AN ABSTRACT OF THE THESIS OF

Brendan Johnson for the degree of Honors Baccalaureate of Science in Bioengineering presented on June 1, 2007. Title: Aegir Innovations: The Journey – Untangling the Web of Social Networking.

Abstract approved: _____

Justin Craig

Social networking is the concept that personal connections can form a large web of people and institutions that are essential in an individual's realization of a goal. Social networking plays an important role in almost every business venture. This has proved to be especially true in the story of Aegir Innovations LLC, a small research and development company. Every goal that the members of Aegir Innovations have accomplished has been either directly or indirectly related to a networking connection that they have maintained. In the case of this small startup, the social networks that were tapped into include personal friendships, family members, roommates, and random connections through multiple degrees of separation. While networking is not always an important aspect of an aspiring entrepreneur's journey, in the case of Aegir Innovations, it has proved to be paramount.

Key Words: Social Networking, Entrepreneurship, Due Diligence, Startup

Corresponding e-mail address: johnsob5@onid.orst.edu

Aegir Innovations: The Journey

Untangling the Web of Social Networking

by

Brendan Johnson

A PROJECT

submitted to

Oregon State University

University Honors College

in partial fulfillment of
the requirements for the
degree of

Honors Baccalaureate of Science in Bioengineering (Honors Scholar)

Presented June 1, 2007
Commencement June 2007

Honors Baccalaureate of Science in Bioengineering project of Brendan Johnson presented on June 1, 2007.

APPROVED:

_____

Mentor, representing Business

_____

Committee Member, representing Business

_____

Committee Member, representing Education

_____

Chair, Department of Chemical Engineering

_____

Dean, University Honors College

I understand that my project will become part of the permanent collection of Oregon State University, University Honors College. My signature below authorizes release of my project to any reader upon request.

_____

Brendan Johnson

TABLE OF CONTENTS

Introduction

There are times in history where radically innovative solutions to problems create great scientific and technological strides. These solutions step beyond the shortcomings of previous solutions in order to solve key problems in promising ways. These leaps and bounds of science are significant and amazing because over the course of a single answer being explored, all previous answers become redundant.

Microscale desalination has the potential to be one of these redefining, innovative and remarkably world changing solutions. Creating fresh water from salt water has been a problem humankind has tried to solve for centuries. Distillation, or boiling water in order to re-condense the salt free steam, is one answer used by millions. Another more recent solution implemented on a worldwide basis is known as reverse osmosis. Unfortunately, both of these answers are prohibitive due to their monumental energy requirements. While these systems are solutions to the problem of desalination, they are not the best solution. They work, but not well enough to adequately supply the ever-growing worldwide demand for fresh water for crops, livestock, and human consumption.

Microscale desalination could prove to be a radically innovative solution to desalination. While still in its infancy, it shows promise that is reinforced and substantiated by those working on its development. It has been shown at a number of environmental design competitions and won prestigious awards for innovation. A company has even been created and funding sourced in order to further the optimization of this technology.

Aegir Innovations LLC was founded in July of 2006 and uses an under-the-radar business strategy and operating procedure. Aegir's development and intellectual property are closely guarded secrets.

There are many important aspects of any entrepreneurial endeavor such as bootstrapping, budgeting, a strong team, and due diligence. Another important aspect is social networking. Social networking is the process by which people connect with other people and institutions in order to accomplish goals. Being a successful entrepreneur requires a well versed understanding of all of these aspects, however in the development of Aegir Innovations social networking has stood out as the most influential.

History of Microscale Desalination

The basic concept for microscale desalination is interesting purely because of its simplicity. Current desalination techniques, such as reverse osmosis and distillation, make fresh water by essentially taking the water out of salt water. While this works and it makes fresh water, these systems are extremely inefficient. Microscale desalination, on the other hand, takes the salt out of salt water by taking advantage of the process of diffusion.

