Plasmasol Corporation:

A Case Study in Academic Entrepreneurship

at Stevens Institute of Technology

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PREFACE/CASE POSITIONING

This case was designed for use in a graduate technology-based innovation and entrepreneurship course. The case provides students with an opportunity to assess the support and development of an emerging technology in a leading US research university, as it seeks to transfer the technology from the laboratory to the marketplace. Ideally, the case should be positioned after the course has provided students with an overview of the foundation concepts of commercializing high technology and the creation of technology based start-up companies. These would include pre-revenue development, marketing strategy, business models, financial strategies and risk management. Students will then be better prepared to analyze and evaluate the complex issues facing the university and develop strategic recommendations that will address the issues of guiding university-based research so as to optimize the value of that research to society as well as to the university, its faculty and its students.

1 © 2010 Stevens Institute of Technology. All Rights Reserved. Portions of this case are reproduced from an article written by Patrick Berzinksi and formerly published in the Stevens Institute of Technology Alumni Magazine. The authors would like to acknowledge Dr. Lex McCusker who provided the case positioning. Special thanks to Seth Tropper for extensive interviews about the Company.
Introduction

President & CEO Frank Shinneman was putting the finishing touches on Plasmasol's confidential private placement memorandum. The document was dated March 2004 – but, in fact, was the culmination of 8 years of scientific research and entrepreneurial effort by dedicated team of faculty and student entrepreneurs. After surviving on founders' capital and government grants for five years, the principals of Plasmasol believed it was finally ready to go to the venture capital markets for its “Series A” institutional financing. The Company was hopeful it could raise $5 million at a pre-money valuation of $20 million or more. This amount of capital, they believed, would lead to rapid commercialization of a new plasma-based medical sterilization technology - though that application was far from proven and was still in the prototype phase.

At this stage of commercial development, many questions had now been answered about the capabilities of the plasma technology and its commercially important applications. But many more uncertainties lay ahead before the technology could make its way out of the laboratory. Of course commercial exploitation was only one goal: as an equally important goal, the investors required an attractive return on their investment.

History of Plasmasol

The work to propagate large-volume cold plasmas began in earnest at Stevens in 1996. That year, Dr. Erich Kunhardt of the Department of Physics and Engineering Physics received a development grant from the Air Force Office of Scientific Research (AFOSR). Kunhardt had also founded the Plasma Physics Laboratory at Stevens in the early 1990s, after considerable work in the field at both Texas Tech and Polytechnic University in New York. His main research interest had been to produce controlled behaviors in fields of energized particles, i.e., plasmas, including non-linear wave propagation. Now, with his Stevens colleague Dr. Kurt Becker, Kunhardt went for a much sought-after goal: engineering dynamic plasma reactions in a non-vacuum environment. Their success translating particle theory to measurable results in the lab opened a whole new range of applications.

"The work I was doing on plasmas was simply looking for ways to prevent plasma instabilities," said Kunhardt, in an interview given in 2000. "The idea is that once you have a plasma, which is a new state of matter, you have all these particles invested with energy. Then you can use these particles to do some interesting chemistry. But I never thought of getting involved in the environmental area at all. That came to be because George Korfiatis and I were friends."

Dr. Korfiatis, the founding director of the Stevens Center for Environmental Engineering, was fascinated by the potential of non-thermal plasma to create solutions to environmental problems.

"Erich had a basic invention," recalls Korfiatis, now Provost and University Vice President of Stevens Institute of Technology, speaking from his offices at the (Center for Environmental Engineering (CEE). "We began to explore it on the environmental front.
Plasmas had been used in the past, but they never really made it into the marketplace. The cost and difficulty of generating them reliably was too great.”

The researchers tackled the problem of reliable generation early on. Dr. Ivo Gallimberti, then a visiting research professor in electrical engineering from the University of Padua, developed the linchpin power-supply technology that made the plasma source a practical reality. “So, from late 1997 on,” recalled Kunhardt, “things fell into place, and we started a serious collaboration with Korfiatis and the CEE.”

Multiple Applications: A Question of Focus

An initial proposal to the US National Aeronautics and Space Administration (NASA) brought the first environmental research funding. This three-year project involved the use of plasma technology for the destruction of airborne contaminants, such as microbials and particulates, which are of special importance in long-term, manned space flight.

