding environmental technology development?

Figure 6 - WPI Student Team Project

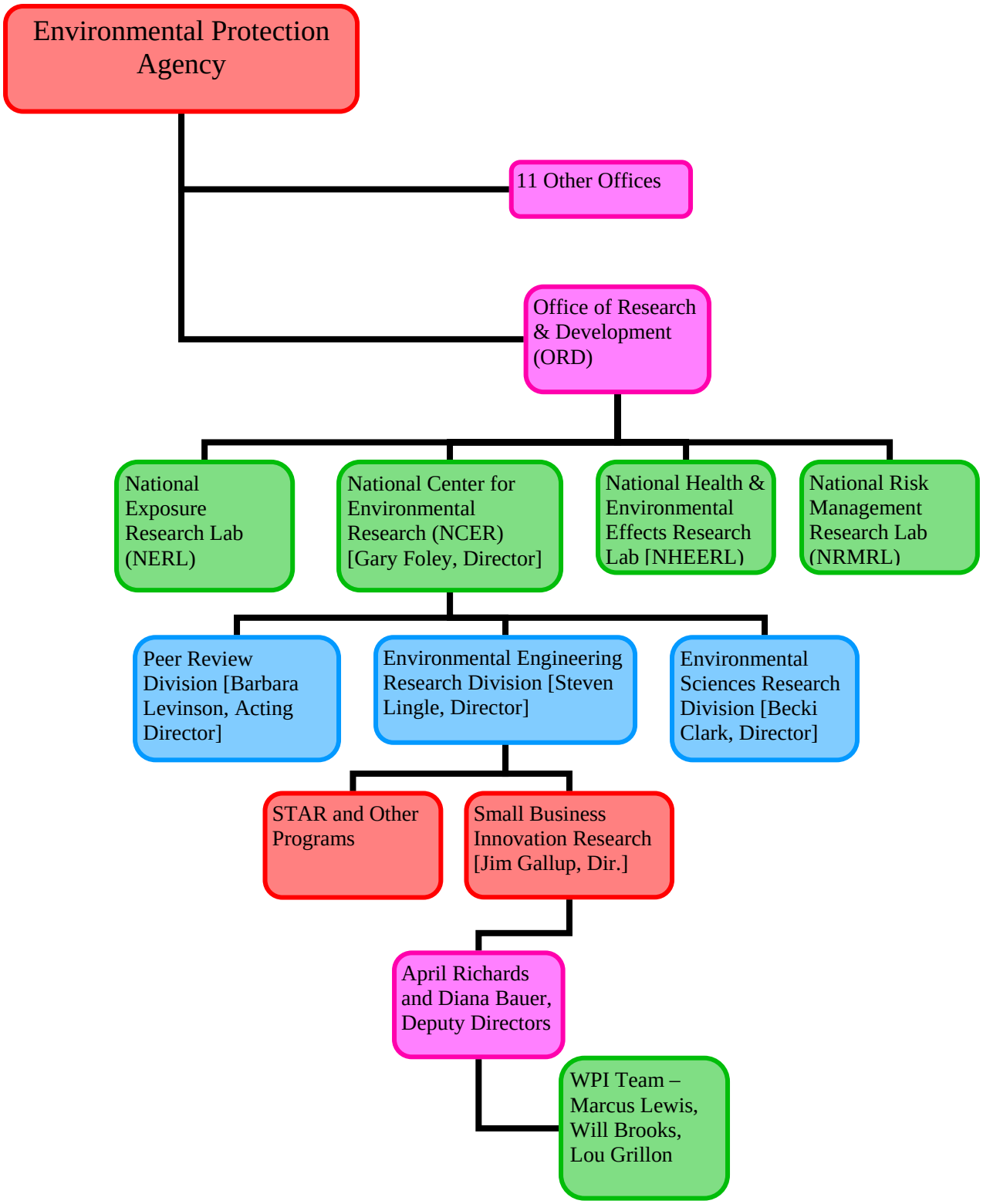

Figure 7 - EPA Organization Chart

Appendix B – Small Business Background

An understanding of some basic principles about small businesses can hopefully provide some insights as to why EPA has noticed a lack of successful technological development in their environmental development programs. "According to the U.S. Small Business Administration, over 50% of small businesses fail in the first year and 95% fail in the first five years" (Start a Business, 2006). With proper planning and some basic information about why most small businesses fail, failure may be avoided. Reasons why small businesses commonly fail can be found on BusinessFinance.com. A PDF based on a walkthrough from SBA.gov suggests several prominent reasons for business failure. A few of the most important are listed here:

- Lack of industry and/ or entrepreneurial experience.
- Insufficient working capital and/or poor credit arrangements.
- Lack of time commitment of the owner and/or staff.

Forming partnerships with pre-existing companies can help a small business in financial trouble. This allows the small business to partner up with a usually bigger and financially more stable company. The small business can then use the resources of the big company to its benefit without having to pay for them out of pocket. Another often-overlooked aspect of financial security is a small business hiring a Certified Public Accountant (CPA) to make suggestions about how to finance the business and to review loan agreements. These suggestions have been compiled with the use of SBA.gov, the primary resource for small businesses in the United States.

Appendix C – Company Interview Plan

EPA Company Interview Plan
Contact number: Contact person:
Pre-Call (Voicemail):
Hello, my name is _____ and I am a third year student at Worcester Polytechnic Institute (WPI). I am currently working as a student intern at EPA, working on a special project concerning technology development and commercialization. We see that your company has been successful, and thought you'd be the best to go to for more information regarding technology development. I would like to know if my other team members and I could schedule a phone interview with you about the stages and problems your technology went through. This information is vital to our project; please give me a call back at 202-343-_____. Thank you for your time, I look forward to hearing from you.

Pre-Call (Operator / Speaking to PI):
Hello, my name is _____ and I am a third year student at Worcester Polytechnic Institute (WPI). I am currently working as a student intern at EPA, working on a special project concerning technology development and commercialization.
We see that your company has been successful, and thought you'd be the best to go to for more information regarding technology development. Are you the appropriate person to speak to? If not, I would like to know who is the Principal Investigator (PI) or appropriate person to speak to for more information. [Name Given and extension: _____]
Mention: Would you like for me to send our questions and a little bit of background on the project or send it later during the interview?
Team assignments: Note taking:
Introducing the team:
Writing the summary:
Reviewing the summary:
Where:
When:
With:
How: The interview will be conducted according to the following outline.

1. Introductions – Explain we are an EPA intern working on a special project.
    a. Mention we may be recording them, talk briefly about project, who we are, say thanks.
    b. team leader
    c. who is there
    d. Send ahead of time, a handout briefly explaining the technology continuum
2. Type of interview-Key Informant
    a. This interview will consist of
        i. us asking you questions about the technology you are developing

ii. you telling us of ideas we should research and look into
iii. should only take about 30-40 min

b. We will use this information to better prepare for the project

3. Ice breaker questions
    a. Tell us about your technology
        i. We are focusing on the progression of the technology, not the actual science behind it.
        ii. rephrase what interviewee says
4. Cued questions about project
    a. probe for clarity and specific information

Cued question list

Part 1 Technology Development applying the Tech Continuum

Important Questions

1. **Did you commercialize your technology?**
2. **What success did you have? What has happened since the patents and/or partnerships?**
    a. **-patents**
    b. **-partnerships, etc**
3. **What were the roadblocks?**
4. **Would you be willing to describe the work environment before and after participation in the SBIR program?**

Research/Proof of Concept

1. Whatever happened to the research?
2. Does the technology have potential application outside the environmental field?
3. Were there any particular problems that arose during the process of research and development?
4. How did you initially get funding for your technology?

Development

5. Was the technology platform adopted by another entity?
6. How did you prepare for the next stages in the process of making it to Phase II of SBIR funding?

Demonstration

7. Were you able to demonstrate the technology?
8. How did you demonstrate that your technology works?
9. What kind of procedures did you conduct?
10. What were the challenges?

Verification

11. Explain the verification process and how you proved that your technology works?
12. What were some of the key issues faced?

Commercialization

13. Has the technology been commercialized?
14. What success did you have?
    a. Patents, partnerships, more funding, etc.
15. Does it still have the potential to be commercialized? Are there sales?

Utilization

16. How long did it take to make it to the market?
17. How did you plan on getting your product into the market?
18. Have there been sales, revenue, and partnership offers?
19. Is it impacting the environment?
20. What did you learn from the problems you faced? What were those challenges?

General Questions in Regards to EPA support

21. What helped make the technology successful or unsuccessful?
22. How long did it take? Was EPA support helpful?
23. What were the primary sources of funding prior to and after involvement with the program, if any?
24. What do you think EPA can do to improve the rate of commercialization? (may not be asked to a company)

Part 2 Environmental Benefit (Ask Only if the technology is actually being used)

1. Who is using the technology?
2. How is it being used?
3. What are the environmental benefits?
4. What are the public health benefits?
5. Does the technology have potential for other applications?
6. How is your technology impacted by regulations?

5. Summary of interview
    a. Post-Call:
        i. We appreciate you taking out your time to conduct the interview with us. I'm sure that this information will prove itself to be useful in our final report. We will follow up with you, and send our interview meeting minutes within the next couple of days. Can we contact you with follow up questions if needed? Thanks Again.

Appendix D – Contacted EPA SBIR Companies

Attribute →	Location	Phase	Technology	prevention/ treatment/ monitor	media (air, water, waste)
Company Name ↓					
ADA Technology, Inc.	Littleton, CO 80127	II	Arsenic Removal System for Point of Use/Point of Entry Drinking Water Systems	treatment	water
Advanced Fuel Research, Inc.	East Hartford, CT	II	Mercury Sorbents and Carbon Black Derived from Waste Tires	treatment	air
Aerodyne Research Inc.	Billerica, MA 01821	I	Monitor Acrolein, Air Pollutant	monitor	air
Applied Sciences, Inc.	Cedarville, OH 45314	I	Reduce Volatile Organic Compounds by New Car Paint	prevention	air/waste
Faraday Technology, Inc.	Clayton, OH 45315	I	Replacement of Toxic Hexavalent Chromium in the Plating Process	prevention	waste
Infoscitex Corporation	Waltham, MA 02451	I	Mercury-free, Electrical Switches (MFES) and Relays	prevention	air
Luna Innovations	Blacksburg, VA	II	Magnetite Nanoparticles for Enhanced Environmental Remediation	nanotech	waste
Lynntech Inc.	Bryan, TX 77803	I	New Chemical Process to Create Oxidizing Agent Potassium Ferrate	prevention	waste
Micell Technologies, Inc.	Raleigh, NC 27617	I	Metal Deposition for Microelectronics Using CO2 as a Solvent	nanotech	waste
Mide Technology Corporation	Medford, MA 02155	II	Fuel Injection to Reduce Pollution	treatment	air
National Recovery	Nashville, TN 37228	II	High Speed Identification and Sorting of Plastic Resin Flake for Recycling	prevention	waste
Ophir Corporation	Littleton, CO 80127	II	Novel Liquid and Gas Pipeline Leak Detection System	monitor	air/water
Phoenix Science and Technology	Chelmsford, MA	III	Innovative Ultraviolet Light Source for disinfection of drinking water	treatment	water

Attribute →	Location	Phase	Technology	prevention/ treatment/ monitor	media (air, water, waste)
Company Name ↓					
Rupprecht & Potashnick Co., Inc.	Albany, NY	II	Measurement System for Determining Particulate Matter Pollution	monitor	air
Sorbent Technologies Corporation	Twinsburg, OH 44087	II	Gas-Phase Bromination for Cost-Effective Mercury Control	treatment	air
USInfrastructure, Inc.	Birmingham, AL 35209	II	Upflow Filter for Rapid and Effective Treatment of Stormwater	treatment	water
Non SBIR company					
Foresight	Providence, RI	NA	Market Services Company Teamed with EPA to Assist SBIR	NA	NA

Table 6 - Contacted EPA SBIR Companies

Appendix E – Table for Analysis

	ADA	Aerodyne	AFR	Infoscitex	Luna	Lynntech	Mide	NRT	Ophir	Phoenix	US Infrastructure
Technology	Arsenic removal system for point of use/point of entry drinking water systems	Monitor Acrolein, air pollutant	Mercury sorbents and carbon black derived from waste tires	Mercury-free, electrical switches (MFES) and relays	Magnetite nanoparticles for enhanced environmental remediation	New chemical process to create oxidizing agent potassium fer-rate	Fuel injection to reduce pollution	High speed identification and sorting of plastic resin flake for recycling	Novel liquid and gas pipeline leak detection system	Innovative ultraviolet light source for disinfection of drinking water	Upflow Filter for Rapid and Effective Treatment of Stormwater
Stage of Development	Pilot Scale Demonstration	Proof of Concept	Development	Proof of Concept	Proof of Concept	Verification	Development	Commercialized	Development / Demonstration	Demonstration, into Verification	Diffusion / Utilization
Phase of Funding	Phase II	Phase I, applying for Phase II	Phase II	Phase I, applying for Phase II	Phase I, into Phase II now	Phase II	Phase II	Phase II	Phase II	Phase II	Phase II
Outside Sources of Funding	NIH/DOD SBIR, Other government grants, royalties from previous tech, industrial contacts	In Kind from JAMA, interested in buying a finished product	Commercial sources, foreign governments/other agencies	none. If get Phase II, will match with internal funding	Internal funding (Luna business development group)	None	Army SBIR	Internal Funding, Plastics Institutions	None	ATP, NSF, NIST, HUD	internal funding
Marketing Plan/People	1 man show	None	none			none	few people, also engineers or scientists	none	yes, trade shows, papers to pipeline companies, gas star program		
Company Size						100(approx)					
Technology End User		Institution that needs to monitor (end user)		OEMs, switch manufacturers	OEM	chemical manufacturing company (OEM?)	Army Humvees / tanks, OEM?	Municipality (end user)	Utility company/pipeline owner	Water treatment facilities	businesses
Development by Company	All the way	All the way - outsource specialize	All the way	R&D + Prep for marketing	R&D + prep for marketing	R&D + Prep for marketing	R&D	All the way	all the way	all the way	R&D

	ADA	Aerodyne	AFR	Infoscitex	Luna	Lynntech	Mide	NRT	Ophir	Phoenix	US Infrastructure
		d components									
Patents / Partnerships	Company in India	JAMA	looking for partners, lack credibility of product		License to OEM, collaboration with Virginia Tech researcher	2 US Patents, Looking for partner for manufacture	none	Name Withheld of prototype testing company, industry alliances exist	tried with Honeywell, market too small	Handshake with Trojan (testing facilities), 2 patents, 1 pending. License agreement with Kyzer Systems Inc.	Yes, sold tech/patent to Hydro Compliance, which was then sold to Hydro International
General Commercialization Problems	Regulation uncertainty, Lack of knowledge about how to commercialize	none to date	Took 6 years to develop technology (funding), change in option task funding	no funding after Phase I until possible acceptance to Phase II	technology put on hold when transition from Phase I to Phase II	scaling tech. up from laboratory scale	finding commercial partners to assist development	Took 3 years to develop technology (funding)	Industry slow to embrace change. Finding someone who will push to package for commercialization, bridging product development gap	ETV only half funded by EPA, would like to use ETV though.	none
Regulatory Impact	Yes, arsenic heavily regulated	none		none, but regulation prohibiting mercury use in electronic switches would help	lowering arsenic standards has helped technology	yes, regulation can benefit this tech	none	none	DOT changed pipeline inspection criteria, created what Ophir saw as a potential market	UV is now recommended, good for this tech. Tech uses Pulse UV, not specifically recommended yet	storm water regulations helped this technology. Businesses are required to look at treating runoff before releasing it