I, Brendan Johnson, originally developed the microscale desalination idea while sitting in a WERC design competition meeting. I remember thinking about new ways to desalinate water because I chose that as my “task” for the WERC competition. The first sketches of the design were done on the back of a magazine subscription form. It was quite frankly a “eureka” moment. The basis for what was first drawn came from a magnificently designed biological model: our bodies. I was enrolled in an anatomy and physiology class at the time and had recently learned that no cell in the human body is more than 100 microns from a capillary due to diffusion of oxygen through extra cellular fluid. As reference, a human hair is about 80-100 microns in diameter.

The most important aspect of microscale desalination is the fact that small channels are used to accomplish an equally small goal. By numbering up, or increasing the number of channels by orders of magnitude, a greater goal can be accomplished. The design for each channel does not change; only the number of channels in a final system. This flexibility allows microscale desalination to be tailored to any production demand and since every channel is identical, manufacturing processes may be streamlined to allow quick and cheap production.

After additional sketches and finalized drawings of possible prototypes, I realized patenting the technology would be smart. I first spoke with Brian Wall at the Technology Transfer office at Oregon State University. I was well received but he made it a point to say that OSU does not patent ideas, it only patents technology. This made sense to me but I also asked what measures I would have to take if I wanted to patent the design I had come up with on my own even though I was taking it to the Waste-management, Education and Research Consortium (WERC) competition in New Mexico on an Oregon State University team. I was told by Mr. Wall that as long as no OSU funds were used to develop the technology and that I did not get grants or funding through OSU there would be no claim to what I developed. After this conversation, I made certain that all of the money put into producing prototypes was my own and there would be no use of OSU funding.

The original single channel prototype was assembled and tested in the lab of Goran Jovanovich, the WERC project team advisor. The total cost of the first prototype was roughly $20 and it removed about 5% of the salt from a saline solution per pass.

Design Competitions

Microscale desalination was showcased at two different international design competitions. The first was the WERC competition in Las Cruces, New Mexico in early April 2006. The second was located in Al Ain, United Arab Emirates at the end of April the same year.

There were roughly 50 teams at the WERC competition, with 4-6 teams spread out over 8 different tasks. As taken from the WERC website, the problem statement for the desalination task was as follows:

> *"Develop and demonstrate a low-cost, simple and reliable system for use in brackish water reclamation. The proposed solution must be applicable for use in inland desalinization facilities and should address waste issues, reject water handling and optimization, energy consumption, and associated costs. The system must be able to produce fresh water for various sized communities throughout the southwest."*

A simple prototype was made creating a single channel in order to demonstrate the viability of the technology; not to bring a fully operation system that could produce fresh water at a commercial rate. Unfortunately, due to a misunderstanding of how the WERC competition is judged, the inability to produce large quantities of fresh water resulted in lower scores than expected. At most environmental design competitions, teams bring proven technologies and slightly modify them to make them more efficient in some way, rather than innovating new techniques. Innovation is asked for but is not usually judged highly unless it comes as a finished product.

Although there were certain shortfalls with the interpretation of the explanation of the judging criteria, microscale desalination caught the eye of the Intel Innovation Award

committee. They were given a private demonstration of the bench-top prototype and were able to ask in-depth questions regarding technology application and development. The OSU team was one of three teams that were thus in the running for the Intel Environmental Innovation Award. This award is considered the most prestigious award at WERC because it encompasses the entire competition rather than just one of the eight "tasks" that were being judged individually. Microscale desalination was chosen over all other finalists for the Intel Award and subsequently awarded to the OSU team.

The second test of microscale desalination was at the Environmental Design Competition (EDC) held at UAE University in Al Ain, United Arab Emirates. This competition was based on the same principles as the WERC competition, utilizing almost exactly the same judging criteria and deliverables. The EDC took place April 30th to May 2nd, 2006, only a few weeks after the conclusion of the WERC competition. As the originator of the design, I was the only team member that went to both WERC and the EDC. It was at EDC that Eric Anderson joined the project.

There were 30 teams at the EDC distributed between 5 different tasks, one of which was desalination of sea water for agricultural use. While at WERC, the team had a single channel in order to demonstrate microscale desalination. Four single channel devices were machined and tested for the UAE trip. Running multiple channels in parallel allowed for a higher overall flow rate and the ability to run multiple passes in order to get a higher separation percentage. Microscale desalination won the Most Innovative Award at the EDC, which was the highest honor at the competition.