Following the first grant funding, the array of applications multiplied. “Of course, with this contaminant destruction technology,” commented Dr. Christos Christodoulatos, a close CEE associate of Korfiatis and Kunhardt – and a principal researcher on the team - “the U.S. Army may have a strong interest from the standpoint of combating chemical and biological warfare.”

Christodoulatos elaborated the other possibilities: “There was also the issue of cleaning of precision parts for electronics and other devices. You can energize surfaces for the purpose of laying down layers of paint or protective coatings. You can, in essence, engineer a ‘plasma blowtorch,’ for etching surfaces, cleaning them, and sterilizing them. There are obvious medical uses.

“And of course the major environmental applications: The destruction of volatile organic compounds, or VOCs, benzene and toluene, which are major and typical contaminants in water and soil, for brownfields remediation.

“Finally, there is the prospect of modifying the characteristics of industrial and automotive exhausts, nitrogen oxides and sulfur oxides, greenhouse gases – an area which, though still in preliminary study, promises to yield very large, very significant applications.”

A technology fertile with such wide-ranging promise led the researchers to the logical question: Where do we go from here?

Personnel

By the spring of 1998, the combined team from Physics and Environmental Engineering was ready to take the next step with non-thermal plasma technology. One item was agreed on. There was a need to commission a survey of the real-world economics involved in trying to develop and commercialize their creation. The question was, how to go about it?

“We all said, ‘What can we do to bring this scientific breakthrough into application?’” says Christodoulatos, leaning far back in his desk chair as he reminisces.
“We knew we were not the people to do this, to bring this into a business environment. We said, ‘We want to be professors, but we want our students to be exposed to technology development. And we want to be part of that process as well.’

“We began talking to our guys at the Office of Technology Transfer – Daryl Boudreaux, and after him Mike Epstein and Joe Moeller. We had had many meetings over a year or so, because we were in search of a new academic model that would allow us to go forward. From the beginning, we saw this as an opportunity to create a new culture at the university. And this is critical,” he says, raising a finger for emphasis, “because in the beginning we had a hard time getting our point across even to our colleagues. We believed that this should occur as part of a developing culture at Stevens.”

This idea had its origin years before in coffee-hour discussions among Kunhardt, Korfiatis, Christodoulatos and others. With the vision and leadership of Stevens’ President, Dr. Harold Raveché, it would soon blossom into the project-based Stevens educational concept of Technogenesis®. The Technogenesis environment now represents the institutional future of Stevens. It has been endorsed and encouraged by the greater Stevens Community.

In April 1998, however, the focus was on getting started. The plasma researchers persuaded the Office of Technology Transfer to release an e-mail enticement to the Wesley J. Howe School of Technology Management. Dr. Gary S. Lynn, then an associate professor in the Master’s in Technology Management Executive Program, forwarded the e-mail to his students. He included the tag line: “Two professors at Stevens invented a radically new process and need some assistance. Would anybody be interested in helping them out (for PAY?)”

The proposition followed:

Masters Level Management/Business Student
Technology Management Experience a plus
Earn $3,500
Research and Produce an Industry Report on “Application of Plasma or Corona Treatment in Plastics/Polymer Manufacture”
You will be part of a team effort to commercialize a breakthrough technology recently invented at Stevens. The immediate goal of the team is to understand the impact of the new technology on selected business areas …

Four of Lynn’s MTM students on the verge of graduation, looking for a master’s project, read the e-mail and were inspired to sign up.

Those four now constitute the core business team of Plasmasol Corp. They were: Kurt Kovach, eventually to become President and CEO of the company; Seth Tropper, Executive Vice President and Chief Operating Officer; Richard Crowe, Executive V.P. and Chief Technology Officer and developer of prototype devices; and Jack Levitt, Executive V.P. and Chief Financial Officer.

Kovach remembers the reaction among his classmates. “We read Gary’s e-mail and said, ‘Hey, this sounds like a ready-made project we can handle!’”
Indeed, the Technology Management grad students were all seasoned veterans with corporate backgrounds. Kovach had spent fifteen years as a high-tech entrepreneur, while Tropper had provided technical and management solutions to various corporate entities, including AT&T. With a degree in electrical engineering from New York Maritime Academy, Crowe had ten years' experience in industrial engineering gained at a number of Fortune 50 companies. Levitt's background was firmly rooted in marketing, accounting and finance, as well as commercial lending.