	ADA	Aerodyne	AFR	Infoscitex	Luna	Lynntech	Mide	NRT	Ophir	Phoenix	US Infrastructure
Suggestions to Improve	EPA should be more understanding about multiple SBIR programs needed to actually develop a tech. (funding) EPA funds better for augment, not create.	Shorten time gap between funding (Phase I and Phase II)	Clearly define deliverables, consider option funding on a case by case basis. Shorten the time gap between funding (Phase I and Phase II)	Incentives to use new environmental tech. Tax breaks for going more enviro-friendly, timeline for change to new products, offset cost of switching products	Increase the $ amount of their awards, fewer awards made. Expedite the Phase I to II process.	support after Phase II (VOD) If tech has market pull, government should offer Phase III help. Shorten the gap between Phase I and II, but don't cut into Phase I to do it.	provide contacts to company that EPA has contact with, and knows are interested in the technology	increase EPA funding, increase time of Phase I More cross-industry help. Create database of companies, universities and gvt labs that could help with testing and analysis. EPA make standing agreements with these places, as well as cost to use facilities	More EPA push for commercialization. EPA could find real needs/cost drivers of marketplace, help push companies to change to more innovative solutions. Broker deals?	use IDIQ contracts, filter money through other government programs without separate app. Process. Fund Matching? Support after Phase II, broker deals between company and VC	QA/QC = important. EPA already does this, good. Commerc. Option = cash, good. Shows serious intent to commercialize.
Nugget	Foresight helpful	Foresight helpful (limited extent)	Had not heard of ETV, majority of business leads come from EPA's website. Create spin off companies when AFR thinks risk is worth it.	contract R&D, do not commercialize themselves	companies need to recognize that they need industrial partners when they enter Phase I	there is no "one size fits all" way to commercialize. Each company has a niche. Commercialization done by ppl good at it, not sci and eng. Companies fit into a part of the continuum, unlikely to take tech from development to sales.	had never heard of Foresight, even though Foresight is supposed to work with every SBIR awardee through EPA	Machines on every continent except 2	Project has been significantly scaled back; at this time, Ophir does not see how to develop a viable product out of what they have already.	EPA app. Process uses most paper compared to other gvt. SBIR	USI = right place and right time. EPA SBIR provided resources needed. Market knowledge is key, awareness of regulations is important. Gallup is excellent, good program.

Table 7 - Case Study Data for Analysis

Appendix F – ADA Technologies Summary

Environmental Protection Agency
Meeting Summary

Meeting date: November 9, 2006
WPI Attendees: Marcus Lewis, Will Brooks, and Lou Grillon
EPA Attendees: None
Company Rep: ADA Technologies – Craig Turchi
****

The meeting was called to order at 10:00 a.m.
Team assignments: Note taking: Will Brooks and Lou Grillon
Introducing the team: Marcus Lewis
Running the Interview: Marcus Lewis
Writing the summary: Will Brooks
Reviewing the summary: EPA Team
Where: EPA – Woodies Building, Washington, DC
How: The interview will be conducted according to the following outline.

1. Since Marcus is the one who booked the interview with Ms. Shorter, he introduced the team and conducted the interview.
2. Marcus began to introduce the project explaining that we are EPA interns working on a special project.
    b. Mention we may be recording them, Mr. Turchi said it was ok to record, so we begin recording.
    c. Talked briefly about project, who we are, said thanks.
    d. Disclaimer that information will not help nor hinder chances for getting EPA funding, and that any information about companies will be used in a positive manner for SBIR program.

Summary of interview

The arsenic EPA Phase II ended last year. The company tries to create a core set of research, and apply to multiple government agencies for funding for similar research, that they can use to effectively develop the technology and commercialize it. The arsenic adsorbent project was funded through the NIH, DOD-Airforce and EPA. The first two funding sources finish at the end of this year, while the EPA's funding ended approximately a year ago. ADA is preparing to run a pilot study in West Bangol, India, for a few reasons. One is that the technology is best suited for use in developing areas due to its ease of use. Another is that India has much higher levels of arsenic contamination than the US, so there will be a larger market for a successful product.

ADA prepares for Phase II by looking at alternate markets for their existing idea to try to generate several projects that will be able to interest multiple federal agencies, but be based on the same core idea. This will enable the company to have access to a larger pool of funding for similar technologies, which will better enable them to develop and commercialize the different versions of the technology. Approximately ¾ of all the

income of the company comes through SBIR programs. Other sources include other non-SBIR government programs, state grants, royalties from previously developed technology that companies want to reapply, and industrial contacts.

ETV program has been used before, though not specifically with this arsenic adsorbent technology. A previous mercury project went through, funded by NIH. The commercial (marketing) partner to the company at the time wanted to use the ETV program, so ADA supplied the technology and materials, and the commercial partner funded the actual testing.

ADA has encountered Foresight on multiple occasions, with varying degrees of success. Though they were able to identify some potential partners, one of which ADA is currently working with called Kinetico, who provides equipment and field testing for the technology. For the mercury projects, Foresight was less helpful. The information provided was exactly what the company already knew. Mr. Turchi also mentioned that it makes a difference what individual project manager your project has as to how effective the information received will be.

In response to a query about how ADA's technology differs from other arsenic removal products, Mr. Turchi explained that the chemical actions of the iron oxide adsorbents were all the same. However, his product has different physical characteristics that set it apart from the other choices. Most arsenic removal products are applied as a solid bed through which the water passes through before it reaches the distribution system. However, his product is much more effective when liquidated. This basically means to take a smaller amount of water, add some of the adsorbent, mix it up, and then use the now arsenic-free water however you wish.

This technology has taken about 4 years to get to where it is at today. It is a spin off of a mercury adsorbent which preceded the arsenic adsorbent by a year or 2. It will probably take a few more years to see if they can create a successful business in India based on this technology. They have partnered with another company for commercialization assistance in India, because of a lack of experience expanding operations overseas. ADA also is involved with charitable actions with this technology, such as Engineers without borders.

ADA does not currently have a marketing department; however they do employ one person with a marketing background. This means that they have to focus their efforts on advertising the technologies that can actually become profitable. Since they only have one person working on this, Foresight assistance is usually quite helpful. Another option they have found is utilizing MBA interns to help with the market research. People can find out about their products through their website, through numerous conferences where personal networks are developed. Of course, this takes time, and means that travel expenses need to be budgeted for. Another way for people to learn about their technologies is through the various partnerships with universities and other businesses (closer to commercialization).

Asking about suggestions for improving EPA's commercialization process led to a discussion of Foresight's usefulness for the extent the funding provided for. Mr. Turchi also mentioned that it is a challenge for companies to get the resources needed to fully develop a technology, especially if the only source of funding being utilized is EPA. EPA could be more understanding to the idea that multiple grants on related areas of a technology are needed in order for a company to effectively develop a technology.

When asked about the impact of regulations on the technology, Mr. Turchi mentioned that uncertainty about a regulation is a problem. Such as, when a regulation is being proposed, but it is unclear whether or not it will pass, because that is the time when a technology must begin to be developed, so that when the regulation takes effect, the technology can be developed before the deadline for people to begin using it. The only problem with developing a technology in that gap is because companies are more reluctant to partner or contribute funding.

ADA currently has patents pending for their arsenic technology, and 2 issued for their mercury adsorbent as well as licensing some of their other technology developed through EPA's programs.

Mr. Turchi mentioned that the company with which they are partnering for help commercializing their technology in India found them at a conference and wanted to know what type of technology they were working on. Their primary sources of advertising are through their website and conferences that they attend. The equipment is currently on a pallet waiting to be shipped to India. They are only waiting on a final OK from the people actually conducting the pilot test in India.

The testing costs for this pilot test have been broken up between ADA and their partner companies so that ADA provides the testing materials and the partners cover the cost of the actual tests.

ADA's ETV experience has not been as beneficial as they would have liked. They worked with ETV to verify a mercury capture technology specifically for recovering mercury and amalgam from dentist's offices. They partnered with Dental Recycling North America, a large company. The technology not only removed mercury from the water being rinsed away, but also the particles of amalgam. They are having a problem getting people to purchase the technology, because it is beyond what is required by International Standards, and therefore more expensive. There is no regulation saying that the additional service provided by this technology is required, so companies are not likely to purchase this more expensive piece of equipment, when they can be in compliance with a simpler piece of technology. ADA was hoping that ETV would give them a market advantage by showing that their technology addressed the whole problem, not simply the problem of mercury removal from water systems. Their technology removes 99.something% of the mercury from the water, but because of the reasons mentioned above, their technology has not been as profitable as they could have hoped.

The arsenic technology has been pilot tested here in the US as well. There have been tests done in Idaho, where current market products were compared against this new technology in a solid bed test. These tests did not show that this product had any competitive edge over the existing competition. Therefore, ADA decided to focus on developing countries, where this technology with its ease of use and ease of manufacture could provide a solution. ADA also applied for an award through the National Academy of Engineering for Arsenic Control Technologies, which if secured will provide enough funding to support the transition overseas. One reason for needing this other source of funding is that DOD and EPA contracts do not allow work to be done overseas. NIH has a little more flexibility, so that is the contract under which they are moving over to India.

An example of a technology that has been through EPA's SBIR program that has been commercialized is the Amended Silicates for Mercury Control. ADA has worked with BASF and CH2 Hill to do this. They are currently working on a full scale

demonstration of this technology, for which they have produced 50 tons of their product. Another example is a mercury scrubber for air circulation in mines, where ADA collaborated with Primer for production. A Nevada mine purchased this product even before Phase II was complete.

Some things that have helped to make these products successful is that the company has been working mercury control for over a decade, so they are not re-learning the market every time they want to produce a new technology. This means too that much of their pre-existing knowledge can be re-applied to the current technological problem. They've also got their history of what concepts for working with mercury control have worked, and which haven't.

A final comment about EPA's SBIR program is that the amount of funding provided by EPA is useful for augmenting an existing technology, but not for completely developing and commercializing a technology.

Appendix G – Advanced Fuel Research Summary

Environmental Protection Agency
Meeting Minutes

Meeting date: November 8, 2006 @ 3:00 PM
WPI Attendees: Marcus Lewis, Will Brooks, and Lou Grillon
EPA Attendees: None
Company Rep: Advanced Fuel Research – Marek Wojtowicz
****

Team assignments: Note taking: Will Brooks and Lou Grillon
Introducing the team: Will Brooks
Running the Interview: Marcus Lewis
Writing the summary: Marcus Lewis
Reviewing the summary: EPA Team

Where: EPA – Woodies Building, Washington, DC
How: The interview will be conducted according to the following outline.

1. Since Will is the one who booked the interview with Marek, he introduced the team and handed the interview over to Marcus.
2. Marcus began to introduce the project explain we are an EPA intern working on a special project.
    a. Mention we may be recording them, Marek said it was ok to record them, so we begin recording.
    b. Talked briefly about project, who we are, said thanks.
    c. Sent ahead of time, a handout briefly explaining the technology continuum. Marek did have a chance to look at them. We said we understand that and are aware not all of the questions are applicable.
3. Type of interview-Key Informant
    d. This interview will consist of
        i. us asking you questions about the technology you are developing
        ii. you telling us of ideas we should research and look into
        iii. should only take about 30-40 min
    e. We will use this information to better prepare for the project
4. Ice breaker questions
    f. Tell us about your technology
        iv. We are focusing on the progression of the technology, not the actual science behind it.
        v. rephrase what interviewee says
5. Cued questions about project
    g. probe for clarity and specific information
6. Summary of interview

Marek was one the phone for the first half hour with another company. He called us back at 3:25 PM, apologized and we began the interview. Marcus began saying that we are

interns at the EPA working on a project (explained project) and as a disclaimer said that none if the information given in the interview will help or hinder them in the SBIR process of receiving funding. Marek asked about the scope of the discussion. Marcus said that we are more interested in the progression of the technology, not so much the technology itself, but a brief synopsis will be good for more discussion. Marek went on saying that there are two different technologies they are pushing towards the market. One is making carbon black from tire oils and the other one is using solid to make activated carbons for the removal of mercury. Neither one of these technologies are commercial technologies. Very few technologies are commercialized. One went through pilot scale testing.

Brief tech synopsis: Waste tires environmental liability is a resource. AFR converts the waste tires onto valuable carbon product through pyrolysis, which is the thermal degradation of rubber to create oils and tars. In the case of AFR, a pyrolysis process was developed for conversion of used tires into activated carbon, carbon black, and fuel gases. Use gas for fuel for paralysis process. The oil can be used as a profitable product since gas prices are high. Another project they have done looks at the liquid oil and convert it into carbon black, which is 30% of the tire material. The other project is about solid tar which has a lot of sulfur in it. It is possible to make activated carbon but limited by high sulfur content. Also have significant inorganic components.

Process of commercialization: Carbon black technology was simpler to do. AFR conducted an economic analysis, and found that it was not economically viable. On the other had, the oil technology is more promising. Making oil from the tires is more valuable, sell for $1/gallon vs. the current gas prices. If the gas prices change, then the dynamics change. AFR would then reprocess the oil into high value carbon black. This technology was demonstrated in pilot scale and was still proven to be viable. Risk assessments have to be made on it,

Commercialization Entity: Carbon tar is much more attractive commercially. AFR got a phone call from a utility company in Michigan. As far as regulations goes, AFR is facing federal and state elections, and depending on whom gets elected governor will determine demand for the technology. The utility company in Michigan is big in the United States and looking at the tar to meet the regulations that may be passed. AFR is unable to go to pilot scale testing with this level of funding that the EPA provides. It is the most under funded agency as far as SBIR is concerned. Phase II funding is $250K which is little compared to $750K. Quite challenging to spread the funds evenly and through out time. The carbon black technology took from 1999 to 2005 to develop; it was intended to take only 2 years. As a Contract R &D company, trying to commercialize technologies is time consuming and challenging, so they would rather stick to what they are good at: making technologies. Marek believes they are more efficient this way.

Option Task: This option provided an additional $70K. But because the rule was change, now AFR has to prove that they have received cash donations from sponsors of the project, instead of the no longer continued rule of simply having to prove that the developing technology project has received in-kind donations. Marek believes that a cash advance means that a company is serious about sponsoring the project, and commercial interest is not strong enough for people to put money up. Marek thinks that the rule changed because it is easier that way for small businesses to take advantage of

the program, so to make it more serious, the rule was changed. AFR currently has no funding and is unable to get the option funding, mainly because the rule was changed, and it is difficult to get a straight cash donation, especially since they are not able to do pilot scale testing to give the technology more credibility. Marek believes that for option task funding to be granted should be handled on a case by case basis.

AFR does not have a sales department. But what AFR does is create spin-off marketing companies that market only commercially viable technologies. Granted, they do lose some employees to their spin-off companies, it is worth the loss. AFR currently has 2 spin off companies and is in the process of creating a third. An economist was hired to perform an in house economic analysis. When it comes to a marketing strategy, people know who AFR is due to their reputation. They are aware that the technology exists, and potential customers call AFR a lot. EPA did a terrific job in the assistance of advertising their technologies, via the EPA website. A majority of AFR's leads comes from the site. The EPA has outperformed the other government agencies in getting people to call them. A business development person is hired as needed, but often times the advertising is word of mouth from the President, and from Marek himself.