Early Business Strategy

Upon conception of microscale desalination, there was little talk of creating a company. Intellectual property was guarded and maintained throughout the duration of the early developments but commercialization did not immediately seem a likely route. After receiving such praise from WERC and the EDC both in the forms of awards as well as personal statements from judges, founding a startup company to handle optimization of a single channel device appeared to be a much more feasible option.

Eric Anderson made such an incredible impact on the presentation and overall showmanship of microscale desalination at the EDC that it was quickly realized he would be a major part of future developments. He has an innate ability to understand physical systems and is able to model them with amazing accuracy through differential calculus. The team that comprised the first stage of Aegir Innovations was Brad Johnson as the primary investor, and Eric Anderson and Brendan Johnson as the developers.

The original business model had a number of unique characteristics that made it different from the usual approach many startups take. First of all, we have worked very hard to maintain an “under the radar” approach to our business and what we have been developing. Rather than flaunt our prototypes and results, we set out to work diligently on producing a table top device that could desalinate a small amount of water in order to showcase microscale desalination. Since we already had an investor that could cover our first year, we did not need to publicly search for investment capital.

Another key difference that we decided would work well with our blossoming business was the idea of operating on very little funding. We did not set out to buy top of the line test equipment or build intricate, multi-channel devices. The original test

"facility" was Eric's basement, a bench and a small collection of tools and a number of electrical outlets. Eric and I decided that we would rather see money from our business fund go into the company and not go to us as paychecks, so both of us found our own income sources over the summer of 2006.

With the basic business model formatted, continued protection of the intellectual property was required. Through a networking connection, we found a patent lawyer in California by the name of John Connors. At first glance, it seemed he would be a good choice, however, I quickly realized in my dealings with him that he was not going to be acceptable. Connors made a very stern point in saying that he only writes patents and does not litigate if anyone violates the patent. He also requested finalized diagrams of a full scale system in order to write a patent, rather than attempting to secure a patent on the design of a single channel. After dealing with Connors for roughly two months, Brad and I decided to search for a new lawyer, both to help us patent the technology as well as protect it and develop the due diligence of the business.

Through another family network connection, Ned Marshall, who comes into play later as an important contact, we were referred to Leonard DuBoff of Portland, Oregon. Mr. DuBoff has also played an important role in the progression of Aegir Innovations. Brad and I originally met with Leonard on June 29, 2006, and immediately felt his law group, the DuBoff Law Group, should handle all legal proceedings for Aegir. Within their firm, the DuBoff Law Group has a dedicated patent attorney. They also handle all LLC formation applications as well as litigation should patent infringement occur. With the DuBoff Law Group as our law firm, I informed John Connors that his services would no longer be required.

After our initial meeting with DuBoff, I performed a search for him on Google and found that he is one of the leading trademark attorneys in the world, having written the number one reference source for art law.

Over the course of my schooling at Oregon State University, I had the privilege to be a student under Justin Craig and be a part of one of his introduction to entrepreneurship classes. Because of this, I felt that a limited liability corporation, or LLC, would be the best choice of legal entity as which to form Aegir Innovations. By using an LLC, each of us would become owners with the flexibility of having different amounts of each type of share. Limited liability corporations have three types of shares: capital, profit, and loss. Tad Davies is the accountant for Aegir Innovations as well as the Johnson family. He is an OSU alumnus and was generous to offer his skills. After having discussions both with Leonard DuBoff and Tad Davies, certain percentages of each share type were decided for Brad, Eric and me.

Difficulties and Discoveries

The course Aegir Innovations took over the summer of 2006 dealt with difficulties and discoveries. While the data found was not stunning, the research always progressed in a forward direction. The team was working in a field that has little-to-no formal research papers written on it. Both the theoretical math and the physical phenomenon of the micro-channel environment are vaguely understood due to a dearth of empirical research. To say Aegir was venturing into unchartered waters is an understatement.