Preparing for their graduation, the students approached the researchers, traded ideas, and were accepted for the project.

The actual market analysis proceeded through the summer of 1998, under the aegis of the Bridge Consulting Group LLC. The results were delivered that September.

"Essentially," says Tropper, "we identified incredibly large markets for which to commercialize this technology. However, it was evident that the task was enormous, and a corporate structure needed to be established. So we offered our services and the opportunity to partner and form a company and spin off from Stevens."

"So they approached us after they did the market survey," says Korfiatis. "And they were all enthusiastic about it. Because we were initiating a company, they asked us if we wanted them to be the business component. We said yes. And Plasmasol was born in its essentials."

### Market Opportunity

During the summer of 1999, Kovach, Tropper and Crowe had identified four key market areas.

- **Combustion engine market**: $3.5B annually
- **VOC remediation**: $1.4B annually
- **Surface cleaning**: >$1B annually
- **Industrial stacks**: $700M annually

Ironically, the ultimate market application - sterilization of medical equipment - did not stand out at the time as the low hanging fruit. Instead, Kovach, Tropper, and colleagues were especially focused on the internal combustion engine market. They were cognizant of federal EPA regulations mandating near-zero auto emissions in 10% of new vehicles by 2003. No current technology offered a solution to this problem for automakers. A precision-engineered non-thermal plasma reactor could, in theory, make the conventional catalytic converter, a fixture in every new car produced, obsolete. The team's enthusiasm only grew as the research went forward.
Growing a Company from a Technology

All that remained by January 1999 was to formalize the company and to build towards the first round of capital formation. Seth Tropper details the modest first steps. “In the very beginning, the eight partners (the researchers and business team) invested $4,000 each to pool $32,000, just to have something in the bank. And that kept us going for a while.”

A period of negotiation was begun with the Stevens Director of Technology Transfer. The company moved into a set of small offices on the Stevens campus while an acceptable contract was hammered out. Work was to be pursued on a part-time basis while the managers maintained consulting contracts and other sources of income.

In February of 1999, the company was organized as Plasmasol LLC. While the pace of research and prototype development picked up, the full business plan was constructed and completed by September. The national phase patent for “Capillary Discharge Non-Thermal Plasma,” the core technology, was filed that same month. The company soon joined the New Jersey Technology Council (NJTC), which would later play a vital role in showcasing Plasmasol at its technology venture fairs. Before the year’s end, Tropper had become an active member on the NJTC Environmental Advisory Board. In November, partnered with the NJTC, the company hosted an EnviroTOUR showcase at Stevens. This by-invitation-only fair attracted numerous corporate and governmental scouts, and it led to Plasmasol’s first contacts with the U.S. Navy, which, as we will see, would result in a most fruitful relationship.

In December, the company made its first presentation to the U.S. Department of Energy’s Office of Automotive Technologies.

Dealmaking with Stevens Institute of Technology

In the closing weeks of 1999, Plasmasol signed a definitive agreement with Stevens Institute of Technology, whereby the firm would license the Kunhardt/Becker patented cold plasma technology from the university, which jointly holds the patent. In return the university would provide like-in-kind accommodations and access to lab facilities and other incentives. These incentives are, in many ways, unique to Stevens.

It was agreed that the four student founders – Kovach, Crowe, Levitt and Tropper – as well as the four faculty researchers – Kunhardt, Korfiatis, Christodoulatos and Gallimberti – would each get 6 ¼ percent of the company, for a total of 50%. Stevens would retain 50%. But only Stevens stock was subject to dilution: the Institute would give back up to 25% of its stock to investors, as the Company needed it for growth.

“Believe me,” says Kovach with exuberant assurance. “I am acquainted with development projects at other tech universities. Of all the major institutions, only Stevens recognized entrepreneurs must be adequately incentivized. Stevens was particularly generous in sharing equity, which kept the team motivated throughout difficult down spells.”
Also built into the agreement were the concepts of the Technogenesis environment, which Plasmasol endorsed and publicized in its own press releases.