What the EPA can do to help: Marek says that so far the EPA has funded Foresight, and their assistance was wonderful. Most of the Foresight interactions pleased AFR. Provisions for options task funding of 70K was helpful thanks to Jim Gallup's personal leadership and dedication to the project. As far as what can be done better is to go back to making in-kind donations a requirement to get the 70K instead of cash from the industry. People are not serious about commercialization, cash=serious. In AFR's case, the change "seriously hampered development" as Marek says. The lack of Phase II support is also a problem. How might the EPA be able to increase seriousness w/o changing the rules? Companies can inflate the cost of contributors and that way cheat the EPA system. Marek says to make a clear definition of deliverables (e.g. pilot scale testing data), and to consider each of them on a case by case basis, and to negotiate. People are interested, just not enough to lay down the money! The length of the funding is also an issue. AFR is looking into 75% of funding from the government and 25% from commercial sources, foreign governments and other agencies. If the technology looks promising for commercialization, they license the technology or create a spin off company to market the technology. Marketing is something scientists do not want to do, and making a technology is what they are good at. He believes in letting people do what they are good at!

One of the spin offs was Online Tech, created in 1991 with about 40 people employed. In 2001, MKS Tech acquired Online Tech for 20 million+. Even thought they lost people when the spin off company was made, they needed it for the critical mass to stay alive as an R&D company. AFR has not heard of the ETV program when asked about it. It is possible that the ETV program would have helped give their technology more credibility to provide more funding from sponsors. Marek wishes us good luck and we will provide him with these meeting minutes.

Appendix H – Aerodyne Research Inc. Summary

Environmental Protection Agency
Meeting Summary

Meeting date: November 6, 2006
WPI Attendees: Marcus Lewis, Will Brooks, and Lou Grillon
EPA Attendees: None
Company Rep: Aerodyne Research Inc. – Joanne Shorter
****

The meeting was called to order at 10:30 a.m.
Team assignments: Note taking: Will Brooks and Lou Grillon
Introducing the team: Will Brooks
Running the Interview: Marcus Lewis
Writing the summary: Will Brooks
Reviewing the summary: EPA Team
Where: EPA – Woodies Building, Washington, DC
How: The interview will be conducted according to the following outline.

1. Since Will is the one who booked the interview with Ms. Shorter, he introduced the team and handed the interview over to Marcus.
2. Marcus began to introduce the project explaining that we are EPA interns working on a special project.
    a. Mention we may be recording them, Ms. Shorter said it was ok to record them, so we begin recording.
    b. Talked briefly about project, who we are, said thanks.
    c. Sent ahead of time, a handout briefly explaining the technology continuum. Commented that technology was only Phase I. We said we understand that and are aware not all of the questions are applicable.

Summary of interview:

The company is currently between funding from the SBIR program, just completed Phase I, and waiting on acceptance to Phase II program. In this funding downtime, there is no progress being made on the technology, because the company does not have the resources to keep developing it. Other sources of funding might include a group from Japan, though they are more interested in purchasing a final product than in developing the technology. Their current monitoring means are older; they would be interested in a real-time system for monitoring.

The current commercialization plan is to look for companies who are interested in using the system. A potential source here is in the automobile testing field, specifically the California Air Resource Board (CARB). Marketing is by word of mouth, based on the company's reputation. They also introduce their technology at scientific meetings.

Interaction with Foresight identified some potential markets for their product as the automobile industry, and possibly some industrial sources. This interaction was

helpful; they assisted in setting up some conference calls, though there was a lack of support on the communication follow-up. Found Foresight to be generally helpful.

The project timeline was unique for this technology, because it was primarily based on a previously developed technology from 5 years before that could generally be tweaked to this new application. An initial thought of a potential application was in the monitoring of jet engine exhaust.

The solicitation by EPA called out specifically for an Acrolein monitor, which made the company think back to their initial encounter with Acrolein when monitoring the exhaust from jet engines. Most Phase I problems came when trying to improve the detection standards and reduce the background interference. Acrolein is not a strong absorber of IR, therefore difficult to measure with this method, especially in the quantities required by the solicitation. Beyond that technical hurdle, there was nothing else worth mentioning.

Aerodyne has identified some potential applications for their technology, mostly within the environmental monitoring field. Their products are potentially useful to anyone who needs to monitor air quality.

Preparation for Phase II funding means successfully completing Phase I. To Aerodyne, this means having a strong technical basis to expand upon with more funding, and some initial consideration of market applications. Also, the ability to provide a small demonstration/comparison to current techniques for monitoring the same thing is of great benefit, and will hopefully shift focus toward their technology for acceptance into Phase II.

In Phase II, build a working prototype and demonstrate it for potential companies and for EPA. For the Phase I demonstration, JAMA (Japanese Automobile Manufacturing Association) brought their current technology for monitoring to Aerodyne and paid for the test.

Suggestions for EPA are to minimize the time gap between Phase I completion and Phase II disbursement. Would be helpful if there were some financial options for keeping the project moderately active between Phases of funding, so Phase II work doesn't have to begin completely cold after waiting a year. If the process could be improved so that there was only 6 months of down time, this would be extremely helpful.

There are no current plans to patent this particular product. Aerodyne already holds patents on key elements of the design, so their basic idea is safe, and it would be wasteful to apply for another patent that is already secure through other patents. They also have a copyright on the software they use to analyze the information. Aerodyne also applied for a patent on the sampling technique. There has been no discussion about patenting the actual instrument. There is doubt that there is enough of a competitive market for a patent to be worth the cost.

Other technologies that are currently being worked on are other IR laser monitors for nitrous oxide and methane. 2-3 of these are sold per year. Also, an aerosol mass spectrometer sells about 10 units a year, mostly to research institutions. The instruments are all manufactured by Aerodyne, though some parts are outsourced because of their specialized nature.

The main problem for the company is its small/ non-existent marketing division. Foresight was of actual, if limited assistance to this company because of a lack of dedicated marketing employees. Aerodyne needs business/ marketing people to help

make the follow-ups smoother. Thought Foresight has a limited budget to help each company, they set up some contacts, but don't actually market the technology. The leads provided by the company are questionable, some have worked out; others have not. A technology niche study is all Foresight is paid to do, find some information, outline a specific potential market, and set up some contacts. This assistance happens early on in Phase I, when there is not much by way of actual results to show companies who might be looking for specifics. Some other government agencies use Foresight during Phase II, might be more helpful there.

Appendix I – Center for Environmental Industry and Technology Summary

Environmental Protection Agency
Meeting Summary

Meeting date: November 7, 2006
WPI Attendees: Will Brooks, Lou Grillon, and Marcus Lewis
EPA Attendees: from CEIT- Maggie Theroux, from NCER- April Richards
****

The meeting was called to order at 2:00 p.m. and ended at 3:00p.m.
Team assignments: Note taking: Will Brooks and Lou Grillon
Introducing the team: April Richards
Running the Meeting: April Richards
Writing the summary: Lou Grillon
Reviewing the summary: EPA Team
Where: EPA – Woodies Building, Washington, DC

The conference call, or informal interview, began with April introducing the WPI team. A short elevator pitch was then given by Lou on the project.
The following is an account of the meeting.

- Maggie Theroux has worked with the New England's Center for Environmental Industry and Technology (CEIT) for seven and a half years
- Office of enforcement and assistance, pollution prevention and assistance is where Maggie Theroux works.
- CEIT was created 13-14 years ago, its job is to serve the environmental technology industry and promote acceptance of environmental technologies. The focus is on companies located in the New England region, but CEIT also does some national work. CEIT works on the utilization and diffusion stages of the technology continuum mostly.
- There are ten regions that EPA is broken down into. CEIT is in region one, New England, including RI, MA, CT, RI, VT, NH, and ME.
- The regions are the frontline of the EPA. They deal with environmental regulations. They enforce environmental regulations and work with the states within their region by delegate regulation enforcement to the states. The regions also deal with regulations by giving out permits.
- Permitting of air, drinking water, and waste water, is dealt with by ecosystem protection.
- Inspectors go out and inspect sites. If environmental regulations broken then they will take action depending on the severity.
- Work with the department of environmental protection within Massachusetts
- CEIT works with environmental technology developers to get technology into market place.

- Problem is that there is not a lot of coordination between programs such as SBIR, ETV, and CRADAs (Cooperative Research and Development Agreements).
- There are not good handoffs between programs.
- **Need coordination/oversight from headquarters to make sure coordination happens.**
- Other agencies do a better job than EPA about having companies work with labs, coordinating.
- Demonstration money is hardly there. SBIR Phase II just ends. (Prove by interview with AFR on 11-7-06)
- Where is the money to demonstrate?
- **EnvirotechNews** was a low budget monthly news letter which listed programs and funding opportunities to environmental technologies. This allows developers to see what is out there and not waste time trying to just find what is out there.
    - Can be found here http://www.epa.gov/etop/envirotechnews/ as of Nov. 7, 2006 the most updated issue was September 2006.
- EPA doesn't have as much funding as other agencies.
- It is hard to move technology along the continuum with ORD concentrating on the left side of the continuum with more R&D focus.
- **Technology Connection** was another publication for companies looking for a certain environmental technology to be matched with a company that was developing, or developed a technology. No longer up and running.
- This could be used if a company had an environmental regulation violation. Company sends out request for technology and a technology that solves that problem is matched. This way the company with the violation(s) is able to do a Supplementary Environmental Project (SEP) which goes beyond the regulation so they don't get in as much trouble.
- CEIT can be the link between companies that want/ need a technology and the companies that have/ are developing that technology.
- Example of how regulations affect technology development.
    - Photo processing company in EPA regulation violation
    - Pre-existing technology of Texas Instruments (TI) could be tweaked to solve the problem.
    - TI found a developer for their technology and set aside money.
    - State government changed mind and did not want to have just a SEP. They wanted an Environmental Management System (EMS) done.
    - So technology was not needed anymore.
- Things can back fire, takes a lot of dedication and work.
- **EPA mind set is not to use technology to solve problems.**
    - **Change this mindset.**
- All regions need to look at the issues… more stringent and swift work required.
- Another example of regulation impact on technology development.
- Company developing an alternative to chlorine for pool disinfection.
    - Silver ionization technology
    - Technology verified by National Sanitation Foundation (NSF) a partner of ETV

    - Pool suppliers were storing too much chlorine and selling diluted concentration.
    - Put out an announcement through EnvirotechNews.
    - Toxic Substances Control ACT (TSCA) regulates silver.
    - That was a regulatory barrier that wasn't even known.
    - **Realization EPA should create a searchable database of all regulations that apply to a certain technology.**
- Lead Paint action team made up of lots of government agencies. Trying to apply technology to reduce lead paint.
- Take enforcement against landlords.
- XRF x-ray technology measures lead paint or lead dust –developed by Niton which was funded through EPA SBIR. Niton bought by Thermo.
- Very successful on market
    - Regulation exists that says you must take lead dust sample and send it away to a lab.
    - This means that this technology that could be used at a reduced cost could not be used.
    - Finally after a few years new regulation allowing mobile testing of lead dust is being passed. Renovation and Remodeling (RR) rule.
    - Released for comments this January.
- Phoenix Science and Technology
    - If paint/house was before 1978 then contractor has to test for lead paint.
    - Phoenix has dust free technology to remove lead paint.
    - Technology vaporizes lead paint and then filters vapor.
    - Technology has to be verified.
    - Make sure all vapor is contained and no lead paint vapor escapes.
    - Convened all MA people that need to pass technology.
    - Need to look at Occupational Safety & Health Administration (OSHA) regulations.
    - Phoenix received grant from U.S. Department of Housing and Urban Development (HUD) to pilot test Surface Discharge (SD) Lamps Systems in Lowell MA.
        - Create mobile unit, i.e. van, to test technology in.
    - Lots of regulations.
    - Abatement technology.
    - Niton XRF device cost $20K.
    - Test kits for lead paint need to be better.
        - EPA SBIR funded research for two different tests kits, one for dust, one for paint.
- **Quarterly check-ins from regional offices with SBIR companies would be very helpful, i.e. conference calls.**
- **Developers need to have conversations with people on the front line, regional offices.**
    - **Real word input from users.**
- For SBIR companies
    - **Have to hold their hand/ stay in contact with them.**

- Can’t leave them after Phase II is finished.
- **Make connections for people.**
  - Venture capitalists, demonstration funding.

Appendix J – Design for the Environment Summary

Environmental Protection Agency
Meeting Minutes

Meeting date:	November 30, 2006 @ 9:30 AM
WPI Attendees:	Marcus Lewis, Will Brooks, and Lou Grillon
EPA Attendees:	April Richards, Diana Bauer, Kathleen Vokes, David DiFiore, Kathy Hart, Melanie Vrabel, Elizabeth Sommer, Clive Davies
Location:	DfE Conference Room, EPA East

This meeting was not an interview for our project. This was simply an informational session to learn about Design for the Environment (DfE), and to let them know a few of the projects that the SBIR program has been working on that relate to similar projects DfE is running.

DfE explained that they are constantly looking at existing chemicals and compounds that are known to be hazardous, and trying to create partnerships in the industrial world to develop other compounds that are less hazardous to the environment. Some examples of their area of effect are in the areas of chemical manufacturing, fire retardant foam, and unleaded solder for circuit boards. DfE concentrates on providing information to these industries to help them make the most environmentally friendly choice of a product to use in the manufacture of their end product. DfE also provides certification for the manufacturers of a more environmentally friendly product that DfE has identified as an acceptable replacement for a more hazardous version of the product. This certification helps because it is providing an endorsement from DfE for the product.

Then we explained what our project was about and what we were planning to do to complete our project. We noticed that DfE would like to be more involved in the process of choosing which projects receive funding through the SBIR program, so they could possibly help their partners develop more non-toxic chemicals. They have been previously involved in the solicitation writing process, so their requests for particular technologies have been heard in the past.

Appendix K – DOD SBIR Program Director Summary

Environmental Protection Agency
Meeting Minutes

Meeting date: November 30, 2006 @ 9:30 AM
WPI Attendees: Marcus Lewis, Will Brooks, and Lou Grillon
EPA Attendees: April Richards
Interviewee: DOD SBIR Program Director – Mike Caccuitto
****

Summary of Interview:

April introduced us, and Lou gave an elevator pitch about our project. April asked for a brief run down of what DOD does to promote commercialization. Mr. Caccuitto mentioned that there was some current literature on DOD in the form of a RAND study highlighting some improvements that could be made to the program. Mr. Caccuitto offered to April the link. DOD commissioned the RAND study because a House conference report asked DOD to summarize how they plan for Phase III. The RAND study examined the program in a broad context, with an emphasis on commercialization goal of the program. The study made good recommendations that were practical in focus. The RAND report had a faster turnaround then academy reports, which take about four times longer to complete.

DOD's focus for commercialization is on three main points. First is an attempt to maximize the effectiveness of the program. Effectiveness here means a higher probability of transition commercialization combined with a more qualitative measure of assessing whether the final product will bring financial gain. Second, DOD makes sure the topics they fund are well crafted at the outset to produce output from Phase II that has the best chance of meeting DOD requirements and being successful. Third is a demonstration of significant commercialization potential. Significant commercialization potential means having dual potential. This means that the technology will be applicable to something outside DOD in addition to meeting all of DOD's requirements. Unfortunately, subjective judgment by the reviewers is the only available means to determine this. There is no good way to tell with any certainty what the commercialization potential of a technology is. The topic writers and reviewers are the ones who get to decide if the potential exists.