Over the latter half of the summer of 2006, Aegir Innovations developed numerous prototypes and testing equipment. In keeping with our goal of a small budget in order to show a proof of concept of microscale desalination, we built both a power supply and a number of different prototypes. Unfortunately, the original single channel design taken to both WERC and the EDC did not prove manageable for research. The multi-layered system that was originally implemented and showed separation values of roughly 5% had serious issues with leaking. Due to the fact that we were working towards a bench scale prototype that could be used to demonstrate the effectiveness of our technology, we realized that professionally made devices were a must and set out to find a machine shop that could produce our prototypes.

Through yet another personal networking connection, Aegir Innovations teamed with the plastic fabrication company ChemWest in Portland, Oregon. Martin Boehm, president of ChemWest, made time to meet with us while he was on a business trip to Corvallis midway through October and we discussed the possibility of making one-off single channel prototypes of microscale desalination with the option to make multi-

channel systems in the future. Martin was convinced that ChemWest could produce micro-channels that were as deep as well as long. After a number of attempts, the machinists at ChemWest were unable to build a channel that was to the same specs as I detailed in the three dimensional drawings I supplied. We discussed a slightly modified design that could be produced and I picked it up from ChemWest in late November.

Testing of the first iteration of our professionally made device resulted in frustration and a realization that we over-complicated an originally simple system. We also had leaking issues that were mostly because of a design issue that was overlooked before production. Essentially, we tried to make the channel much more complicated because we were having machinist produce it, rather than have ChemWest just professionally make what we had for the design competitions. The design flaws that existed were evaluated and fixed for the second prototype.

Eric utilized a large amount of literature research in an attempt to find papers that modeled the phenomenon we were trying to take advantage of in our device. He was able to find only a handful of papers by mid December 2006 when we set out to design our second prototype. None of the scientific documentation dealt with anything relating to desalination by micro-channels. Eric came to the conclusion that the tolerances we were working with could be expanded and our channels could be made larger. This resulted in a design that was much more eloquently made by ChemWest and was free of the design flaws of the previous device. We commenced testing on this device in early January 2007. Once we were able to control the leaking problem that has been inherent in every system, we achieved noticeable separation of salt from the bulk flow. Our single channel

design was working and we were looking to continue testing through February when Brad received a very important phone call.

Business Model Execution

Ned Marshall is an old friend of Brad's as well as a lawyer in Boise, Idaho. He heard the praise microscale desalination and its developers received in the United Arab Emirates from Brad and relayed it to his brother, Todd Marshall. Todd works with the Wilson Group and they were searching for growing technologies to purchase. Ned told Brad that Todd wanted to get in contact with us when we had established both a company and secured all of the intellectual property regarding microscale desalination. Essentially, once the due diligence was in order. Ned had many good things to say about the Wilson Group. They are globally situated with construction contracts across the world. The Wilson Group is also environmentally conscious and has been developing a novel system to produce biodiesel. They are family owned by the Wilson family and were established in the early 1900s.

By mid February of 2007, our due diligence was in order and we controlled all of the intellectual property for microscale desalination, the Wilson Group decided to invest a few days to meet us and hear about our process and what we had accomplished to date. Eric and I set out to develop an information packet that contained the background of microscale desalination as well as the patent disclosure agreement and a mathematical basis for the system. We completed the packet and sent it off about ten days before the Wilson Group was scheduled to meet us.

The two days of meetings were planned well in advance for what their content and schedules would be. Monday night, the 20th of March, we were all to have dinner at Le Bistro in Corvallis after having picked up the Wilson Group from the Corvallis Airport. Dinner on Monday was intended to be primarily a meet and greet affair with

very little business talk taking place. Tuesday morning was planned around a short breakfast at the Johnson's home in Albany followed by a complete business presentation.

The group that traveled from Florida consisted of Todd Marshall, vice president of the biodiesel branch of the Wilson Group, Tony Silva, the marketing manager of biodiesel development, and Christopher Wilson, vice president of the Wilson Group. They also picked up Ned from Boise so that he could be a part of the proceedings and to see Brad again.

