Product Development & Business Planning for a Fishing Innovation

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Fall 2009 IPRO Team 358

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Table of Contents

1.0 Executive Summary

This project is to produce an innovative fishing hook, named the Delta Hook, which is intended to solve the existing problems related to safety and fishing performances, that offers unique feature such as the new innovative interlocking design; a new and revolutionary concept in the fishing industry. The idea was conceived by Taylor A. Park who is the founder of Sparrowhawk LLC, based in Glenview, IL. This company is the sponsor of IPRO 358 which consists of a product and a business team. The class began in the summer of 2009, and is currently in its second semester. The target fish for this specific product is the Largemouth Bass. The product design resembles 3 flexible hooks integrated in an inward hook configuration (for the safety feature), which deploys (expands) when a fish closes its mouth with all the 3 hooks pointing outward as it locks on to the fish as the fish tries to escape.

The manufacturing process of this product differs from the previous summer team, which utilized heterogeneous materials in developing the hook to have both performances of hardness and flexibility. While the fall team only utilized a homogenous material trying to achieve the same performances as the summer team. This is a leap forward in reducing cost of manufacturing and performance, which reduces mechanical failures during the fishing operation

The business team primarily focused on pricing, promotion, and placement strategies.

For placement, several perceptual maps were created based on features like safety, weed less, snag less, sharpness, competition and price which we thought were key components in a hook. After taking into account the perceptual maps and the reviews of the customers about the competitor products it was decided that it was fair to charge a certain amount of premium to the Delta Hook. The price that was determined was based upon a survey conducted at various retail stores and fishing spots and the results obtained from the analysis of the sample population that was surveyed. This gave us a rough estimate for the demand that existed for a superior hook in terms of design and performance. The hook was intended to be sold to our target markets which were fishing enthusiasts and professional anglers, and with relatively low variable and fixed costs, and a high contribution margin it was estimated that this would be a profitable venture.

For promotion, advertisement through media channels like television and finishing magazines was determined to be the best source for promotion. The intent of the ad campaign developed was educate the public regarding the safety, performance and also to spread awareness of the new revolutionary fishing hook featuring the new interlocking design. Creative artworks and slogans were then used to develop brochures and posters.

Overall the unique features of the Delta Hook, designed and developed primarily to tackle the existing sports-fishing safety and performance issues, puts Sparrowhawk in prime position to capture a portion of the market share of the 1.3 billion industry.

2.0 Purpose and Objectives

2.1 Purpose

The purpose of this project was to continue the development and creation the Delta Hook Technology (DHT) as well as lay the foundations of a business model for Sparrowhawk, LLC, a startup company. The goal for the product development team was to create a functional prototype to: 1) draw the interest of investors; 2) aid manufacturers in the production of the hook; and 3) draw the interest of anglers at iCAST 2010. Sparrowhawk generated a concept for an innovative fishing hook, the Delta Hook (using DHT), that offers its users better catch and hold abilities by incorporating an interlocking design, weedless and snag-proof operation, as well as both improved angler and fish safety by incorporating a barbless design. The design concept of the Delta Hook may be viewed below in Figure 1. Notice the interlocking of the three shanks when in the engaged mode. The safety features as well as the weedless and snagproof capabilities are demonstrated in the standard mode with the inward facing hooks as well as a barbless hook point. These features eliminate the hook to be stuck into human flesh unintended, where it only engages when the fish bites it.

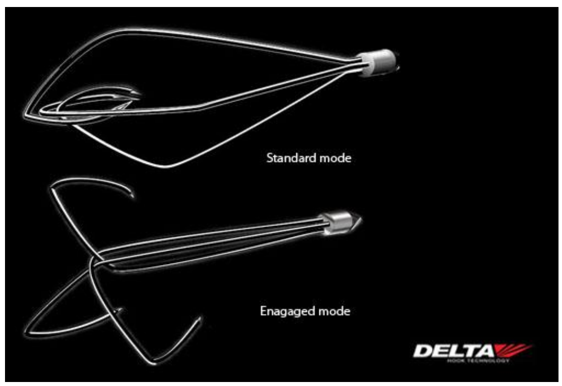


Figure 1 – Delta Hook

To make this concept a reality, the team designed, constructed, and tested mock-ups to maximize the hook strength, minimize fatigue in the shanks, and maximize sharpness in the hooks. Work was done to understand the demand of the consumers and determine probable distribution channels as well as the strategies to best use them. The new IPRO team was divided into two sub-teams (Business and Product Development) that worked together to accomplish the objectives established at the beginning of this project. The objectives for each team are outlined below.