When DOD issues a solicitation, they generally receive 15-20 proposals per topic. The three review criteria for each proposal are of its technical merit, demonstrated capability of the developing team to commercialize, and the commercialization potential of the proposal. The demonstrated capability typically looks at the company's previous track record of commercialization, but also at the different personnel strengths of people working on the project.

When working with Phase II projects, DOD issues each company that has developed four or more Phase II technologies a Commercialization Achievement Index (CAI). This index compares each company to its peers, and ranks them based on commercialization successes. They cannot assign this index to companies with fewer

than four Phase II projects because the results are not statistically significant. This index is used in source selection and deciding what projects to award Phase II to. The lowest 15% of CAI values are penalized in the commercialization potential of proposal review. This is because the CAI makes note of how many commercial successes a company has had, and how many projects they have had funded. Receiving lots of awards without producing anything is therefore penalized with this system. DOD is raising the percentage of penalized companies slowly. The RAND report wanted big jump to 35 or 40%, and to ban companies under that mark from receiving awards. Companies have to supply their own commercialization data for this index. RAND feels that most companies are inflating their results, which prompted their recommendation for a higher percentage of companies to be penalized.

DOD has been collecting self reported commercialization data since 2000. Every company applying for an award in Phase II is required to submit their previous commercialization record. DOD collects sales and investment data on all Phase II applicants. This data is part of the new proposal application, not a contractual part of the Phase II agreement. DOD is looking to build it into their contracts so they can get the most information possible. DOD is also looking for other ways to capture that data. Companies sometimes misrepresent themselves, but most companies don't want to provide a bad image. This information capture program is currently catching a large amount of Phase II awards that are non DOD. 38% of awards captured are currently non-DOD. April would like the information about EPA companies that has been collected.

Pre-award selection commercialization emphasis is found in the form of a requirement. The requirement says that at least 50% of topics from Army, Navy and Air Force have support from the acquisitions community, who deal with the purchase and development of weapons systems. This ensures that DOD maintains a focus on technology investments that have a likely path to market. It could be considered an endorsement from a future customer. Surprisingly, this endorsement does not work as well as DOD would like. The commercialization rate for acquisitions community for Navy and Air Force is the same as for non-endorsed companies. The Army's endorsement works such that the commercialization rate for technologies is higher than it would be if the technology were not endorsed. DOD wants to attach parameters to endorsement to give it some with teeth. This way, the endorsement will not just be from someone on the ground who thinks it's a good idea; it will be supported by someone higher up in the organization. The endorsement simply means that the DOD could purchase it, if everything keeps moving in the direction it seems to be headed now.

Once companies have received an award, the NAVY has a transition assistance program, called Dawn Breaker. This assistance program is also used by DOE as a supplement to their SBIR program. They take Phase II awardees, and put them through a 10 month program to develop marketing and commercialization plans, elevator pitch etc. This culminates in a business opportunity late in year. Dawn Breaker brings together potential customers for their technologies, and lets them network with their potential business partners. DOD also provides a venue for networking between end users and technology developers in the form of a conference that Phase II awardees from the past three years are invited to, to try to make effective connections.

Other parts of DOD also have assistance programs. DARPA works with the Virginia Center for Innovative Technology to provide contract writing assistance. The

Missile Defense Administration (MDA) works with NTTC to provide “murder boards” where companies come present their ideas to a panel of experts who grill them. DOD recently received approval from Congress to put 1% of their budget toward developing an overall commercialization program for Phase III and commercialization support.

Appendix L – EPA SBIR Program Deputy Director Summary

Environmental Protection Agency

Meeting Minutes

Meeting date: November 28, 2006 @ 10:00 PM
WPI Attendees: Marcus Lewis, Will Brooks, and Lou Grillon
EPA Attendees: April Richards – Deputy Director of EPA's SBIR program
****

Team assignments: Note taking: EPA Team
Writing the summary: Will Brooks
Reviewing the summary: EPA Team

Where: Lounge, Woodies Building, EPA

Summary of Conversation:

SBIR Process:

After going through the external review, the proposals must pass a relevancy review where EPA decides if the projects are relevant to what they were asking for in their solicitation. EPA also prioritizes the projects according to importance to the agency if there are more than can be funded that are relevant. Then they are entered into a database and EPA finds someone within EPA (usually a program office and a lab) that would be willing to review the proposal for technical merit and applicability to the agency. These usually take a month to review, though it is different for Phase I because there are so many proposals. They then meet with the reviewers to decide if the projects still qualify to receive funding. Once those proposals have been selected, the Director and Deputy Director of the SBIR program (Jim Gallup and April Richards) meet with the director of EERD (Steve Lingle) and the center director of NCER (Gary Foley) to receive final approval on funding. This process of meeting with the directors takes a few weeks. Then the proposals are sent to Marsha Johnson in the contracts office in Research Triangle Park, North Carolina. She sets up contracts with all the companies, makes sure that all the companies have been recommended or denied for good reasons. It takes approximately two months for contracts to receive the proposals and get the signed contracts back. The company then receives their first allotment of funding after their first month of work on the technology, and their first monthly submittal of a bill and progress report. Phase I disbursements are fixed for each of the six months. Phase II is more like real life, in that the companies actually bill EPA for the work they have done.

Phase II solicitations open as soon as Phase I ends, and are open for approximately three months. Once Phase II proposals are received, they are sent to contracts to make sure the basic requirements of the proposal are there. This takes about a month. Then they are sent to the peer review division. (See Appendix W for Barbara Levinson interview summary) To help speed up the peer review panel choice, April or Jim could communicate with peer review to say what companies appear most likely to apply for Phase II based on the monthly progress reports.

During Phase I there is a two day networking workshop that is not required for companies to attend. At this workshop, there are presentations by Foresight and EPA about what they expect/hope the companies to be able to do. EPA could look into doing something similar to DOE's opportunity forum through Dawn Breaker in Phase II, which allows companies and end users the opportunity to network. Maybe EPA could piggyback on that event, because there is not enough funding to run one solely for EPA companies.

Debrief:

EPA could piggyback on DOE opportunity forum. (have in past, what happened?)

Shorten the solicitation periods.

Communicate with PRD to set up panels more quickly.

Appendix M – EPA SBIR Program Director Summary

Environmental Protection Agency
Meeting Minutes

Meeting date: November 28, 2006 @ 10:00 PM
WPI Attendees: Marcus Lewis, Will Brooks, and Lou Grillon
EPA Attendees: Jim Gallup – Director of EPA's SBIR program
****

Team assignments: Note taking: EPA Team
Writing the summary: Will Brooks
Reviewing the summary: EPA Team

Where: Jim Gallup's office, Woodies Building, Washington, DC

Summary of Conversation:

An SBIR option funding requirement for eligibility was changed to no longer allow in-kind contributions. This change was not applied to the verification option funding available through the program. This change only affected companies who were applying for an additional $70,000 of funding. Mr. Gallup mentioned that the program initially wanted the companies to get the money, but when EPA stopped being able to accurately verify that the funds were actually provided to the company applying for funding, they decided to do something about it. There were doubts that the companies were being truthful in their claims to have obtained the required $100,000 in outside funding to be eligible for EPA's $70,000 commercialization option. Some of the things they would do would be to associate the cost of attending a conference toward that $100,000, or change someone who was working on the project to a higher wage then they should have had, and then fail to prove that the employee had done anything helpful for the technology. The objective of changing this requirement was to tighten things up so that EPA could more easily verify the accuracy of a company's claims to have obtained the required support. NSF's SBIR program has option funding, but has never allowed in kind contributions because they foresaw the types of problems that have been described by Mr. Gallup. One example of slightly questionable funding allocation was a company that was "purchasing" a prototype from another company. Since the funding was described in such a way that the purchase would be to further development, it was allowed.

The SBIR review process is a lengthy one. The Peer Review Division (PRD) requires approximately four months to fully evaluate all of the proposals. Three of the four are needed for preparation for the review. Some of the preparations include choosing panel members, and sending out the information about each proposal. Then meetings need to be scheduled. Because of the number of proposals in Phase I, approximately one month is required to actually evaluate all the proposals. After the external review comes the internal review. The program labs that do the evaluating require around one month. After this, write ups for each proposal are done, relevancy

reviews are conducted, as well as procurement requests. This takes two to three months. Then the contract writers get to begin work crafting the contracts between EPA and the company. They must check that this award will not be a duplicate to another agency already funding the same topic. They must also double check the company's eligibility for the program before they write the contract. This also takes between two to three months. Mr. Gallup thinks that NSF's program is maybe a month faster, and also includes an external review of the proposals. The SBIR programs that have very fast turn around times do not conduct this external review. EPA started doing this external review process around the beginning of the STAR program. Congress was concerned that there could be some favoritism toward particular proposals. Now EPA only funds projects that receive Very Good or Excellent marks in both the external and internal review.

EPA could probably do more internal communication about what technologies are coming up for funding. There should be someone in the organization that wants the technology to be commercialized since the technologies being funded have been suggested by different areas of EPA. Those people who want the technology to serve a particular purpose in their area might be more driven to help push the technology to commercialization. EPA funding is much more suited to developing an environmental application of an existing technology than to creating an entirely new product. EPA would like to see companies accelerate the development of their technology through Phase I and II, so that at the end of Phase II, they have a working prototype to show to potential customers. Mr. Gallup does not feel that it is SBIR's place to connect the companies. He also commented that SBIR is only a small piece of the puzzle that a company needs to have in place to create a successful product. A company cannot survive entirely on SBIR awards. SBIR is a tool, not an end result.

A month after being awarded Phase I, there is a meeting with EPA and representatives from the companies to explain what EPA would like to see occur during the development and commercialization of these technologies. EPA wants to get the technology to the marketplace, so they try to make the companies think about how to be better business people during the SBIR program. Foresight could provide more assistance locating appropriate conferences to network at, and perhaps more direction about how to proceed through the process of commercialization.

Appendix N – Environmental Technology Verification Summary

Environmental Protection Agency
Meeting Summary

Meeting date: November 9, 2006
WPI Attendees: Marcus Lewis, Will Brooks, and Lou Grillon
EPA Attendees: April Richards - NCER, Abby Waits - ETV
****

The meeting was called to order at 2:00 p.m.
Summary of interview with Abby Waits of ETV:

(Abby provided a small slideshow overview of ETV for us to follow during the interview.) She mentioned that the program is voluntary, and that ETV simply functions as an independent source of credible test data about products. They then make that data available to end users of technology, people who purchase it or regulate it. This helps companies to market their technology. ETV tests the performance of the technology against the company's claims, nothing else. This program only applies to commercial ready technologies, because ETV wants to make sure that if a sale results from the test data that the technology is ready to ship.

Approximately 50 companies have been back after their first verification with ETV to verify another technology or re-verify an improved technology. The criteria for being commercial ready vary from center to center, however the common thread that the product must be able to ship ties them together. ETV has stakeholders that work with the program to assist in the verification of technologies that they feel are useful. These stakeholders also ID priority technology categories for verification. These categories are where people from the market want more performance information about a technology or field in general. Another aspect of ETV is that sometimes ETV goes out and finds the technology to be verified. Other times, the company with a technology comes to ETV asking for verification.

ETV looks for vendors and collaborators for the technology looking to be verified. Then they work with the stakeholders and technical panels to develop testing protocols for each technology. They have to ensure that the testing will substantiate the claims of the technology, not test the technology for something it is not designed to do. Once the testing is complete, ETV issues their Verification Report to the stakeholders and other end users. This information simply evaluates the product based on their claims; it does not support one product over another.

ETV outreach works toward the stakeholders and the organizations they represent. Each center has their own outreach that involves going to more local conferences and publishing in journals. The program publishes information, attends conferences, and hosts workshops at the regional level to advertise for the services offered. Some of ETV's successes have been the products that have been verified that range over a wide variety of technology types. They have also established approximately 80 general testing protocols that companies can use to independently verify their

technology. Verification is funded by the technology developers and any interested collaborators who want the data from the test. ETV currently has 500+ stakeholders representing 19 different areas of research.

ETV has a very active website by EPA standards, with approximately three million hits. Though, currently ETV funding has decreased, limiting the number of technologies that can be verified in a year. Because verification costs anywhere from $5k up to $150k, some test centers will not agree to verify a technology without two or three collaborators who will pay for the entire test. Testing of a monitoring technology can take anywhere from two days to a week. Waste water treatment verification can take six months to a year.

Abby mentioned the Niton Company as one that had gone through SBIR and ETV and had used the verification option of funding from Phase II. She also mentioned that she works specifically on outreach of the program. The web is great for ETV; there has been an almost exponential growth of interested parties. ETV tries to follow up after their program ends to see if they were successful. They have tried to conduct surveys, but did not get the types of information wanted. Vendors were particularly reluctant to share information about the sales of their products. ETV now attempts to follow up on a case by case basis, and has some case studies of companies written up on their website. Another problem ETV has encountered when trying to follow up, besides vendors reluctance to share information, is the issue of contacting all the potential end users of a product to see if the product is/was useful to them. Ideally there would be surveys done of the vendors, purchasers, and the people who permit the technology. However, EPA has some strict rules about the questions that can be asked during a survey.

One of the reasons a company would want to get their technology verified is that it is easier to approach a potential buyer and say that there is data supporting the companies claim than to go in there and sell your idea by the sheer force of it, without anything to substantiate it. Another reason is that small businesses need a leg up so they can compete with the much larger companies that might be working in their field.

An interesting point Abby made is that ETV testing protocols are becoming a part of regulations as they are being developed. Some regulations are starting to say that testing must be done through ETV, or by using a testing protocol on par with those developed by ETV.

The number of technologies being verified by ETV has been decreasing over the past few years, though this is not because of a lack of companies asking for verification, but a matter of funding for the ETV program. There is approximately two years lag between funding being decreased and the number of verifications being produced by ETV. ETV would like to do approximately 25 verifications a year, a number they are comfortable with. The actual verification process can be as short as six months, from initial acceptance to final report. However, it can also last from two to three years. Abby mentioned that the average length of time to verify a technology is approximately one year.

Appendix O – Foresight Science and Technology Summary

Environmental Protection Agency
Meeting Summary

Meeting date: November 1, 2006
WPI Attendees: Marcus Lewis, Will Brooks, and Lou Grillon
EPA Attendees: April Richards
Foresight Attendees: David Speser, Chairman
****

The meeting was called to order at 11:15 p.m.
We began the meeting with an introduction of our project and some information about what we hoped to produce through the project.

Mr. Speser began by introducing his company, Foresight Science and Technology. He explained that they are a global multidisciplinary company with 850 new projects this year. His company is one that is used as a resource to help a company take an idea from its initial disclosure and commercialize it. He explained that his company takes technology in or out, and that they try to find multiple outlets for the technology that a company has only initially considered in one application. One of the problems with developing a technology these days is that the technology is obsolete in 5 years because technology is evolving so fast. He highlighted a problem with the SBIR program in the length of time it takes to produce results. If you assume 3 years to navigate the SBIR program to a marketable product, that only leaves 2 years to market the technology and regain your investment.