**Fundraising Challenges and the Need for Focus**

Subsequently, Plasmasol sought important seed funding to begin construction of prototypes for its major applications. Through a personal contact of the founders, the Company was introduced to Wilton Hawkins – a successful entrepreneur who had sold an industrially important chemical process to the Saint-Gobain corporation for millions of dollars. After studying the technology, Hawkins invested $1 million of his personal fortune for a 5% stake in the Company. The Company burned through his investment capital meeting many of its milestones of raising government grant money, but without generating operating income.

In 2001, the Company was introduced to the Cali family, who controlled a multi-billion dollar commercial real estate portfolio under the Cali-Mack moniker. The Cali’s were intrigued by the potential of the technology to decontaminate pollutants in office heating ventilating and air conditioning (HVAC) systems. They saw Plasmasol as a strategic investment to their real estate portfolio. In a series of two investment rounds, they invested approximately $400,000 in Plasmasol. They also made introductions to potential strategic partners in the HVAC industry, with whom the Company had prolonged (but ultimately fruitless) discussion.

The Company was stumped in finding another angel investor who had as much confidence in the early-stage technology and Plasmasol’s entrepreneurial team as did the Cali family or Wilt Hawkins.

Still without a marketable product or service, the Company soon discovered that it was too early to solicit further angel funding. So the principals started looking at grants at the State and Federal level. In fact, the Company was remarkably successful obtaining grant money. From 1999 through 2004, the Company had received about $7 million of grants. Sources of grants were NASA, the Memorial Institute for the Prevention of Terrorism, DARPA, the Environmental Protection Agency, the National Science Foundation, and the Office of Naval Research.

According to Tropper, “We were almost too successful at raising grant money. This had the unintentional effect of de-focusing our marketing efforts. If the grant making agency directed us to focus on one application, we were basically obligated to work in that area – even if our market research and business sensibility told us there was an easier route to commercial success.

Tropper continued, “The quantity and quality of funding was constantly a concern. The grants paid for research, but we needed investment capital to pay the salaries of the marketing team. You cannot run a business when you run out of cash.”
In 2003, the Company had revenue from grants of $1.5 million and a net loss of $630,000. In 2003, the Company received a cash infusion from an angel investor in the amount of $115,000 plus a bridge loan from shareholders of $600,000.

**Financing Pressures and Personnel Challenges**

In 2004, Plasmasol employed 10 people, including a technical staff of 6. And the Company leased a 6,000 square foot facility from an incubator affiliated with Stevens. Funding challenges created inevitable tension within the entrepreneurial team, who often missed paychecks due to shortages in cash flow. Eventually, the cash flow strain was too much for Kovach, who resigned from his position, but kept his equity in the Company. Levitt, too, kept his equity, though he never quit his day job, and was not active in Plasmasol's continuing operations. "This inequality created a certain amount of reflection from other members of the team," noted Tropper. "If we could go back and change employment compensation packages, everyone would have been put on a vesting schedule."

**Shift toward the Medical Sterilization Application**

Sterilization of medical devices was always in the back of the minds of the research scientists and student entrepreneurs. In fact, sterilizing medical devices appeared as a target market (though not the 'low-hanging fruit') in the original 2000 market study. But by 2004 it was time to refocus. Homeland security applications were lucrative for obtaining grants, but hit a dead-end in commercial markets. So in late 2004, the Company decided to re-write its business plan concentrating now on medical sterilization. This was largely based on feedback from the marketplace. From its anti-terrorism projects, the Company already had test results from the scientifically-related area of surface decontamination studies. The Company then made a strategic hire - Mike Orrico, a biomedical engineer who formerly worked at Johnson & Johnson and Stryker to focus on this new area. Quickly, the Company developed a process for medical instrument sterilization using plasma as a gas generated to produce a transient biocide based on active chemical radicals. Orrico was then able to introduce Plasmosol to his former colleagues at Stryker. The Company discussed a strategic investment with Stryker for almost a year, as it simultaneously pursued the venture capital route.