2.2 Product Development Team Objectives:

The primary goal of the Product Development Team was to explore different design possibilities, and to create a mock-up of the DHT that incorporate safety, weedless operation, snag-proof capabilities, and strong holding abilities. This includes the following objectives:

- Optimize the geometry of the hooks and shanks
- Finalize the total number of pieces in design (base, shanks, hooks)
- Determining the optimal size of the Delta Hook which is comparable to treble hook

• Optimize the geometry of the hooks and shanks
• Finalize the total number of pieces in design (base, shanks, hooks)
• Determining the optimal size of the Delta Hook which is comparable to treble hook
• Select the appropriate material for the Delta Hook
• Identify test material treatment methods (e.g. carburizing, quenching and tempering,
• Construct 4-7 mock-ups to our specifications (see section 4.1.5).
• Make an appropriate final material selection for shank and hook based on test results.
• Determine proper manufacturing processes for final production.
• Communicate product ideas to business sub-team, and make sure the DHT will be profitable, by taking into account the cost of materials and manufacturing methods (e.g. spring steel, welding, soldering, carburizing).
• Have a working final prototype by the end of the semester.

2.3 Business Team Objectives

The primary goal of the Business Team was to develop the foundations of a working business model for our sponsor Sparrowhawk LLC. To attain this goal, the team set the following objectives:

To conduct in-depth research on consumer behavior, focusing on price sensitivity, purchasing behavior of the product (bought in bulk or individually), problem recognition within the market including internal and external stimuli. Also to determine what features are most attractive to the customers.
To use previous data/research to build positioning strategies for the product in accordance with the major target markets focusing on physiological (safety or performance), situational (single family consumers versus families with kids) and socioeconomic (income group) factors.
To create a perceptual map of the product space, helping the product team to differentiate the prototype and or series of mockups. The coordinates of the map is to be determined using the completed survey
To create a distinct marketing mix focusing on promotion and distribution channels, by developing a marketing campaign / sample advertisement for the product.
To coordinate, communicate, and discuss with the product team the probable cost of goods associated with the DHT technology, the time frame required for the finished product to be developed and to determine a break even point as well as the logistics of manufacturing.
To utilize the existing resources (focus group/previous data) e.g. Mr. Park, members of Sparrowhawk, Windy City Fishing for any further queries

3.0 Organization and Approach

Students were responsible for attending all formal class meetings and collaborating on all IPRO deliverables. Class sessions alternated between:

1) A meeting of all IPRO 358 students followed by feedback and assessment by the IPRO instructors; and
2) Sub-group meetings followed by feedback and assessment by the IPRO instructors.

Faculty conducted debriefings as necessary with each team to discuss the progress of the project, usually in class. After the first month of the semester these debriefs morphed into class-wide discussions, that lasted the length of the period, usually punctuated with team reports, and presentations.

The two sub-teams were each responsible for reporting on a weekly basis, their progress and future goals using the weekly report template posted on iGROUPS. These reports were to be posted on iGROUPS by 7 p.m. Monday night. In addition, overall team meeting agendas, and two sub-team meeting agendas were to be posted when appropriate (templates for these deliverables may be found in Appendix O, along with a sample report). The deadline for posting these agendas was also 7 p.m., the evening before the class meeting. The responsibility for drafting and posting of these documents rotated among team members. All team members had the opportunity to create at least two weekly reports by the end of the fall semester (each student's participation grade depended on the successful completion of these documents).

4.0 Analysis and Findings

4.1 Product Team

4.1.1 Introduction to the DHT

The Delta hook is being introduced into a market which is saturated with many versions of 'J' hooks and treble hooks shown in **Appendix V** below. The 'J' hook is a regular fish hook of the kind that we are all familiar, it is an individual hook whose engaged section has a barb sticking out of it that is essentially a spike sticking out of the tip of the hook. The function of this barb is to get lodged in the fish's mouth and provide for a better hold. A treble hook is comprised of three 'J' hooks joined back to back at the shaft. Barbs are known to severely injure fisherman and inflict fatal injuries upon fish. Also these hooks have major snagging problems, that is they may get caught in the muck that is often floating around in water, which inhibits the hooks from catching fish – rendering them useless.

The Delta Hook shown **Appendix V** above has two modes – a standard mode and an engaged mode. While in standard mode, that is while not in the act of hooking a fish, the three hooks are tuned in on each other so that no hook is exposed; this is its standard mode. In its standard mode the hook is protected against snagging, as well as from inflicting harm upon its user (as its hooks are not exposed). However once opposing forces, that is, force from more than one direction (more specifically when a fish bites down on it), act upon the product causing its hooks to become exposed and interlocked, that is its engaged mode.

The Delta Hook shown in shown **Appendix V** above is comprised of three hooks which are joined at the eye and are all turned inward so that in the standard conformation the engaged sections are facing each other. The eye of the hook is where the Delta Hook will be attached to the fishing line or lure. The shaft of the hook is the section of the hook which has to have the most amount of flexibility, as it is the area where the planar motion of the hook will originate (this will be elaborated on in the mechanism section). The shaft and engaged section of the hook are the areas which have to be the hardest and most rigid, as they will have to fight against unbending forces. At the end of the engaged section is the hook point, which has to be hardest and coincidently the sharpest of the hook as well.