His company can also look for licensing options for technologies that have been developed outside of the core technologies for a company. He mentioned that in his book there is a roadmap to successful commercialization (market) that shows how to take an idea from disclosure all the way to sales. He cautioned that technology can be released too early, if the product being developed is too advanced for the available technology. He also mentioned that sometimes it is necessary to sell licenses for an idea off to a larger company instead of going into direct competition with a larger company and being driven to bankruptcy. His company looks at how best to support a company's technology through development, market, and manufacture. Support for demonstration involves finding beta testing sites and talking to potential end users. There are similar products to virtually every technology being developed these days, those that have no peers are called disruptive technologies that can completely upset people's daily lives. Some examples of this are the computer and IPod. Free beta testing can come from a company that is interested in getting the technology commercialized so they can use it. Potential end users can include companies that are currently using a similar technology, because they might be interested in switching to this new product if it cheaper than their existing product.

Patents are another aspect of this process. Ideas need to be protected, and the best way to do that is through a patent. However, if the technology is already obsolete, or a

company can easily engineer around a patent, then there is not much reason to spend the amount of money needed to keep a patent active. Niche markets also don't usually need patents, because it is less likely that there will be some direct competition in this venue. Sometimes a technology is not worth pursuing further, either because there is already a larger company that would be in direct competition of the technology, there is no financial incentive for the company to switch to a different technology, or there is a federal regulation that is about to change to a more stringent level, and the technology cannot adapt to that new standard.

EPA and Foresight

Phase I

Foresight goes to the company with a setup form to determine who the best person to talk to is, and if there are any people that the company does not want Foresight to talk to. This form also highlights the currently envisioned application for the technology, which then allows Foresight to branch from there to see what other potential applications could fit the technology. Then they look at the technology and try to find an active market for it, obstacles to the market (large companies, previous patents, etc), and a potential partner to assist in the product development. This process deals with the 4 P's; Product, Price, Place, and Promotion. Foresight also does a SWOT analysis of the company and technology to determine their Strengths, Weaknesses, Opportunities, and Threats. An important thing to remember is that nothing happens without a sale. Once that information has been determined, Foresight creates a value statement to determine what the product actually is, and how it can be sold to a prospective partner or end user. They also create a risk analysis for outside companies or sources of funding to use when looking at whether or not to assist the technology. The next step is telling the companies where they should be promoting their technology by being members of a particular organization, or some free publications, to create some pull through momentum. This will assist in commercialization, if the public hears about a technology that could be coming and wants it, more people would be likely to assist the development, because they would be more assured of a return on their investment.

Foresight also looks for potential target companies to work with the initial company in Phase II and III as partners. Then they work with those target companies to find the best contact person in the organization, hopefully someone who has the technical background to understand the technology, and some decision making power. They also determine the level of technology readiness the potential partner would be interested in seeing before actually partnering with a company. Another factor to consider is the amount of time potentially needed for the target company to decide whether or not the technology is worth pursuing and jump on board. Once this information has been determined, a report is sent to the initial company that has received an award. Also, usually included is a letter of commitment from the target company, saying to what extent they will help to develop the technology.

One area of disappointment from Foresight's perspective is a hesitancy to follow up on the leads produced through Foresight's market preparation work. Foresight appears to do most of the market research legwork for the company, and the company simply has to follow up with the leads produced to advance farther down the commercialization path.

Phase II

For Phase II companies, Foresight does all that was mentioned above, and may also try to put a final deal together for the company. To do that, they create a term sheet that outlines the data about the initial company and the information provided by the target partner company as to what they expect, how risky they feel the venture to be, and how much help the initial company can expect from the target. There also needs to be an understanding of how the technology may change when attempting to scale things up for mass production.

Mr. Speser's final comments for the SBIR program were that the companies need to be less afraid to follow up on the information provided by his company. Companies also need to focus more on the market side of things than simply getting the technology to work, which could explain the reluctance to follow up on the commercialization contacts. A company also needs some credibility in order to get anywhere when trying to commercialize a technology that needs external support. He also suggested looking at a survey of companies done by Foresight and NSF over a three year period to determine the success ratio of his company. A way a company can be successful is if they are developing a technology that they can turn around and use. He suggested that more small business people talk to end users in broad terms about the end result, (If I can do this… for less than you're paying right now… would you be interested?). Another comment was to specifically ask companies if they have been following up on the leads provided, and if so, how soon after the final report did they contact the companies. If they did not, why did they choose not to talk to them? Also suggested was to ask the companies what else they need to commercialize, to see what other options the companies are looking for in terms of commercialization assistance, and to not get discouraged if a Phase II award does not follow a Phase I. It would be better to know why they were not awarded a Phase II contract than just give up.

Other comments were informational, but of less importance to our particular project.

Appendix P – Infoscitex Corporation Summary

Environmental Protection Agency
Meeting Minutes

Meeting date: October 31, 2006
WPI Attendees: Marcus Lewis, Will Brooks, and Lou Grillon
EPA Attendees: None
Company Rep: Infoscitex Corporation – Robert Kovar
****

The meeting was called to order at 3:30 p.m.
Team assignments: Note taking: Will Brooks and Marcus Lewis
Introducing the team: Will Brooks
Running the Interview: Lou Grillon
Writing the summary: Marcus Lewis
Reviewing the summary: EPA Team
Where: EPA – Woodies Building, Washington, DC
How: The interview will be conducted according to the following outline.

1. Since Will is the one who booked the interview with Mr. Kovar, he introduced the team and handed the interview over to Lou.
2. Lou began to introduce the project explain we are an EPA intern working on a special project.
    a. Mention we may be recording them, Mr. Kovar said it was ok to record them, so we begin recording.
    b. Talked briefly about project, who we are, said thanks.
    c. Sent ahead of time, a handout briefly explaining the technology continuum. Robert wanted to make a comment saying that his technology on Low-Cost, Mercury Free electrical switches is only in Phase I. We said we understand that and are aware not all of the questions are applicable.
3. Summary of interview

The EPA made them aware of the issue with mercury and the environment. EPA published solicitation requesting companies to solve the problem. Mercury is released into the environment. For example, cars have 30 mercury switches in them, when they break or when a car is melted the mercury evaporates and gets in the rain and spreads all over the environment. Mercury is also used in blood pressure machines, thermostats, thermometers and switches.

Problem Identification: Talked to mercury switch companies and proposed the idea to come up with a cheaper and environmentally safer switch. Organic Ionic Liquids can be used to achieve this goal. There are some technological challenges. One was that ILs conduct ions and not electricity, so the entire switch board had to be redesigned to conduct ions. The company overcame the problem by looking at other designs. The second problem was the properties of mercury. Mercury is a volatile metal that leaves a clean surface, with no traces behind unlike water. The challenge was treating the surface so that the OIL can bead up and not conduct a current which could short out the switch.

EPA SBIR is their only source of funding. It was the only funding for Phase I and they plan on getting Phase II. Once they receive Phase II funding, they will try to get funds from other sources such as other switch manufacturers.

Once Phase II funding is received they will see if they can apply the technology for other uses. If they win Phase II funding, then other outside companies will try to match the EPA SBIR funding so that they can continue with the development of technologies. Infoscitex is a contract R&D company. Meaning, they need funding to do research and only under contract to a company or the government. The concept worked, it is simple, but is cheaper, lighter and more efficient. They are going to evaluate more ILs, the method of synthesis, make prototypes and find out the requirements for switches, get companies to buy them. Mr. Kovar does believe that they will have a successful technology with a high commercialization rate.

Regulations: Do you think the technology is regulation driven to go non-mercury? EPA cannot abruptly make a law that will force companies to create non-mercury switches b/c they may go out of business. Instead, Mr. Kovar preferred if the EPA created incentives for companies to actively push for non-mercury products. Incentives such as tax breaks, a timeline for change and new production can be even cheaper. Competition is fierce. The EPA does offer incentives for changing the technology which can be very helpful.

Appendix Q – Luna Innovations Inc. Summary

Environmental Protection Agency
Interview Summary

Meeting date: November 14, 2006
WPI Attendees: Marcus Lewis, Will Brooks, and Lou Grillon
Company Rep: Luna Innovations Inc. - Matthew Hull, Principal Investigator in Life Sciences Group
****

The interview began at 10:30 a.m.
Team assignments: Note taking: Will Brooks
Introducing the team: Marcus Lewis
Running the Interview: Lou Grillon
Writing the summary: Lou Grillon
Reviewing the summary: EPA Team
Where: EPA – Woodies Building, Washington, DC
How: The interview will be conducted according to the following outline.

1. Since Marcus is the one who booked the interview with Mr. Hull, he introduced the team and handed the interview over to Lou.
2. Lou began to introduce the project explaining that we are EPA interns working on a special project.
    a. Lou asked if we may record the interview, Mr. Hull said it was ok to record.
    b. Lou talked briefly about project, who we are, said thank you.

Summary of interview

- Technology concentrating on magnetic nanoparticles for enhanced remediation
- Resending interview questions and continuum – apparently Mr. Hull didn't get the information the first time.
- Disclaimer- this interview this will not affect EPA funding of Luna.
- Focus on Magnetic nanoparticles – details about how SBIR funding has helped
- Q1 – Did you commercialize the technology? Do you have any partnerships, patents, agreements?
- In the process of commercialization, Luna filed an initial disclosure for the synthesis of one particle
- Intellectual property picking up in Phase II, couldn't look at in Phase I, not enough development complete
- This is a patent intensive field
- Luna tries to be more innovative, differentiate themselves, incorporate different components into nanotech, make more reactive to other contaminants
- Make decision on patent later, after an extensive review of what is out there, it is difficult for small companies to decide what patents to get which ones not to
- Luna worked with Foresight

- Foresight was very helpful in understanding what aspects of technology can be expanded on
- Luna does not have enough personal in business side to give as much attention to marketing as they want to
- Small commercial development group here at Luna, overwhelmed by size of market
- Other patents involved in this technology, Luna may license so to have a bigger market share
- Luna sees patents that they might license, one from a federal lab; two from academic labs
- Based on outcomes of experiments, Luna is figuring out best route to move forward
- Q2 What has been helpful in the development of this product?
- Pre existing technology Luna has from advanced materials group
- Group of researchers dedicated to developing new types of materials, nano, metal oxides, polymers
    - This project came out of that work: Re-apply nanoscale iron to environmental technology
- Virginia Tech: Use of an-aerobically synthesized iron. – Luna is working in collaboration with VT researcher
- EPA Phase I helped make linkage between VT and Luna
- Q3 Other funding?
- Internal funding from Luna business development group
- Luna went public back in February, other internal funding from IPO, looking to put into research
- Advanced materials group: Other funding that has attributed to the development of nano-scale stuff, some funding from DOD, other funding from private companies
- Q4 What can EPA do to help commercialize technology?
- EPA SBIR Phase II is small comparatively to other SBIR agencies
- If a company is successful in reaching sales milestone, they still come out at funding amount that is the lowest in government.
- With that said, EPA gives the opportunity to commercialize better than other SBIR programs. Mr. Hull likes the EPA oversight of providing Foresight. EPA is doing a lot of things better than some other agencies.
- Foresight gives good results and extensive reports
- SBIR = high risk technology, Mr. Hull believes that EPA wants company to put forth own funds
- To have external buy in, need to show results, results not available until after Phase II, this makes things a little difficult
- Another aspect: Bridge funding between Phase I and Phase II
- After Phase I feasibility of technology is proven but not to the point of attracting investors (internal or external), companies still have nine months of downtime because of this lack of funding.

- Need to look at the sources of funding to cover Phase I to Phase II gap in the very earliest stages of Phase I, which isn't possible.
- Possibly make fewer awards at a higher level of funding
- Not really anything else besides money for EPA to improve. Good job with assisting, just not enough money
- Q5 Do regulations help or hinder this technology?
- Remediation is a regulatory driven sector
- Arsenic standards have definitely helped drive technology. This technology can be used for arsenic, which helps.
- Concern about nanotech health and safety issues: Public concern, there is no way to predict regulatory climate for next five to seven years.
- Since this technology would be released into environment, it would come under intense scrutiny.
- Do regulations make people not want to invest, because the climate is uncertain?
- Not really, more of a driver for new technologies for the environment, and Remediation.
- Nothing to say nano-iron will be derailed because of regulations.
- Q6 Preparation for Phase II at end of Phase I? What did you do?
- Luna has participated in lots of SBIR awards and launched commercial spin-off companies
- Trimedisphere – Danville VA, commercially produced. Scaled up to be used in medical applications
- Past success at moving from SBIR to sales: Formula for success…business sense Know going into Phase I –that you need industrial partners to scale up the production. Luna has production milestones set up for Phase II, of two tons of material
- Luna is working with OEM type company to license technology to. Using existing sales network with partnered company locally
- Identify manufacturing partners, potential clients (internal list). Who we can sell to who have expressed interest.
- Discussed ETV, who can help field test, partnered with phase I academic partner…
- Health Corillion – medical company partner
- Sometimes greatest market pulls are not from environmental industry, for example nano-scale iron is of use in medical field.
- Formed this partnership to show EPA diversified market
- Q8 How did you establish the OEM deal?
- Located 30 minutes down the road, knew company from previous experience. Easy to talk with them. One guy at Luna goes to church with main guy at the partner company.
- Q9 Were you able to demonstrate the technology?
- Demonstrated technology in lab, de-chlorinate Carbon Tetrachloride
- Process generates chloroform, need to reduce that toxic intermediary
- Demonstrated in lab decontamination of Arsenic

- Want to make a more comprehensive solution particle, water treatment is rarely only one problem (toxic) substance
- Q10 Do you know about ETV? Did your company consider trying to use that?
- Luna would like to verify through ETV. Luna plans to try and to do some testing internally first.
- Talked to some folks – lack of understanding how options work together, need more understanding. Make sure people know that option for verification money goes to ETV, not to SBIR company for development funding.
- Proposal outlines a few potential sources for information, make more efficient, the distribution of information about option funding. To the technical person, it is easy to understand option funding. Business partners don't understand the mechanism of option funding.
- Trying to align technical people to business people: create model of funding that business people can understand as well.
- EPA has taken the time to try to explain it, could do better.
- Q11 Your company has a business development group? Yes, trying to improve link between technical people and business people. The business development group works with government, etc.
- Foresight compliments this project; they help to bridge the technology/ business gap.
- Q12 Anything else EPA can do to help commercialize technology? Expedite reviews on Phase I proposals. Try to award contract <6 months.
- Other Option funding? Air force and Army (Phase I options) 70k award, 30k Phase I option award. (between Phase I and Phase II)
- Make option funding based on internal audit of proposals? Instead of peer review system, which is good.
- Q13 What is your position in company?
- Principal Investigator in Life Sciences Group
- Thanks for time, would you like an Interview Summary? Yes please, Call or Email back

Appendix R – Lynntech Inc. Summary

Environmental Protection Agency
Interview Summary

Meeting date: November 14, 2006 @ 3 PM
WPI Attendees: Marcus Lewis, Will Brooks, and Lou Grillon
Company Rep: Lynntech Inc. - Oliver Murphy, President and Founder
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The interview began at 3:00 PM.
Team assignments: Note taking: Marcus Lewis and Lou Grillon
Introducing the team: Lou Grillon
Running the Interview: Will Brooks
Writing the summary: Marcus Lewis
Reviewing the summary: EPA Team
Where: EPA – Woodies Building, Washington DC

How: The interview will be conducted according to the following outline.