**Conclusion/Epilogue**

As it turned out, Shinneman was unsuccessful raising venture capital: the Company was just too early stage to attract institutional investors. Especially in the wake of the dot.com crash, when venture capital dried up in the United States. New grant money allowed the Company to survive until 2005, when Stryker decided to purchase the Company outright for $17 million. Upon the Company's sale, Stevens still owned 35%. The founders and employees still controlled approximately 50% of the Company, and the angel investors held the balance of equity. In the end, all parties were paid handsomely
for their efforts and the risks they took, though the financial ‘exit’ was not what anyone had originally anticipated.

**Study Questions**

1) What were the initial markets that the Plasmasol founders pursued? How did they narrow down their market scope to medical sterilization?

2) How did the Plasmasol founders recruit the entrepreneurial team? Did they have the right mix of skills to commercialize the technology? How did team dynamics evolve along the way?

3) Where did Plasmasol receive financial backing? What are the benefits and drawbacks of relying on government agencies as a source of funds? What was the position of angel investors and institutional venture capitalists?
APPENDICES

Appendix I: 2004 Private Placement Memorandum
[incorporated by reference – see attached]

Appendix II: Selected Corporate Milestones

2000

Plasmasol was honored with a visit from Governor Whitman, who praised the efforts of the Incubator businesses at Stevens and elsewhere.

Plasmasol received its first major development grant. The New Jersey Commission on Science and Technology awarded the company a recoverable grant for $250,000 to build a prototype for VOC remediation.

Company signed an agreement with the Lakehurst Naval Air Warfare Center to field-test a VOC remediation platform.

Major honor from the New Jersey Technology Council (NJTC), citing Plasmasol as the vendor displaying the “Most Innovative Product” at the annual NJTC Venture Fair

Company became a co-recipient (with Stevens and Alcoa) of a $350,000 grant from the National Science Foundation for work in surface cleaning.

Plasmasol was able to declare the first round of funding closed - $1 million from Wilt Hawkins. Three founding employees left their days jobs to join the Company full-time. Jack Levitt withdraws from ongoing management team, leaving only three of the original four student founders – Seth Tropper, Kurt Kovach and Rich Crowe.

Company named “Environmental Company of the Year” by the NJTC.

Company won two Naval Air Warfare Pollution Prevention (P2) contracts, adding to their growing roster of high-visibility contracts.

2001

Plasmasol received a NASA contract to demonstrate sterilization of spacecraft components using non-thermal plasma technology.

Plasmasol publishes new investor pitch with the following market foci:
1) remediation of volatile organic contaminants (VOC) from contaminated soil and ground water; 2) automotive emission control; 3) surface cleaning; 4) industrial stack and emission control.

Cali family invests $300,000 as second round of angel investors in Company.

2001
Terrorist attacks of 9/11 shift government granting agencies focus away from environmental protection and toward anti-terrorism applications. Plamasol adjusts its business model accordingly.

2002
Company received contracts from the Environmental Protection Agency (EPA) and Department of Homeland Security to build a portable field unit to kill airborne bacteria.

2003
DARPA and US Navy funded Company for demonstration of a portable air sterilizer and virus inactivation unit.

Company developed a process for medical instrument sterilization using plasma as a gas generated to produce a transient biocide based on active chemical radicals.

Frank Shinneman replaces Kurt Kovach as CEO. Of the founding management team, only Seth Tropper remains.

Joint ventures are pursued in the heating ventilation and air conditioning (HVAC) industry. Introductions are facilitated by the Cali family, which invests an additional $100,000.

Company announced annual revenue of $1.5 million (all revenue based on government grants) and a net operating loss of $630,000. No commercial product has been sold yet.

2004
Company re-focuses business plan on medical sterilization based on feedback from the marketplace and test results from anti-terrorism related surface decontamination studies.

Rich Crowe withdraws from daily management of company, leaving only Seth Tropper as original student founder.
Private placement memorandum is published with medical sterilization theme. Shinneman attempts to raise $5 million.

Company hires Mike Orrico, a biomedical engineer who formerly worked at Stryker, to focus on medical sterilization application.

Orrico introduces Company to Stryker. Discussions on a strategic investment ensue for almost a year.

2005

Company is unsuccessful raising $5 million venture capital. Venture capitalists find the technology too early stage – i.e. no demonstrable prototype, application-specific test results or third party certifications for the medical sterilization application.

Stryker elects to purchase Company for $17 million cash.