4.1.2 Mock-up Construction

Objective:

Mock-ups were constructed so a physical model of the DHT could be tested. These tests informed the team what improvements needed to be made and new mock-ups were constructed.

Methodology:

We started out analyzing the mockups created by the summer 2009 team as well as the sponsor provided mockups. The mock-up progression may be viewed in **Appendix T**.

Mock-up A was constructed by the summer 2009 team out of paperclips for the shanks and epoxy as the base. This was the first hook constructed by the IPRO project and served as a physical model of the DHT in order to spark ideas for further designs. Mock-ups B-D were provided by the sponsor and allowed for the team to physically see how the engagement mechanism worked. Mock-up B was constructed by a cable company contacted by the sponsor. The shanks were constructed out of a 1/16" diameter cable and were connected using a crimping method to three modified j-hooks. The base construction was another type of crimp including an eye that housed the ends of the three cable shanks. The steel cable shanks did not exhibit planar motion and moved in all directions causing the hooks to become tangled. A similar result came from mock-up C where the shanks were made out of guitar string. This three dimensional motion out the steel cable and guitar string led to the next design change. Mock-up D has a flat metal shank geometry constructed from clips removed from a pen cap. This flat feature of the shank demonstrates planar motion with the central axis of the hook. This planar motion solved the problem of the hooks becoming tangled in one another and can be seen in the remaining mock-up constructions. New to mock-up E were custom bent hooks. Previously the hooks were modified versions of off the shelf j-hooks. In order to achieve the desired geometry of the shank and hook design, the hooks were bent out of safety pins using pliers. The base and the joining method for the shank to the hook was a water proof epoxy clay. Mock-up F was of an almost identical design. Changes came in the forming of the hooks and the base construction. The shanks were inserted into the cap and the epoxy allowed to dry. Mock-ups G and H were created this semester. They were constructed using three pieces of spring steel that have flattened shanks. In both cases, the three individual hooks were joined at the base by solder. The major improvement in mock-up G was incorporating a one piece design for each of the hooks. Instead of having the shank connect to the arm using epoxy, a single bent wire was used for the shank and arm. Two improvements were made in mock-up H. First, dimensional accuracy of the hooks was much greater and can be seen in the picture above as the hook points line up closer to the central axis. Once again, these measurements were simply a visual comparison with design drawings and previous mock-ups. Secondly, the overall size of the second mock-up was reduced by approximately 25% from mock-up G. The Delta Hook size is comparable to treble hook, refer **Appendix U.**

Team Structure and Assignment:

Fabrication process was made at Crown hall and Fabrication Laboratory at the Museum of Science and Industry. Here the team used the computer numerically controlled (CNC) milling machine to construct male and female jigs of the hook shape to use in a manual forging operation. The jigs were made using a redwood (a hard wood) so they would be able to withstand the wear and tear of bending hooks repeatedly.

Results:

After completing the first two mock-ups, it was determined that development methods using pliers and hammers had been exhausted. The manual forming of the wire was becoming too difficult to accomplish at the required size found on the schematic for the Delta Hook (the torques required for bending were too large to accomplish manually. [Appendix X] A metal jig would have been ideal but to save time, wood jigs were made at the Museum of Science and Industry Fabrication Laboratory where access was easily granted through IPRO 333. The jigs worked well with the untreated medium carbon steel because it was very ductile and easily formed to the contours of the jig. A full mock-up made using this jig method was not completed and should be examined by the team next semester.

4.1.2(a) Mechanism

Objectives

Mechanism in terms of the Delta hook refers to its ability to move between its two modes, standard and engaged. As such the goal of the team was to develop a way for the Delta hook's individual hooks to move and pass from the standard mode into the engaged mode.

Methodology

There were certain parameters that the team had to work within while considering a mechanism for movement. The summer's product team had determined that only motion in one plane could be allowed, that is, only forward or backward motion (planar motion) shown in **Appendix W**. Out of plane motion would decrease the hooks effectiveness in terms of catching fish, as the hooks might get in the way of one another and keep the hook form engaging properly.

The solution that the summer team arrived on called for each hook having two pieces, a flat piece which would be the shank and wire which would comprise the arm and the engaged section. This solution would have meant two separate materials as well as a connection between them, which would have served to further complicate the process of construction and also make the individual hooks much bulkier. The flattened a portion of each hooks shaft; this flattened piece would facilitate movement in one plane while restricting it in the other shown in **Appendix W**. It is to allow for the desired planar motion while keeping the hooks as solid pieces.

In order to flatten a portion of the shank originally we just hammered the wire directly on an anvil – however this created two undesired results. The first being that area we flattened was simply too large. To alleviate this problem we decided to use a punch which would direct the force of the hammer to a smaller area. The second was that the transition between the flattened area and the regular wire was to sudden, which created a lot of stress around the edges of flattened portion, which weakened the hook shown in **Appendix W**. In answer to this, the head of the punch was curved so that the transition would be much more gradual.