1. Since Lou is the one who booked the interview with Mr. Murphy, he introduced the team and handed the interview over to Will.
2. Will began to introduce the project explaining that we are EPA interns working on a special project.
    a. Will asked if we may record the interview, Mr. Murphy said it was ok to record.
    b. Lou talked briefly about project, the WPI EPA team introduced themselves, said thank you.

Summary of interview

Oliver received the interview questions and was ready to go. Will began by saying that we want to look at the technology "a new chemical process to create oxidizing agent potassium fer-rate". The technology went to Phase II.

Q1) What kinds of success has Lynntech had? Has Lynntech obtained any patents and/or licenses? There are at least one or two US patents issued on that technology. It has not made it to market. Over the last two years, Lynntech went to a number of chemical companies. Lynntech sees it being commercialized. The technology will supply a company's need of oxidants for water treatment. Lynntech also provides the manufacturing of strong oxidants that have a "green" aspect associated with them. They currently have an agreement with a potential supplier. It cost a lot of money to produce a small sample for the interested company. The company called in May 2005 saying that they were interested, and wanted to proceed with it. Lynntech has now made a bigger batch, and provided it to the interested company and would like to license the material. Oliver said he can't name the company. Sometime in August the company wanted to be the sole licenser of the technology and they are in that process right now.

That company assisted with the success of Lynntech's technology because they are putting it on the market.

Lynntech has looked into other applications from water treatment, to pharmacy to energy. Future users need to sample the material. They need to see if there is a market, and if it meets customer needs.

Will mentioned that EPA has a program called ETV, and Oliver doubts that they are looking at it. Oliver is familiar with the program. Oliver believes that there cannot be a one size fits all means for commercializing technologies. Lynntech is currently producing the material on a lab scale, and in order to scale up, they need more support/funding. That would be a Phase III program.

EPA has been very supportive up to Phase II. Oliver used the phrase we have heard before "the valley of death", and Oliver asks so what do we as a company do once we approach the valley? The "valley of death" is the period of time after Phase II funding is completed up to commercialization. The next step is to scale up. If the company needs the chemical, then there will be more involvement in the Phase III activity.

Will asked if Lynntech was looking into any other sources of funding. The answer we got was No.

Can the EPA do anything better? Oliver said that if a technology has market pull, then the government needs to get involved with Phase III. Even if the market pull is three years down the line, the government should support the company. Phase II is a working model. Phase I is feasibility. Phase III needs government support. Oliver is not saying all Phase II technologies should go to Phase III.

Develop-> patent->market->customer

Oliver feels that there are no road blocks to commercialization as experienced by Lynntech. Lynntech does not have a marketing division. Researchers and senior management do the marketing by attending exhibits and tradeshows where they market. Attending these places cost money. Funding is needed to pay for the hotels, transportation, conference registration fees, etc.

Oliver does not feel like there are other sources of funding for this particular technology. There is not a topic under other agencies SBIR programs that will fund this specific technology. NASA, DoD, DOE, NSF are all the other SBIR programs that Lynntech has participated in. Lynntech has used multiple SBIRs to develop similar technologies in the past. Oliver does not see a difference in the other SBIR programs. The issue it what to do after the SBIR program is over.

Oliver also feels that there is a problem with the allotting time of funding and application in the SBIR programs. The DoD SBIR program wants Phase II technologies to be to applied for three to four months after Phase I begins. Oliver says that three months is too short to develop and research a concept. Continuous funding is ideal, for the time between Phase I ending and Phase II beginning. This is impossible, a reasonable goal would be three to five months between Phase I ending and Phase II beginning. To decrease the downtime between Phase I and Phase II, some SBIR agencies have companies apply for Phase II funding about two thirds of the way into Phase I. This gets the application process going for Phase II. It also means Phase II awards are only based off of a few months of work. Oliver think that for Phase II to be submitted two thirds of the way into the Phase I is not how to do things. Oliver believes that doing that cheats

the small businesses because they do not have adequate time to develop their technology to the end of Phase I.

If there is a stoppage in funding between Phase I and Phase II funding companies lose momentum on their project. The developers have to begin working on some other project. Companies then have to start back up in nine months when Phase II funding starts. It is hard to switch your mind from one project to another, it takes time to remember and become reacquainted with the material. Oliver then makes an analogy to the NFL in regards to losing momentum. The pre-season games are not near the quality as regular season games. Coaches cannot expect the same performance if you stop playing and do not continue practice. It takes months to pick up a technology again and to get it going.

Lynntech is a development and commercialization company. R&D is a tool to be used for development and commercialization. Marketing, interacting with labs for licenses, securing intellectual property, are the tools to get to commercialization. Larger companies do little R&D. GM is a marketing company and takes parts that exist and puts them together. Scientists and engineers are not skilled in marketing and therefore should not do lots if any marketing. Why reinvent the wheel, when the technology will be irrelevant by the time it is done over. GM doesn't have it all, they don't manufacture their own batteries or tires, and they utilize what is out there.

Lynntech did find Foresight helpful for SBIR companies. Foresight has a standard write up for EPA SBIR program participants. There is so much they can do, give hints and tips, but they can only do so much with their limited budget. At some point the SBIR company has to do it themselves.

You have to find your company's niche. Commercialization is going to be done by people that are good at it, not scientists and engineers.

A myth is that you receive two or three SBIR awards, manufacture and sell the product. This is not true 90% of the time. There is a continuum of companies that are good at a specific stage of the continuum. The companies are static; the technology is dynamic and moves from one company to another along the continuum. Each company fits into a certain spot on the continuum.

SBIR is cutting edge technology. You need conviction, knowledge, passion, perseverance, and lots of marketing, to be successful.

Appendix S – Mide Technology Corporation Summary

Environmental Protection Agency
Interview Summary

Meeting date: November 20, 2006 @ 10 AM
WPI Attendees: Marcus Lewis, Will Brooks, and Lou Grillon
Company Rep: Mide Technology Corporation – Attila Lengyel- Chief Operating Officer

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The interview began at 10:00 AM.
Team assignments: Note taking: Marcus Lewis and Will Brooks
Introducing the team: Lou Grillon
Running the Interview: Lou Grillon
Writing the summary: Will Brooks
Reviewing the summary: EPA Team
Where: EPA –Woodies Building, Washington DC
How: The interview will be conducted according to the following outline.

1. Since Lou is the one who booked the interview with Mr. Lengyel, he introduced the team and began to conduct the interview.
    a. Lou asked if we may record the interview, Mr. Lengyel said it was ok to record.
    b. Lou talked briefly about project, the WPI EPA team introduced themselves, said thank you.
2. Summary of interview

We began by talking about their pollution reducing fuel injection system. This technology has not been commercialized as of yet. According to Mr. Lengyel, the technology got to the development stage, but has not been able to move farther. There was a market for the product; however the technology would have required a few more years to become developed to the point of being cost effective. That would have required more funding that the company didn't have. It might have been worth it in the long run to pursue the technology further along; however Mide is a small company with limited resources. Their main source of funding is from the government. Development stopped after the funding stopped from EPA's SBIR program and the DOD-Army SBIR program. They walked the line a little to get funding for almost the same project from two different SBIR programs.

SBIR in general is a useful funding vehicle; however different levels of SBIR assistance might be helpful because some technologies take so much more to get off the ground than others. Marketing information is another aspect where EPA can do more. Assistance through a contact at some big companies would be a huge favor, and connections between government agencies would be appreciated as well. The company thinks that EPA has its collective ear to the ground about who wants what, and who is working on what. Support after Phase II ends, such as a nudge in the right direction of a company who would like their product, would be useful. In Mide's experience, DOD

SBIR has done that for them in the past. Mr. Lengyel could not recall getting any market assistance from EPA during the development of their product. Even if the assistance is simply a contact number of someone inside a company that someone at EPA knows, that would be much better than just starting from scratch to find someone to talk to about their technology.

Regulations have not had an impact on this product as far as Mr. Lengyel knows. One thing that did have an impact was knowing who the end user of the technology was. This product was not meant for every day car use, because the materials being used were very expensive. The Army was looking to utilize this product in their tanks and/or Humvees. Some demonstration that the technology worked was done by Mide in a laboratory setting. Some marketing was required by the few people at Mide who focus it. However, those people also have other engineering responsibilities to the company at the same time that they have marketing responsibilities. More focus on finding more companies that would have been interested to assist the development of the technology would have been extremely helpful. Mr. Lengyel had never heard of Foresight, who is contracted through EPA to provide commercialization assistance to EPA SBIR awardees.

A final suggestion would be for EPA to take a personal interest in the technologies that they want to see developed to help find them a market or interested party to assist the commercialization.

Appendix T – National Recovery Technologies Summary

Environmental Protection Agency
Meeting Summary

Meeting date: November 7, 2006
WPI Attendees: Marcus Lewis, Will Brooks, and Lou Grillon
Company Rep: National Recovery - Robby Perish, Technical Products Manager
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The meeting was called to order at 11:30 a.m. and ended at noon.
Team assignments: Note taking: EPA Team
Introducing the team: Marcus Lewis
Running the Interview: Lou Grillon
Writing the summary: Lou Grillon
Reviewing the summary: EPA Team
Where: EPA – Woodies Building, Washington, DC
How: The interview will be conducted according to the following outline.

3. Since Marcus is the one who booked the interview with Robby Perish, he introduced the team and handed the interview over to Lou.
1. Lou began to introduce the project explaining that we are EPA interns working on a special project.
    a. Mention we wish to recording the interview, Robby Perish said it was ok to record, so we begin recording.
    b. Talked briefly about project, who we are, said thanks.
    c. Robby Perish did not want interview questions or background on the technology continuum ahead of time. He did not want to see the interview summary.

Summary of interview:
Was the technology commercialized? Yes. Our company manufactures and sells the product. Therefore there are no licenses. National Recovery has sold approximately $800,000 worth of that technology to date.

What helped commercialize the technology? Funding is very important. Other resources? Government lab, Fisk University in town (Nashville TN) provided instruments and analysis. Plastics Council and plastics institutions also helped out with coming up with ideas and defining market.

National Recovery works with the DOE. National Recovery knew market, worked in it, have extensive connections (existing customers).

How long did it take to develop technology? Approximately three years. National Recovery has other technology for sorting bottles. They used Infrared (IR) spectroscopy. This is a completely new technology. They did use general knowledge from previous projects.
DOE Phase IIb Phase III- commercial partnerships.

National Recovery started working with a company (secret- name withheld) to test their prototype technology at no cost to National Recovery. This helped get kinks out and debug. They were able to test in an industrial setting. Company still has working prototype. They took that information to improve design.

Product not a big seller. Fairly costly machine costs 70-100k. National Recovery contributed their own money for R&D.

What can EPA do to help commercialize? EPA offered funding is low compared with other agencies SBIR funding. Large percentage of research from own budget. Could use cross industry marketing help.

We are always looking for a new market. Foresight has been a help/ benefit with this. Find new areas to sell technology in. National Recovery has a sales department that is based around the industry we know, plastics. National Recovery sales department does not look for other markets. They have a niche. Specific contacts for other industries and where to go would be helpful.

Difficulties? They started using x-rays, but had to jump ship to IR. X-ray technology was not as promising as thought to be. Plastic flakes of different thicknesses absorb different amounts of x-rays. This can cause two different materials to appear to be the same if they are different thicknesses. Using the CCD camera gave lots of signal noise.

Process bumps? This was smooth. National Recovery has experience and pre-existing infrastructure. They have previously sold similar equipment.

Small Phase I awards, short amount of time. Maybe nine months instead of six months would be better, give more time to get stuff started.

What other helpful things would be helpful? Access to basic research at national laboratories would be good. List of labs at companies, universities, and government that can help with testing and analysis would help. Standard agreements between EPA and resources, it will cost X amount for this.

What are National Recovery marketing strategies? Marketing strategies include; trade shows, web presence, and occasional advertising in trade journals.
It is a fairly small industry; National Recovery feels lots of marketing not necessary. The international market is tough. They have expanded to Japan and Europe, but there are competitors in Europe.

National Recovery has their machines on every continent except Africa and Antarctica.

Alliances within industry and working agreements exist. They shared research and results with alliances. Alliances are more helpful with specific contact person who is a decision maker.

Appendix U - Office of Air Summary

Environmental Protection Agency
Meeting Summary

Meeting date: November 27, 2006 @ 10 AM
WPI Attendees: Marcus Lewis, Will Brooks, and Lou Grillon
EPA Attendees: April Richards and Diana Bauer
Office of Air Attendees: Ellen Brown (ORPA), Bill Maxwell and Ravi Srivasta on the phone
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Ravi began by talking about the halogen sorbent injection technology innovated by Sorbent Technologies. The technology was developed under the SBIR program and has tremendous potential. Ellen said they sold about a dozen systems. Ellen said she would be able to give us a list of who was using it. The technology fills in a need and on a full scale test had excellent removal potentials, had minimal capitol requirements. Anticipated regulations do have a bearing on the technology. EPA or state agency creates a demand for the technology (mercury regulations for power plants) and states require stiff limits on power plants and mercury. It creates a demand because no one is going to put on controls unless it is required. But if the controls are not out there, then you can't really create a law requiring it. So, SBIR can help! SBIR funds technology for future regulations. Small company impediments: It cost a lot of money to develop and market.

Sorbet Technology's success story:
Sid Nelson was the driving force for networking and marketing the technology. He set up many demonstrations and his persistence paid off in the end. Sid had incorporated SBIR requirements to actually short marketing. A university professor may not want to commercialize. Government Agencies ask the question to small businesses: Do they (the companies) want to commercialize? It would require the small businesses market their technology. Sid gave briefings to everyone and workshops, talk to people, write proposals. Companies need the drive to push their technologies to commercialization. Office of Air mandated to control mercury from power plants. The power plants have commercial interest even if they develop something viable, which drives the industry. Annarbor is a mobile source, they have their own lab. The Office of Air puts out a solicitation to inform people of the new regulations and what they are looking for in a new technology.
ICAC.com is a website that has commercial sales that OAR refers to. ICAC stands for Institute of Clear Air Companies.

Office of Air views them as regulatory authority. A lot of companies, both small and large want EPA stamp of approval. Control Technology doesn't think these go thru ETV. Mercury monitors went thru ETV. The DOE program tests are more broadly

conducted and the field scale projects that demonstrate the technology. They are not at specific to the condition as ETV.

Small companies want more help that the government is mandated to do. KFX did the marketing part. Power industry doesn't take risks with the technologies, and Sid push marketing further. He has contracts in place and in the plant. KFX traded on NY stock exchange, the technology that takes moist mercury and sulfur out of coal.

Mike Duhen, ADA tech developer talked to air people a lot. He was very suave and polished. Air feels that the small businesses need to go to conferences, talk to people and follow up. AWMA is a specialty conference on pollutants. This is a good place to present and talk to the right people. DOE test program gets them more exposure. Tom Pheely is on of the NETL guys. National Energy…..Big companies influence the regulations to sell the technologies.

Nugget:

Small businesses attending technology conferences are essential.

Come up with a searchable database for conferences to present at. The EPA clearly does not communicate amongst its own departments. Tell companies that this is what EPA gives you.

Appendix V – Ophir Corporation Summary

Environmental Protection Agency
Interview Summary

Meeting date: November 21, 2006 @ 11:00 AM
WPI Attendees: Marcus Lewis, Will Brooks, and Lou Grillon
Company Rep: Ophir Corporation – Martin O'Brien, Vice President
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The interview began at 11:00 AM
Team assignments: Note taking: Will Brooks and Lou Grillon
Introducing the team: Lou Grillon
Running the Interview: Marcus Lewis
Writing the summary: Will Brooks
Reviewing the summary: EPA Team
Where: EPA – Woodies Building, Washington, DC
How: The interview will be conducted according to the following outline.