Overall, the two days went very well. Business discussion was held off during dinner, we did talk about the other companies that are owned by the Wilson Group but Aegir Innovations and microscale desalination were not discussed in great detail. It was very easy to talk with everyone; there was an instant rapport which was very relieving. The dinner itself was absolutely stunning; six course meal with a different wine for each course. Brad is close friends with the owner of Le Bistro, Ian, and while the restaurant is normally closed on Monday, he agreed to cook for us and serve the entire evening with his wife. We had the restaurant to ourselves and were then able to focus entirely on getting to know each other. There was an overall sense of good tidings at the end of the evening when we dropped our guests off at the Hilton in Corvallis and agreed to pick them up at 8am the following morning.

On the morning of the 21st of March, Eric and I picked up Todd, Christopher and Tony from the Hilton and drove to Albany to meet up with Brad and Ned who had stayed at the Johnson's house. Breakfast was ready when we arrived and we got to know one another a bit further, most of all we talked about the previous evening and how wonderful it was. After breakfast was concluded, Eric and I began out presentation.

I presented a history of microscale desalination as well as the different awards it has won along with other praise it has received. I spoke of how Aegir Innovations was conceived and executed along with the different prototypes that we have made along the way. Eric presented the mathematically modeling of the channel design that he developed. After Eric finished his discussion of the proof of concept math, I began talking about the applications and costs associated with microscale desalination. Much of the presentation was in a question and answer format that was very open ended but focused on our presenting and the Wilson Group members responding. They asked a lot of very intriguing questions and we fielded them with strong answers. One of the biggest problems that we made sure to point out is the fact that this technology is still in an early developmental stage thus the numbers and predictions we were presenting were very basic. After the presentation was over we took time to have a lunch that was prepared by my parents, Brad and Jan, we had spent over three hours sharing microscale desalination with the group. Over lunch, we talked more about the possible uses for microscale desalination.

One of the most important reasons that the Wilson Group is interested in making fresh water is the production of biodiesel. Biodiesel production systems require large amounts of organic feed stocks and usually a crop is grown and harvested to meet these demands. The Wilson Group has been in communication with a number of arid countries that are willing to loan tracks of land to them in order to have a biodiesel plant. The problem is that these acreages are short on fresh water. The Wilson Group saw microscale desalination as a way to solve their water problem.

As the conversation lulled and we started to run out of things to discuss in regards to business aspects, Christopher dropped something of a bomb shell at the table. He offered his family company to be the sole investor in microscale desalination and offered to buy out our shares in Aegir Innovations with the option for us to continue working on the project. While it was not a complete surprise after our well executed presentation, it was still an exciting turn of events. Due to the history we had learned of the Wilson Group from Ned and having met Christopher Wilson and his colleagues, we agreed to have the Wilson Group buy out our company and offer us jobs. Christopher offered to draft a proposal and get it to us within two weeks. He also asked us what was most important to us so he could personalize the proposal. Brad answered and said that a strong salary that is on par with other engineering salaries would be a must as well as a stake in the future of microscale desalination in the form of a percentage of its earnings. The timing for this ending to their trip was impeccable due to the fact that they had a dinner they had to be at in Idaho within a few hours. We shook hands and by this point were completely ecstatic with the two days.

Christopher Wilson followed through and offered a proposal in the coming weeks; it needed little to no revision so we have since moved onto formal contracts and are in the process of signing.

Reflections

In the writing of this thesis document and over the course of my reflections on what I have achieved with microscale desalination and Aegir Innovations, I have realized that social networking and maintaining contacts with people has been the most influential aspect of my journey. The networking connections that have been important to me go beyond those that I have made in the last few years. Even contacts I had established as far back as high school, as I will discuss shortly, have had a resonating affect on the course my life has taken. Essentially, every positive aspect of what has happened to me over the course of taking on this project and completing my schooling at OSU while being a part of the Honors College has been because of a networking connection. I was originally taught this idea of networking and its importance in Justin Craig's "Introduction to Entrepreneurship" honors class fall term of my junior year. Only now have I come to the conclusion that social networking should be the most important goal of any aspiring entrepreneur.