Team Structure and Assignment

Work for the flattening began with sketches in class, which is the same way in which most tasks were approached. All four team members were asked to come up with ideas and bring them to class meetings; once the ideas were discussed the team would decide how to move forward. The product team's four members all worked together on this part of the project, members would meet regularly in the wood shop of Crown hall, and carry out work on the flattening process.

Results

The team was able to achieve its desired results in terms of flattening. Through the flattening of the wire, instead of introducing a pre flattened piece the team was able to keep the all the hooks solid which also helped in simplifying the construction process. Also with the introduction of the punch the team was able to control the area and shape of flattening.

4.1.2(b) Material Selection

Objectives

1. Corrosion resistant, 2. Able to be sharpened, 3. Strong enough to hold a fish,
4. Flexible enough to transition from standard to engaged mode

Methodology

At the beginning of the semester we were given a material that we researched to find was ASTM A228 1080 carbon steel (aka 1080). We used this material for most of the semester but in the middle of the semester we picked up two more types of wire 302/304 Stainless Steel (aka Stainless Steel) and 1006-1008 Carbon Steel (aka 1006). We then tried to heat treat all three wires. After heat treating the wires we determined the 1006 was the best choice because it was the material that received heat treatment the best and was very malleable which made it very easy to form into the shape that we wanted.

Team Structure and Assignments

The whole product team helped out in material selection. The task of ordering new materials for testing fell to Nathan.

Results

Right now the material we believe will be best for our hook is the 1006 carbon steel.

4.1.2(c) Heat Treatment

Objective:

The heat treatment process was implemented to give the Delta Hook strength after being formed into the desired hook shape. This process occurred by subjecting the steel to various heating and cooling sequences to change the microstructure to tempered martensite.

Methodology:

The technical design and the material selection, described in sections 4.1.2.a and 4.1.2.b, were used as the guiding principals for determining the heat treatment procedure for the Delta Hook. Through the use of the iron-carbon phase chart [Appendix Q], time-temperature-transformation diagram [Appendix R], and heat transfer calculations [Appendix P] the following heat treating protocol was developed by Izmir.

Team Structure and Assignments:

As a proof of concept and to quickly determine what material to pursue further in heat treatment, the protocol was carried out using a small propane torch as the heating source and a bucket of water for the quenching medium. This process was carried out on a high carbon spring steel wire [Appendix X] and a medium carbon steel wire [Appendix X]. Both wires showed an increase in the overall strength however, the high carbon spring steel was found to be brittle while the medium carbon steel retained its ductility. After determining that an increase in strength could in fact be obtained in the wires being used, a better controlled heating environment was found in the Engineering One building.
NOTE: More will be added to this section as the heat treatment in the E1 lab is carried out.

Results:

Results pending our experimentation.

4.1.3 Testing

Objectives

1. Compare DHT characteristics to industry standards
    a. Strength in tension
    b. Sharpness
    c. Corrosion resistance
2. Create testing procedure for DHT specific features
    a. Fatigue
    b. Hook set
    c. Snag
3. Incorporate Finite Element Analysis results into mechanical testing

Methodology

A total of seven tests have been developed for the DHT. They are (listed in testing order)

1.Tensile, 2. Fatigue, 3. Sharpness, 4. Corrosion resistance, 5. Hook set,
6. Snag, 7. Customer satisfaction

Tensile Test: The unbending resistance test (i.e. a specific type of tensile or tension test) provides a direct method of measuring the mechanical strength of a fishing hook. The unbending test is able to provide a quantifiable measure of the force that the bend of a fishing hook can withstand. By using a Universal Tensile Machine (UTM), the strength of the DHT is determined by creating a load versus displacement correlation where the maximum strength of the hook may be calculated. The full testing procedure may be viewed in the appendix.

Fatigue Test: The fatigue test is used to determine a material's ability to under cyclic loading. The data obtained from a fatigue test simply provide the number of cycles undergone until failure. The fatigue test is unique to the DHT because there are no other hooks on the market that use a flexing unit. The fatigue test is used to ensure that the DHT can withstand the flexing encountered during fishing activity. The full testing procedure may be viewed in the appendix.

Sharpness Test: The sharpness test is simply a geometrical measurement of the tip of the DHT. These measurements are taken using a comparator capable of precise measurements of small parts. The geometrical measurements from the DHT will then be compared to measurements taken from industry hooks to determine what changes need to be made to the sharpening process. The full testing procedure may be viewed in the appendix.

Corrosion Resistance Test: The corrosion test uses a salt spray apparatus that subjects the hook to a series of salt baths over a period of 96 hours. A graduate doctoral student from the Mechanical, Materials, and Aerospace Engineering department, Mark Landow (landmar2@iit.edu),. The full testing procedure may be viewed in the appendix.