1. Since Lou is the one who booked the interview with Mr. O'Brien, he introduced the team and handed the interview over to Marcus.
2. Lou began to introduce the project explaining that we are EPA interns working on a special project.
    a. Lou asked if we may record the interview, Mr. O'Brien said it was ok to record.
    b. Marcus talked briefly about project, the WPI EPA team introduced themselves, said thank you.

Summary of interview

Mr. O'Brien received the interview questions and was ready to go. The novel pipeline sensor had only reached the development and demonstration stage of the continuum. Some brief background about the technology included a description of how Ophir got the idea for this product. The Department of Transportation (DOT) changed the pipeline inspection criteria about 5 years ago. What had previously been a strictly managed system for inspecting pipeline under DOT control was changed to a system where the company owning the pipeline would tell DOT how they would inspect their line. DOT would then approve that inspection plan if it met their criteria. Ophir saw this as an opportunity to change how the several million miles of pipeline in the United States were monitored. The plan was to install sensors at key flow points that were either difficult to manually inspect, at junctures near large groups of people, or at areas of particularly high volume of flow.

The goal was to build a low cost continuous emission monitor to sell to major pipeline owners to simplify the inspection of their pipelines. The technology was going to be such that the sensors could be placed up to a mile apart and still retain a picture of the entire pipeline in between them. EPA funded the project up through Phase II, at which point there was a working prototype of the technology. There were some partnership/ field testing arrangements with El Paso Energy and Williston Basin Interstate Pipeline

Company. These groups were interested in the topic of the project and allowed Ophir to demonstrate their technology on sections of their pipelines in a variety of potential detectable scenarios. These demonstrations were either funded through Phase II or from Internal R&D funds. They were never paid to do a demonstration by El Paso or Williston.

The intent was for the technology to simply monitor fixed locations, not to have a whole service associated with it. The technology was never really adopted by the marketplace because the utility companies are so set in their ways that have worked to think about adopting a different policy that might not work. There is a huge gap between a working prototype at the end of Phase II to an end product that companies can actually purchase. Finding the funding to make that last jump is extremely difficult.

Despite most of the industry not being interested, Aleska Pipeline Company is interested in the product. They have approximately 300 river crossings which are impossible to monitor and are most at risk for pipeline collapse that would be ideally suited to continuous remote monitoring. Ophir demonstrated their technology for Aleska by mounting their detector on a boat and detecting methane and ethane emissions arising from the natural oil slicks near Santa Barbara, CA.

A commercialization stumbling block was finding someone who will pay to package the technology. Most people only want to purchase a finished product, not actually pay to design the working prototype into a saleable model. A venture capital group might be interested if Ophir could definitely say that a utility company wants X number of units, so the venture group could be ensured of recouping their money. (This is note quite true. We had a very good idea of the market size and cost for development. Venture groups were not interested in projects this small. In addition, they were not interested in projects where the industry profit margins were as small as those supported by the pipeline utilities. For environmentally-driven technology development efforts, some method of bridging the "product development gap" would be a huge step forward. We were not able to find any funding partner interested in developing environmentally-focused products for smaller markets. Industry finds it easy to state that "no technology exists," when in fact the technology exists, but has not been finalized into a final product.) Potential partnerships were also examined with large sensing companies such as Honeywell. They were turned down, saying that the market was too small for them to be interested in.

The product has been in development since 2001/2002, when they received Phase I funding. Phase II happened around 2003, but beyond that, there have been no other sources of outside funding. (Phase I actually started September 2000. Phase II ended June 2004)

The SBIR program is a small part of Ophir's revenue stream. Their main focus is on a laser radar system that is mission critical on a number of military aircraft.

Ophir looked at ETV in the demonstration phase. They didn't go through it because they were so concerned with market and knowing they had a client. They decided to focus on finding a niche for it instead of verifying that it works. (We had field data that verified the sensor's performance. We chose to focus on market development/exploration BEFORE we expended funding/effort on verification with ETV). When conventional pipeline utilities turned it down, they scrambled to find marketplace for the technology. No-one else except Aleska was interested. The industry

is not, but EPA is. The utility companies are closed minded when it comes to these types of things. It is a tough sell to convince the utilities that new technology is required and will result in improved performance at a lower cost.

Few companies implemented any changes to what they are doing, even with the DOT freedom. The utilities industry is conservative and slow to react. Ophir was surprised at this. Industry is conservative and not likely to change when old technologies have been working for 40 years. Mr. O'Brien feels that even with government incentives, industry will still be slow to change.

Their marketing plan was to: attend trade shows, have booths, spend a considerable amount of money to get marketplace interested. They also presented papers at some gas/pipeline companies. They participated in gas star program, presented how their sensor would increase environmental credits with the pipeline companies, etc. We also worked with local utilities and pipeline operators. We performed technology demonstrations, at no cost to the utility or pipeline operator, as a way to introduce the technology. Ophir did their homework when coming into this technology and market. They were already well aware of the key players. Ophir did a very thorough search of the marketplace, what pipelines there were, who owned them, where they were located, etc. As you go up the chain in management, interest wanes. People on the ground were the most interested in this technology.

Foresight only provided marginally helpful advice. Ophir has their own marketing and business development division. Mr. O'Brien said that in the right context, Foresight can be a huge help to a company. His company did learn a few things from them; however his own personnel dug up more information and put more time into the research than the Foresight representatives. Foresight's assistance came after they began to receive Phase I funding, but before they received Phase II funding. Through DOE they worked with a similar company, Dawn Breaker (market assistance company) that had apparently worked with Foresight/EPA before.

The competition was all known to Ophir before they began developing this product. They knew what the industry was doing, and they had done enough homework to develop a target price that could be competitive with existing technology.

Mr. O'Brien thinks that EPA can improve their programs by making more of an effort to get the technology commercialized. Some form of support to industry, perhaps as simple as an endorsement to look at technologies developed by EPA's SBIR. They would have to implement a top down approach. Get industry interested in change from the top management down.

The next steps for this technology are non-existent. The project has been significantly scaled back because there does not appear to be the market that was initially hoped for. Ophir cannot see a good way to take what has been developed and turn it into a viable product. They are not big enough to do that on their own. They are still keeping Aleska interested; they might develop models for that one pipeline in hopes that they will get their foot in the door.

Regulation impacted this technology because it made it possible for the utility industry to change their pipeline inspection methods, if they so chose. This opened the door for them to choose to utilize this technology being developed by Ophir. Perhaps if there were strict emissions regulations for the pipelines, then Ophir's product might sell.

Mr. O'Brien also commented that EPA investigations into the real needs and cost-drivers of the marketplace (utilities) would be a important step. This is difficult, since Ophir has experienced first-hand that initial positive statements regarding technology adoption do not always materialize when the technology becomes available. EPA wants to make a contribution to industry, but EPA needs reality check to see how industry will actually react. EPA should find out what industry will actually spend on a sensor, then focus on funding those projects that aim for that price range. EPA should find out what industry will actually do, not what they say they will do.

EPA could also meet with executives, as an independent broker. They could encourage companies to invest in EPA sponsored companies/technologies, but they need to understand what industry will buy. This is not to say EPA should only invest in technologies that only have big markets, because those will likely have the biggest environmental impact. They should balance between the big market items and the hot topic items that deal with problems of large environmental risk.

Mr. O'Brien said that we are free to follow up with more questions, and would like a copy of our interview summary.

Appendix W – Peer Review Division Summary

Environmental Protection Agency

Meeting Summary

Meeting date: December 5, 2006 @ 3:30 PM
WPI Attendees: Marcus Lewis, Will Brooks, and Lou Grillon
EPA Attendees: Barbara Levinson, Acting Director Peer Review Division, SBIR Program

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Meeting began with the WPI Team giving Barbara a break down of the project. Barbara then began to explain her role with the SBIR program and what peer review is. She mentioned that Phase II Peer Review is going on right now and that we could go there to Silver Springs tomorrow and see how a peer review panel/discussion is conducted. She explained the steps of the SBIR Application/Proposal Review Process and it goes as follows:

1. Proposals are received in NCER
    - Could be submitted electronically or via mail
    - Few days to sort through the proposals
        - *SBIR awards are contracts not agreements
2. EPA sorts out what they want to be worked on
3. Set up third party peer review panels by topics (Takes 3 months)
    - Write up letters to potential peer reviewers
        - Can take weeks for a response, peer reviews are experts in their fields and are usually professors, teachers, etc.
    - Ann sets up the date for the peer reviews
    - Contractor find a hotel for the peer review panel to be held
    - A contract for each Peer Reviewer must be written
        - To pay the peer reviewers, their airfare, hotel rooms, and for them to abide by their given budget from EPA
    - The contract then goes to the EPA Contracts Office, and they have 30 days to write the contracts
    - Once the contract is received, NCER can then send the proposals to the peer reviewers, it is illegal to do it before then!
    - Scan and put the proposals onto a disk
    - 3 Peer reviewers get a month to read the proposal, write the write-up for the panel summary
    - Someone from NCER runs the panel, no EPA employee is allowed to speak during the third party peer review session
4. Relevancy Review is held by NCER via conference call to determine which proposals are important to what the EPA wants
5. Diana makes recommendations as to what is important and what should be funded

6. Gary Foley and Jim Gallup deals with the funding process after approval

**********On a side note, this year the peer review process was weeks ahead schedule, due to the work of Don Tang, who took his best educated guess based on the monthly reports form the programs on which proposals from Phase I would end up showing up again for Phase II.

Barbara the made the following comments:

1. Each peer reviewer needs an individual contract
    a. Other agencies do not have to ALWAYS go through the Contracts Office; all of the others have a blanket contract so that they could sign off on contracts themselves.
2. EPA is always under scrutiny, there are a lot of politics behind the environment and environmental technologies.
3. The industry is reluctant to change, and spending more money to change is not desired by the industry, so the government slows down the process.
4. Slowing down regulations = more money

Appendix X – Phoenix Science and Technology Summary

Environmental Protection Agency

Interview Summary / Minutes

Interview date: November 3, 2006
WPI Attendees: Marcus Lewis, Will Brooks, and Lou Grillon
EPA Attendees: None
Company Rep: Phoenix Science and Technology - Robert Schafer
****

The meeting was called to order at 2:05 p.m.
Team assignments: Note taking: Lou Grillon and Marcus Lewis
Introducing the team: Lou Grillon
Running the Interview: Will Brooks
Writing the summary: Marcus Lewis
Reviewing the summary: EPA Team
Where: EPA – Woodies Building, Washington, DC
How: The interview will be conducted according to the following outline.

1. Since Lou is the one who booked the interview with Robert, he introduced the team and handed the interview over to Will.
2. Will began to introduce the project explain we are an EPA intern working on a special project.
    a. Mention we may be recording them, Robert said it was ok to record them, so we begin recording.
    b. Talked briefly about project, who we are, said thanks.
    c. Sent ahead of time, a handout briefly explaining the technology continuum. Robert said that he had a chance to look at the questions and the continuum we sent him. He liked the continuum and said that they are only at Phase II.

Summary of interview

Will began by saying we are looking at the Innovative Ultraviolet Light Source for disinfection of drinking water technology. Will had asked about patents. Robert said Phoenix has 2 patents and a third one pending. Patents are a basis for licensing. Will then went on asking if Phoenix had partners with other companies or funding of some sort. Robert replied saying that Phoenix has "hand shake" agreements with Trojan Technologies. There is no written agreement. The agreement is to lend testing equipment and facilities, advice, etc. Phoenix has a licensing agreement with Kyzer Systems Inc. Will asked how the arrangements were made. Robert said that he does not remember how the one with Trojan was made, but they kept in touch with Trojan, talked to many companies, and Phoenix and Trojan just gravitated towards each other. Trojan also has a strong R&D department. Some of the contacted companies are from a niche study done by Foresight S&T. Foresight was not really helpful when it came to considering alternate paths, mainly because Phoenix already researched alternative routes

and applications the technology can go. Some companies are so into developing the technology that other applications are not looked into, and Foresight may help them more so than Phoenix. Phoenix has a few SBIR Phase I technologies.

Licensing was through a personal contact that Robert had. Robert helped with Boeing program using flash lamps to remove paint. Robert met the KSI president that way. Advanced Technology Program (ATP) gave a couple million dollars, was a high risk, high pay-off type deal. EPA came before the ATP. EPA program was aimed at the specific disinfection of drinking water, which helped establish credibility when Phoenix demonstrated that it worked. NSF (contaminants) gave funds for other applications, same for and HUD (stripping paint) and EPA gave funding for the lamp helping the environment. Robert was the head of a corporate lab a while ago. Phoenix has had problems with commercialization. They proved the lamp works, but too short of a non practical life span.

SBIR Programs: Is a great program, but has room for improvement. The SBIR programs set you up for Phase I and Phase II, but the technology is the dropped off at Phase III and receives no funding. This gap is what Robert describes as the "valley of death". The gap when the technology is proven to work and now has to make it into the market. Most small businesses are 10-20 people, and do not have the resources [expertise and time] to fairly work with venture capitalists. The SBIR program can act as a broker to bridge the gap. Foresight trains the head of the company, throws a ton of information at the person being consulted and has to take off and run with it. A more preferred option is if the EPA sets that up for small businesses. A new change to the program has been brought up, to let venture capitalists participate in the SBIR program which Robert believes defeats to purpose of the SBIR program. Robert is going to send the letter stating his opinion about the program when he is done. One idea now is to allow companies controlled by the venture capitalists to participate on the SBIR program. SBIR have entrepreneur with ideas. SBIR program funds for 3-3.5 years max. Technologies are time sensitive, and can take up to 7 years to develop through the first 4 stages. Long and difficult process for applying (EPA only takes paper copies by mail of a proposal instead of accepting them online). Robert believes that SBIR programs should not fund manufacturing, but instead fulfill the goal, to foster commercialization. Fund a pre-prototype to the point where other people will invest in it. The budget that the EPA SBIR programs give out is not worth as much as what they used to be mainly because of the economy doing poorly.

Phase III of the DOD program allots several million dollars. 750k definitely helps, but is the same amount, if not more work to apply for, the EPA SBIR programs requires the most paper. Grants.gov uses little to no paper. Applying for the DOD is a lot easier. The DOD has an active Phase II program. Indefinite Delivery, Indefinite Quality (IDIQ) Contract is a task ordering contract, is how the DOD handles issues. EPA Phase I and II had an army core of engineers that sent money to the IDIQ at the Navy to do more research. Another thing the EPA can do is maybe shift around funding, or move money around to another agency, may take away from administrative work. The DOD does "matching" with received funds. For example, if the DOD offers 1 million, then ask the EPA to come up with half. If the EPA had the IDIQ process the EPA could issue Phase III, save trouble by making a difference between funding and not funding gaps in the continuum.

The ETV program the EPA has is really good. It is a place where the technology can be tested independently. ETV helps mainly for EPA solicitations during Phase II of the technology development stage. 2 options required to submit and one being verification and the other money doesn't cover the cost of participating in the program. Max funding is 50-60K and is can be up to 100K for verification. So what Phoenix has done as an alternative is to work with Colleges & Universities, such as Duke University, develop relationships there so that they can test in their facilities. Experts are hired and the independent researchers get paid.