Over my time at OSU, both direct and indirect connections have been made around me and being in the Honors College has been a major catalyst for opportunity. I was fortunate to take Justin Craig's class at the same time of my first inventing microscale desalination. While at the time, I did not see the long term implications of what I started then, but Justin played a monumental role in everything that happened to me. Most of all, I knew that Justin was a great resource and I could call upon him for a second opinion in regards to business endeavors, which has proved invaluable since I have little business experience. He also introduced me to Erik Larson in the College of Business who gave me yet another view point of business proceedings by asking Eric and

me questions of reflection for a project he was developing. Another important bond that I have maintained since high school has been my friendship with Mike O'Malley. Mike was the most influential teacher I had at West Albany High School, teaching me both history and English. He always supported me in my endeavors and would take time out of schedule, which is now primarily at OSU in the Department of Education, to talk with me. Because of the connections I have with these three men, I have chosen for them to be on my Honors Thesis defense committee, taking advantage of networking connections.

Goran Jovanovich, of the Chemical Engineering Department, played a major part in my development of microscale desalination because he originally allowed me to be involved in the WERC project. This set my mind thinking in the direction of desalination. He also organized OSU's appearance in the United Arab Emirates. Without the help of Dr. Jovanovich and his connections, microscale desalination would have never received its recognition. It was also through Goran I originally was introduced to Eric Anderson, which has had lasting positive implications on the development of Aegir Innovations.

As microscale desalination was originally going from a design on paper to an actualized device, I used a networking connection to develop the machining for the first set of prototypes. One of my friends from Chemical Engineering, Evan Caddock, was on my team for the WERC project and his dad owns a machine shop in southern Oregon. This allowed for huge amounts of savings in the production of the first prototypes because Evan was willing to work for free using scrap plastic that his dad's shop had available.

Once it was a realization for us to build a small company around microscale desalination we were referred to Leonard DuBoff of the DuBoff Law Group. Ned

Marshall, who was responsible for much more than finding Aegir Innovations a strong legal counsel, was a major catalyst in our introduction to the DuBoff Law Group. Ned knows the lawyers that run Ransom and Black, a large firm in Portland, Oregon, and through his networking web, Ned set up a conference call for us with Ransom and Black. We spoke directly to Jack Ransom and he informed us that small business was not an aspect of law that his group covered, and he in turn set a meeting with Leonard DuBoff. Mr. DuBoff met with us directly a few weeks later and we all decided that our two groups would work well together, with the DuBoff Law Group representing Aegir Innovations as well as handling all patent proceedings. This indirect connection has been a great example to me how direct networking is not always responsible for accomplishments and by taking advantage of the networking connections that other people have can be just as strong as developing those contacts for oneself.

While I called upon a close friend to develop the original prototypes produced, I also found out about ChemWest through a friend. One of my closest personal friends, whom I met in the dorms, Nick Boehm, has been with me in the same engineering department, as well as the Honors College, for four years. His father, Martin Boehm, was very interested in helping one of his son's friends and agreed to produce more elaborate prototype devices for Aegir Innovations.

After our professionally produced prototypes were delivered and assembled from ChemWest, we took advantage of another connection within Aegir Innovations to have a specialty power supply made for testing. Cassady Roup, the roommate and close friend of Eric Anderson, graduated from OSU with an electrical engineering degree in 2006 and was able to help us by building a power supply with parts Aegir Innovations had ordered.

Nick Boehm and Cassady Roup are two interesting networking connections because not only have they played important parts in the development of Aegir Innovations, they have also been close friends to members of Aegir for many years. In this regard, Ned Marshall is similar and has been associated with Aegir Innovations through Brad, both as a friend and as a source for connections in the legal world. Ned, as it turned out, has played a much greater role than either Nick or Cassady in that he has provided connection to the future of Aegir and not just the development. Without both the direct and indirect connections that Ned has provided for us, our current fortuitous situation could not have been possible at this stage of our development.

Conclusion

The future of Aegir Innovations and microscale desalination continue to take shape each day. There is a definite potential for monumental world change in the development of microscale desalination, however, radical innovation is not only about pure science. As I reflect on a discovery which has worldwide implications, it is refreshing to realize personal connections and friendships made it all possible. There is a significant element in the actualization of a dream that requires strong networking and the ability to find connections through people. Although it is unclear as to where the coming years will take those involved in Aegir Innovations, there is no question that networking has been a vastly important part of its initial development.