Snag Test: The snag test compares the snagging tendencies of the traditional J-hook, treble hook, sponsor provided mock up, and IPRO developed mock-ups. A snag, for testing purposes, is defined as a situation in which the hook is irretrievable due to engagement with or entanglement in any obstacle. This test can be conducted by finding fishing environments that provide various obstacles (e.g. trees, branches, rocks, roots, lily pads, and weeds). Individual fishing hooks must be cast and retrieved in each environment a significant number of times ($\geq$100), using line strength between five and ten pounds. If a hook becomes engaged in an obstacle, the angler will pull on the line until the hook frees itself from the obstacle or the line breaks. For design improvement purposes, a detailed description of the actual obstruction type must be recorded. The full testing procedure may be viewed in the appendix.

Anglers with different levels of experience will be approached and asked to complete a form. Each level of experience will be given different types of hooks (e.g. J-hooks, treble hooks, and DHT) and each individual will cast using the hook with a bait or on a lure. The test will be conducted as close to a double blind experiment as possible, by attempting to ensure that neither the angler nor the results recorder is aware of what kind of hook he is using.

Results

The only results to date regarding testing are qualitative and have been used to improve the following design. Due to the destructive nature of the testing procedures, the mock-ups constructed have not been subjected to them. It will be a goal of the following team to develop methods to rapidly produce prototypes, or work with a company who can, so destructive tests can be completed to improve upon the design of the Delta Hook.

4.1.4 Manufacturing

Objectives

In which case, a successful conclusion for the project would facilitate the mass production and distribution of the Delta Hook. To that end the product team tackled the task of assessing a manufacturing process. So in those terms our objectives were to produce deliverables which manufacturers could use to produce the Delta Hook, namely a set of blue prints (schematics) which would detail the number, type and measurements of parts for the Delta hook.

Methodology

At first the team started to research manufacturing processes in order to better informs our design, however in terms of actual methods we found next to nothing, as in we could not find texts in libraries or online. We decided then to approach actual manufacturers (mostly in China) all of whom were reluctant to provide us with information as it seems fish hook manufacturing techniques are closely protected as trade secrets.

Referring to **Appendix X,** it seemed to us that the treble hook was comprised of two pieces, one piece which had two hooks connected at the center (piece a) and then an individual hook (piece b). Piece 'a' would be bent at the center to form the eye of the hook and bring its two hooks back to back. Then piece 'b' would be joined to bent piece by means of braising or welding. As this seemed to be an efficient process and one which was already used (meaning that there are manufacturers set up to do it) we decided to adapt it to the Delta Hook. To that end we developed a set of schematics.

Completed schematics were sent to Richard Ice, the CFO of Sparrowhawk, presented it to manufacturers in China. The manufacturers required a more detailed blueprint to start production,

Wire bending manufacturers will be another alternative; initially we contacted AIM, or Automated Industrial Machinery, advanced wire bender to provide us with the names of several wire benders in the Chicago Land area, namely Master Spring and Wire Form Co.

Team Structure and Assignment

The research focused in on methods, technology and the production of Schematics the work was carried out entirely by the Product, as these goals were more pertinent to the Product team. As far contacting Wire bender, those tasks were delegated to and carried out by two members of the Product team, Erik Egland and Shaad Zaidi.

Results

The product team was able to produce an accurate set of schematics which can be given to manufacturers. The team was also able to eventually contact several manufacturers directly, in the case of AIM and Master Spring, and indirectly in the case of the Chinese manufacturers contacted by Mr. Ice. It was disappointing however to find that we could not get information pertaining to the actual manufacturing processes involved in hook making due to trade secrets.

4.2 Business Team

4.2.1 Market Research / Survey Analysis

Objectives

To identify the customer behavior in order to understand our target market of sport fishing enthusiasts and experienced anglers.

Methodology

The Business Team administered the survey in locations around the Chicago area, modifying the version used by the previous semester. Survey locations included both fishing equipment stores (e.g.Henry's) and other retail stores. (e.g. Walmart). We also obtained a large percentage of our surveys from anglers we met along popular piers and seawalls on Lake Michigan. An example of the survey may be seen in Appendix A.

Team Structure and Assignment

The Business team members split into two groups. Keegan Springfield and Andrew Lichai administered surveys in the North half of Chicago, while Maggie Ng, Se Won Lee, and YunJung Kim administered surveys in the Southside. Both teams attempted to talk with customers of bait shops, but Keegan and Andrew's team were turned away, forcing them to focus primarily on Lake Michigan's shoreline. After obtaining the data from the sample population, Nikhil was responsible to analyze the survey.

Results

Several pie charts were made based on every aspect of the survey. The results/pie charts can be seen in Appendix B

4.2.2 Positioning

Objectives

To further develop the positioning concepts from the summer class and to help form an idea of where Sparrowhawk stands compared to its competition. With this knowledge the team can have a better understanding of the fishhook market and how to best market the Delta Hook to potential customers.