Questions were then asked about regulations. In January there were 2 new rulings issued. The first one is that UV treatment is more than approved, it is recommended. Market for UV is going up, and will grow for the next ten years. Phoenix's technology uses pulse UV, and they are not sure if that is ok. Robert said that Foresight did a good job in providing niche studies (2-4 targets you get through the EPA), but would appreciate it if they assisted with making the deals, just like a broker does. Out of all the 36 contacts provided, only 1 seemed to lead to something. Serving as a catalyst for interactions, bringing it all together will foster interaction between the small business and the larger one. Foresight only takes you to a certain point.

Appendix Y – US Infrastructure Summary

Environmental Protection Agency
Interview Summary

Meeting date: November 29, 2006 @ 11:30 AM
WPI Attendees: Marcus Lewis and Lou Grillon
Company Rep: US Infrastructure – Ramjee Raghavan – retired from USI
****
The interview began at 11:30 AM
Team assignments: Note taking: Marcus Lewis
Introducing the team: Lou Grillon
Running the Interview: Lou Grillon
Writing the summary: Marcus Lewis
Reviewing the summary: EPA Team
Where: EPA – Woodies Building, Washington, DC
****

Summary of the Interview

Lou introduces what we are doing. Looking at EPA SBIR and how it helps. Wanted to know if you could give info on how the tech went far, etc.

SBIR program is good, especially for small companies that want to bring ideas out. ETV option, we chose this route of salt water clean up. New regulations are coming from EPA. Problem with down flow filters is they get clogged up and contribute to environmental problem if the filter is not changed every six months. No one cleans/maintains them. So we designed an up flow filter which is just a reverse of the of the down flow filter. Ramjee says it works better, contaminant come down by gravity, last ten times longer, can be installed into any manhole and it has low maintenance. The technology has great applications.

Once regulations come into place, most of the buildings will have to have them. It is cheaper because on a long term basis the idea will not have to be maintained as much as the down flow filters. Penn State is where the Principal Investigator did field testing, as well as at the University of Alabama. Ramjee believes it is the small business' job to find some money, put their money into the idea. USI talked to vendors that do filters, did a survey about the market.

USI did find Foresight helpful and thought it was a good idea for small businesses.

Ramjee is now a contractor working for EPA in New Jersey for salt water treatment. So he knows who the vendors are and the contractors are. One of the researchers working with USI is an expert in the area, and had many contacts in industry. Some companies were interested. Hydro Compliance was one of these contacts. They bought the technology from USI. Hydro Compliance then came to an agreement with Hydro International, an international company trying to grow in the United States. Hydro international gave them $100K for commercialization funding, which allowed USI to go through the ETV program. The results for ETV are not officially out as of the interview

date of 11-29-06; even though USI began the verification process two years ago Development was successful. In the meantime, they did pilot testing.

Hydro International looked at what customer needs and did a good job at commercializing the product. As part of a commercialization option, they looked at the country and figured which parts will need the drainage the most and where the technology would be most used. FLAMM, A company was interested and thought that they could get a leg up; they are trying to penetrate the US competition.

Innovation Tech Evaluation (ITE), cost $40,000 and these experts do the test at different universities for field testing. ITE does ensure that the technology meets state requirements and a third party review. This process is required by some states such as NJ, PA and NY.

Ramjee says make sure you know your market! You, the small business, should also know when a new set of regulations are coming in and if it's something new, and if you are definitely innovative, it gives you the advantage. A lot of times universities do not have good marketing techniques. Hydro International made nice marketing brochures. Small businesses just have to be in the right place at the right time with the right product, and find a good marketing company like Hydro International.

When asked about his opinion on the EPA SBIR program he said that Jim Gallup is an excellent project officer and is running a good program. Ramjee worked with the EPA for the last 25 years. Quality Assurance/ Quality Control (QA/QC) is important. It is good that EPA SBIR program requires these, because when a company tries to commercialize their technology it is helpful. EPA SBIR program has been around a while and is mature, it works well. He agrees with the Commercialization Option at the end of Phase II being awarded by cash donations instead of in-kind because it show an outside company is serious about development and so that small businesses do not try to take advantage of the SBIR program. USI put in 50% of its internal budget and the other came from in-kind donations from universities and from the EPA. Grad student helped out = cheap labor.

When asked about how he made his connection with Hydro Compliance, Ramjee attended a conference and after his presentation, someone from Hydro Compliance liked the idea and wanted to buy it. Hydro International bought the patent, and then came to an agreement with Hydro International who did all the marketing and packaging. Hydro International people were willing to invest. Ramjee runs a consulting and engineering company that offers solutions to municipalities. His company does not hold technologies, they consult.

Buying into your own idea helps! Put own moneys toward the technology, and had a grad student work on it. Ramjee attended conferences, one of them being the EEEF conference. Ramjee's company does the following, vendors offer a design service, and if they keep getting other offers of products then the competition goes up. Then he offers the best product, markets at conferences. So he gets business from the competition.

Book/Journal References

1. Audretsch, David B., Link, Albert N., and Scott, John T. Public/private technology partnerships: evaluating SBIR-supported research 2002/1 Retrieved September 9, 2006 from http://www.sciencedirect.com/science/article/B6V77-44WYNMD-9/2/b0e3319ae1e82a35ec245434d33b25e8
2. Environmental Impact Assessment, http://www.gdrc.org/uem/eia/impactassess.html
3. Glaser, Barney G., Strauss, Anselm L., The Discovery of Grounded Theory: Strategies for Qualitative Research, Aldine de Gruyter, Hawthorne, New York, 1967
4. Gutterman, Alan. Technology Development Transfer. Westport, Connecticut: Quorum Books, 1997.
5. Integrated project evaluation and selection using multiple-attribute decision-making technique**,** *International Journal of Production Economics, Volume 103, Issue 1, September 2006, Pages 90-103,* Prasanta Kumar Dey
6. Kotler, Phillip. Marketing Management Analysis, Planning, Implementation, and Control. Englewood Cliffs, NJ: Prentice Hall, 2000.
7. Towards a sustainable America: advancing prosperity, opportunity, and a healthy environment for the 21st Century, The President's Council on Sustainable Development, May 1999, 165 pages, http://www.osti.gov/bridge/product.biblio.jsp?query_id=0&page=0&osti_id=7088
8. Yin, Robert K. Case Study Research Design and Methods. 2nd Edition. Thousand Oaks, California: Sage Publications, 1994.

Website References

9. Advanced Fuel Research, Inc., Company Overview. Retrieved November 16, 2006 from http://www.afrinc.com/company.htm
10. Advanced Fuel Research, Inc., Next Generation Energy. Retrieved November 16, 2006 from http://afrinc.com/nge.htm
11. Basic Arsenic Info. Retrieved November 13, 2006 from http://www.epa.gov/safewater/arsenic/basicinformation.html
12. DOD SBIR Success Stories. Retrieved November 2, 2006 from http://www.dodsbir.net/SuccessStories/default.htm
13. DOE SBIR & STTR Power Point. Retrieved November 2, 2006 from http://www.science.doe.gov/sbir/NEWWEB/presentation.ppt
14. DOD SBIR & STTR Programs. Retrieved November 2, 2006 from http://www.acq.osd.mil/osbp/sbir/
15. Department of Defense: SBIR/STTR/Fast Track – Overview. Retrieved September 10, 2006 http://www.acq.osd.mil/osbp/sbir/overview/index.htm
16. Description of SBIR Program. Retrieved September 9, 2006 from http://www.sbaonline.sba.gov/SBIR/indexsbir-sttr.html
17. DHS SBIR. Retrieved November 2, 2006 from http://www.hsarpasbir.com/

18. Environmental Mentoring Business to Business, Peer to Peer. Pollution Prevention Program Idaho Department of Environmental Quality. December, 2002. Retrieved September 1, 2006. from http://www.deq.state.id.us/multimedia_assistance/p2/env_mentoring_report.pdf
19. EPA. Retrieved Sept 15, 2006 from http://www.epa.gov
20. EPA 2006-2011 Strategic Plan. Retrieved October 27, 2006 from http://www.epa.gov/ocfo/plan/2006/entire_report.pdf
21. EPA about NCER. Retrieved September 7, 2006 from http://es.epa.gov/ncer/about
22. EPA ADA SBIR. Retrieved November 13, 2006 from http://cfpub.epa.gov/ncer_abstracts/index.cfm/fuseaction/display.abstractDetail/abstract/6362/report/0
23. EPA Administrator. Retrieved October 27, 2006 from http://www.epa.gov/adminweb/
24. EPA Air Toxics. Retrieved November 13, 2006 from http://www.epa.gov/region1/eco/airtox/acrolein.html
25. EPA Budget in Brief. Retrieved September 9, 2006 from http://www.epa.gov/ocfopage/budget/index.htm
26. EPA CEIT. Retrieved October 26, 2006 from http://www.epa.gov/ne/assistance/ceit/
27. EPA CEIT PDF. Retrieved October 26, 2006 from http://www.epa.gov/ne/assistance/ceit/pdfs/ceitfactsheetn.pdf
28. EPA Environmental Technology Research & Development Continuum Retrieved September 1, 2006. from http://www.epa.gov/etop/continuum/index.html
29. EPA Environmental Technology Programs. Retrieved September 9, 2006. from http://www.epa.gov/etop/continuum/programs.html#STAR
30. EPA ETV. Retrieved Oct 26, 2006 from http://www.epa.gov/etv/
31. EPA Funding Opportunities. Retrieved November 28, 2006 from http://es.epa.gov/ncer/rfa/2006/2006_sbir_phase1.html#I
32. EPA Goals Retrieved September 16, 2006. from http://www.epa.gov/history/org/origins/goals.htm
33. EPA Grants and Funding Retrieved September 16, 2006. from http://www.epa.gov/ord/htm/grantopportunity.htm
34. EPA Infoscitex SBIR. Retrieved November 6, 2006 from http://cfpub.epa.gov/ncer_abstracts/index.cfm/fuseaction/display.abstractDetail/abstract/7958/report/0
35. EPA Mission. Retrieved October 27, 2006 from http://www.epa.gov/ebtpages/envimission.html
36. EPA Mission and Goals. Retrieved September 9, 2006 from http://www.epa.gov/epahome/aboutepa.htm
37. EPA NETC. Retrieved October 26, 2006 from http://www.epa.gov/etop/netc/index.html
38. EPA NHSRC TTEP. Retrieved October 26, 2006 from http://www.epa.gov/nhsrc/pubs/posterTTEP032106.pdf
39. EPA OPEI. Retrieved October 25, 2006 from http://www.epa.gov/opei/about.htm
40. EPA ORD. Retrieved October 26, 2006 from http://www.epa.gov/ord/

41. EPA Outreach. Retrieved September 18, 2006 from http://www.epa.gov/oppt/greenengineering/pubs/outreach.html
42. EPA P3. Retrieved October 26, 2006 from http://es.epa.gov/ncer/p3/
43. EPA P3 Goals. Retrieved September 9, 2006 from http://es.epa.gov/ncer/p3/success/index.html
44. EPA, Recycling City: Service Station, Information. Retrieved November 13, 2006 from http://epa.gov/recyclecity/service.htm#Maintainance
45. EPA, Recycling City: Material's Recover Center, Information. Retrieved November 13, 2006 from http://epa.gov/recyclecity/recovery.htm#Plastic
46. EPA Research / Proof of Concept / Development Retrieved September 16, 2006. from http://www.epa.gov/etop/developer/financial.html
47. EPA SBIR Description. Retrieved September 8, 2006 from http://es.epa.gov/ncer/sbir/
48. EPA Small Business Innovation Research: Success Stories. Retrieved September 4, 2006 from http://es.epa.gov/ncer/sbir/success/
49. EPA Technology Programs and Intra-Agency Coordination. Subcommittee on Environmental Technology. Retrieved September 8, 2006 from http://www.epa.gov/etop/nacept/NACEPT%20Report%20FINAL_May%209%2006.pdf#search=%22define%20%22technology%20continuum%22%22
50. "Identifying Innovative Tech Transfer Practices through Case Studies" http://cosmos.buffalo.edu/t2rerc/research/case-studies/method.htm
51. NASA, *IPCC Scientific Assessment of Climate Change,* 1992.
52. NCER SBIR Luna (search "Luna"). Retrieved November 15, 2006 from http://cfpub.epa.gov/ncer_abstracts/index.cfm/fuseaction/searchControlled.main?RequestTimeout=180
53. NCER SBIR Luna PI. Retrieved November 15, 2006 from http://cfpub.epa.gov/ncer_abstracts/index.cfm/fuseaction/display.abstractDetail/abstract/7466/report/0
54. NCER SBIR Lynntech (search "Lynntech"). Retrieved November 15, 2006 from http://cfpub.epa.gov/ncer_abstracts/index.cfm/fuseaction/searchControlled.main?RequestTimeout=180
55. NCER SBIR Lynntech PI. Retrieved November 15, 2006 from http://cfpub.epa.gov/ncer_abstracts/index.cfm/fuseaction/display.abstractDetail/abstract/5185/report/0
56. NCER SBIR Mide (search "Mide"). Retrieved November 21, 2006 from http://cfpub.epa.gov/ncer_abstracts/index.cfm/fuseaction/searchControlled.main?RequestTimeout=180
57. NCER SBIR Ophir. Retrieved November 27, 2006 from http://cfpub.epa.gov/ncer_abstracts/index.cfm/fuseaction/display.abstractDetail/abstract/1746/report/0
58. NCER SBIR Ophir II. Retrieved November 27, 2006 from http://cfpub.epa.gov/ncer_abstracts/index.cfm/fuseaction/display.abstractDetail/abstract/5189/report/0
59. NCER SBIR PS&T (search "Schaefer"). Retrieved November 9, 2006 from http://cfpub.epa.gov/ncer_abstracts/index.cfm/fuseaction/searchControlled.main?RequestTimeout=180

60. NCER SBIR USI. Retrieved November 20, 2006 from http://cfpub.epa.gov/ncer_abstracts/index.cfm/fuseaction/display.abstractDetail/abstract5613/report/0
61. NCER SBIR USI II. Retrieved November 30, 2006 from http://cfpub.epa.gov/ncer_abstracts/index.cfm/fuseaction/display.abstractDetail/abstract/6366/report/0
62. NIH SBIR. Retrieved November 2, 2006 from http://grants.nih.gov/grants/funding/sbirsttr_receipt_dates.htm
63. Partners in Science: Federal Technology Transfer Act (FTTA) Retrieved September 16, 2006. from http://www.epa.gov/osp/ftta.htm
64. Promoting Environmental Education, Training and Stewardship. Retrieved September 1, 2006. from http://www.21stcentury.state.pa.us/2001/v_promoting_environmental_educat.htm
65. PS&T SD Lamps. Retrieved November 9, 2006 from http://www.phoenixsandt.com/sdlampII.htm
66. SBIR and STTR Programs and Awards. Retrieved September 9, 2006 http://www.sba.gov/SBIR/indexsbir-sttr.html#sttr
67. SBIR Facts. Retrieved November 21, 2006 from http://www.sba.gov/sbir/SBIRSTTR_3CourseFullOverview.ppt#519,19,WHY%20SBIR
68. Start A Business – Where to Begin and How to Grow. Retrieved September 1, 2006 from http://www.businessfinance.com/books/StartABusiness/StartABusinessWorkbookTOC.htm