Methodology

In order to best visualize the fishhook market, the Business Team created several positioning charts. Each member gathered information from several sources to produce each positioning map, primarily retail outlet's websites, such as www.basspro.com. These stores provided not only prices but important information about what customers who bought the products thought about each one (customer reviews). To do this we rated the hooks from 1 to 6 in product features, as well as price per hook in $. We further broke the hooks down by popularity, taking into account both reviews and total purchases.

Team Structure and Assignment

Business Team leader Keegan Springfield created the first positioning map, Keegan's chart was an overview of the fishhook market taking into account popularity/sales and price/hook The rest of the group members worked on creating two more maps, based on the specific features pertinent to the Delta Hook. Andrew Lichaj worked on plotting price vs. safety, and Maggie Ng worked on plotting price / barbless, and price vs. weedless (snagless)

These maps are perceptual because Sparrowhawk does not yet sell these hooks. Their strength lies in their ability to give the Business Team an opportunity to see where Sparrowhawk *should* be positioned with respect to the fishhook market. These maps may be found in Appendix C.

Results

Using the maps the Business Team developed a good idea as to who the Delta Hook's competition is and how to take the next step with Sparrowhawk's promotion. From the maps the Business Team concluded that our hook will be superior in the safety category since there aren't any hooks currently produced that have specific safety features. Barbless and Weedless hooks do exist, with several competitors pricing these hooks very competitively.

Positioning Statement

The Delta Hook is designed for ardent sport fishermen both armature and professional who are looking for a safer, snag-free, high performance hook. Unlike its competitors the Delta Hook employs DHT interlocking technology and is completely barbless. It will be priced at $3.25/ hook and will be sold in packs of 2, 3 and 4 with price discounts associated with each hook added.

4.2.3 Promotion

Objective

To create a final Promotion mix for Sparrowhawk to be implemented after the release of the hook at iCAST (a 3 day conference in Las Vegas in July of 2010 dedicated to showcasing emerging products in the sportfishing industry. www.icastusa.org)

Methodology

Team members were each given the task of developing ideas of what they imagined a Sparrowhawk commercial or advertisement would look like. Each member then chose a different promotional channel for their ad. Channels included, but were not restricted to: magazines, TV, newspapers, and outdoor advertising such as billboards. Team members looked at different ways other companies market their products including the latest fishhook innovation, the Trokar made by Lazer, who provide great visuals and music on their website to promote their new hook.

Team Structure and Assignment

When assigning the Promotion task the group decided to not place restrictions on any specific channels. The two primary ideas that the group came up with were to compare the look of the Delta Hook, specifically its interlocking feature, to something in nature such as a bird's talons, with a tagline along the lines of "The way nature intended it." The second idea focused on relating the Delta Hook to a trap, or cage. It was conceptualized as a short online video advertisement, depicting a fish being pulled up from the water in a net. Upon braking the surface of the water it is revealed to the viewer the fish is actually hanging from a Delta Hook. This would be punctuated with a tagline along the lines of "Don't just catch your fish, trap them with the Delta Hook."

Results

The Business Team found both of these ideas to be great starting points. With these advertisements the team can operate in both of the channels the group thinks would be critical to the success of the Delta Hook post its debut at iCAST, T.V. (outdoor programming), and outdoor magazines. From this task the group also concluded the most successful advertisement would be to show potential customers a very intriguing, sleek advertisement, showcasing the hook, and leaving them wanting to learn more. Sparrowhawk's website would be displayed at the end of the commercial or at the bottom of the print ad to help them learn more about the hook.

4.2.4 Supply Chain

Objectives

Our objectives included identifying the flow of the Delta Hook from customer order to production to delivery. As well as identifying both the ideal locations for production and packaging of the Delta Hook.

Methodology

Sparrowhawk is not itself assembling the Delta Hook, but is instead outsourcing that job to a manufacturer in the U.S. (in the Chicagoland Area if possible, and profitable) or possibly China, specializing in wire bending. The average fishhook manufacturer's supply chain was not something we were able to document due to issues we encountered regarding un-publishable trade secrets.

The most glaring decision we faced was whether or not to have the Delta Hook made in China, or the U.S. Also, should we choose China, whether or not we should have it packaged there or in the Chicagoland Area. The packaging these hooks require is what is known as Blister Cards, an example of which can be seen below in the Figure below.

In order to accomplish our objectives we researched both Chinese and American manufacturers that we felt were capable of producing the Delta Hook, as well as several packaging companies in both countries. As we do not yet know all the *specific* details relating to the treatment process the hook will have to undergo, we were unable to obtain any quotes from these manufacturers. A list of these companies may be found in Appendix D.

Team Structure and Assignment

The team members primarily responsible for this task included Se Won Lee, Andrew Lichaj, and Maggie Ng, Keegan Springfield. All four participated in conceptualizing the process, as well as researching manufacturers and packaging companies.

Results

We decided on two scenarios. The first entailed Sparrowhawk receiving orders from both individual customers (online) and from retail outlets (e.g. Walmart, Basspro Shop), then shipping them their packaged hooks by ground or air depending on the location of those chains' distribution hubs. Furthermore, in this scenario, the Delta Hook would be manufactured in China, and packaged in the U.S. before being shipped to Sparrowhawk and held as inventory. A visual depiction of this scenario may be found in Appendix D.

The Second scenario entailed Sparrowhawk receiving orders from the same sources, and shipping them their packaged hooks by ground or air again depending on location and shipping costs. Furthermore, in this scenario, the Delta Hook would be both packaged *and* manufactured in the U.S. before being shipped to Sparrowhawk and held as inventory. A visual depiction of this scenario may also be found in Appendix D.

4.2.5 Pricing

Objective

To determine the price of the Delta Hook

Methodology

To determine the price we had considered inputs like, Positioning/Perceptual map, Competition/Competitors their products and price and the costs associated with manufacturing the hook. Another input that was considered was the survey analysis which would give us an estimate of the demand and the price the customers are willing to pay for a superior performance hook, which would catch a fish on a consistent basis.

Our first job as a team was to conduct research on the various hooks that are available in the market, their price and what the customers who bought them thought of those hooks. After doing research online and reading customer satisfaction reviews, we were able to determine the various price levels of the hooks that were available and the features each had associated with them. Based on the Delta Hook's Barbless feature and its price, we determined that the Eagle Claw Lazer Sharp hook was our product's closest match.

Costs Associated with Manufacturing of the hook: (Estimates)

Direct Material:

- High Carbon Spring Steel- .039in OD, - ASTM a228

The Product Team it was determined that approximately 7 inches of material would be required per hook including 0.5 inch of wastage per hook. After doing research from various manufacturers we found the best price from: http://www.smallparts.com.

[Direct Material cost per hook: $0.33/hook (180 inches → $8.67)]

Direct Labor:

While we may not know for sure who will be manufacturing the Delta Hook, we know that there will be some labor involved in the process, specifically heat treatment (for more information see section 4.1). To estimate these costs, we have contacted a heat treatment firm in Ohio familiar with the processes the Delta Hook would require. For calculation purposes we estimate that the aforementioned steps would cost $0.17 per hook.

Overhead Costs: (Fixed Costs):

Depending on the level of demand for the Delta Hook, Inventory accommodations must be factored in. For calculation purposed we estimate the average fixed costs to be $1/hook.

[Total cost of goods: $1.50]

Survey Analysis:

The survey we conducted told us that 46.1% of anglers purchased 20 hooks or more per year and 20% purchased 10 to 20 hooks per year. Furthermore Around 40% of the population showed willingness to pay in the price range of $2 to $4.99 per hook, and 28% would pay between $5 and $9.99 for a superior product (safe, weedless/snagless, barbless, and better catch and hold).

Team Structure and Assignment

Nikhil was responsible for the pricing strategy.

Results

While it is difficult to determine costs associated with the Delta Hook at this time due to numerous unknown variables, we were still able to decide on a probable price per hook, based on what we learned the market was willing to pay; approximately **$3.25 +/- (20%)** per hook, to be sold in packs of 2, 3, or 4.

4.2.6 Financial Analysis

Objective

Our objectives included producing a Break Even analysis, and a Cash Flow analysis, both of which were completed using estimates.

Methodology

Break Even Analysis:

Fixed Cost:
$50,000 → iCAST + $20,000 → Marketing and Administrative Expense

Total Fixed Costs: $70,000

Expected Unit Sales: (Estimated in the fiscal year of 2010)
150,000

Unit Price:
$3.15 (excludes packaging costs)

Total Variable Cost: (Expected Unit Sales * Variable Unit Cost
$75,000

Total Cost: (Fixed Cost + Total Variable Cost)
$145,000

Total Revenue: (Expected Unit Sales * Unit Price)
$472,500

Profit (or Loss): (Revenue - Total Costs)
$327,000

Break Even: (Fixed Cost / (Unit Price - Variable Unit Cost)) = 26,415 hooks

Using the assumed values, Sparrowhawk would be required to sell 26,415 Delta Hooks in order to break even. For a breakdown of Revenue Projections, please see Appendix F

Discounted Cash Flow Analysis and Net Present Value:

** Excludes Tax and depreciation and the probability of all scenarios is equally likely (assumption)

Scenario 1: Sale of 70,000 hooks

Time period: 6 years
Discount Rate: 15% (Assumption)
Growth rate: 20% for first two years, 14% for next two years and 8% thereafter

Scenario 2: Sale of 100,000 hooks
Time period: 6 years
Discount Rate: 15% (Assumption)
Growth rate: 20% for first two years, 14% for next two years and 8% thereafter

Scenario 3 Sale of 150,000 hooks
Time period: 6 years
Discount Rate: 15% (Assumption)
Growth rate: 20% for first two years, 14% for next two years and 8% thereafter.

An initial investment of $200,000 has been considered at time period 0 for the calculations below

Scenario	**CASH FLOWS PROJECTED** All Values in $					
	YEAR 1	**YEAR 2**	**YEAR 3**	**YEAR 4**	**YEAR 5**	**YEAR 6**
1	142,000	170,400	204,480	233,107.2	265,742.20	287,001.58
2	195,000	234,000	280,800	320,112	364,927.68	394,121.89
3	327,000	392,400	470,880	536,803.2	611,955.64	660,912

Figure 13 – Cash Flows Projected

NPV of Case 1: $576253.40

NPV of Case 2: $865,981.79

NPV of Case 3:$1,586,057.13

Team Structure

Nikhil Madan was responsible for the financial analysis.

Result

With an initial Investment of $200,000 at the estimated projected growth rates and discount rates we have shown this venture to be a fairly attractive investment opportunity.

5.0 Conclusions and Recommendations

5.1 Conclusions and Recommendations for Next Semester's Team

- The IPRO Team recommends the following to next semester's class:
  - Determine the true cost of manufacturing the Delta Hook.
  - Identify and contact likely manufacturers both in China and the U.S. and document what the capabilities of each company are.
  - Test prototypes in fishing situations, i.e. with actual consumers.
  - Remain in contact with Master Spring & Wire Form Co.
  - Reach out to as many manufactures as possible to get a final prototype constructed.
  - Utilize Mr. Augy Park and the resources he has available to him.
  - Go on a team fishing trip to strengthen team and gain experience.
  - Establish an on-campus work space for construction and testing purposes.
  - Determine a method of rapid production of the Delta Hook so destructive testing may be conducted.
  - Explore the capabilities of swaging in regards to flattening the shank.

5.2 Conclusions and Recommendations for Sparrowhawk

- **The IPRO Team recommends Sparrowhawk:**
  - Focus on targeting males between 20 and 45 years old who identify as "sport fishermen" and may or may not compete in amateur fishing tournaments.
  - Take out advertisements in fishing and outdoor magazines that are designed to catch the consumer's eye, and entice them to visit Sparrowhawk's website. In the beginning stages it would be wise to avoid costly marketing campaigns and instead focus on targeting a sufficient foothold market, as mentioned in the bullet point above.

- Try to utilize domestic manufacturing to reduce shipping costs, as the primary benefit of over seas production (low labor costs) is not significantly crucial to the making of fishhooks.

6.0 Appendix

Appendix A – Consumer Fishing Survey

This Appendix shows a sample fishing survey that was administered by the Business Team in September and October of 2009 in and around Chicago. Some respondents preferred to fill in the survey themselves, while others preferred to be asked each question (many respondents were fishing at the time of the survey).

Consumer Fishing Survey

Illinois Institute of Technology

1. Age

3-10 11-20 21-30 31-40 41-55 56+

2. Gender

M F

3. What type of fish do you typically set out to catch?

____

4. How often do you go fishing each year?

0 1-4 5-9 10-19 20 or more

5. How many years have you been an angler?

0-1 2-5 6-10 10 or more

6. Which season do you fish the most in?

Winter Spring Summer Fall

7. How many fishing hooks (individual) do you purchase yearly?

0 1-4 5-9 10-19 20 or more

8. How many fishing lures do you purchase yearly?

0 1-4 5-9 10-19 20 or more

9. What do you usually pay per hook?

$0.01-0.49 $0.50-.74 $0.75-0.99 $1.00-5.00 other__________

10. Where do you purchase the majority of your fishing hooks?

Outdoor Retailer (e.g. Bass Pro Shop) Discount Retailer (e.g. Wal-Mart) Local Bait Shop other__________

11. Please rank the following hook features by order of importance (1 is most important, 4 is less important):

Weed less/snag less _________
Catch and Hold _________
Safety _________
Barbless _________

12. If any what other features are important to you in a fishhook?

____
____

13. If there was a hook that offered all of the following features (weed less, better catch and hold, and safety), what would you be willing to pay per hook?

$ .30-0.99 $1.00-1.99 $2.00-4.99 $5.00-10.00 other___________

14. When you fish, what is your motivation?

Sport Recreational Other_______________

15. With whom do you fish?

Adults Children Both Neither

16. What's your favorite fishing hook? Why?

____
____
____

17. What's your favorite fishing lure? Why?

____
____
____

18. How often do you rely on the following to receive information on fishing? (1 = always 5 = never)

		Description
Magazines	_____	____________________________
TV	______	____________________________
Radio	______	____________________________
Internet	______	____________________________
Friends	______	co-workers / family / friends / _________
Other	______	____________________________

Appendix B – Results of Survey

This Appendix includes visual depictions of the results of our survey, administered in September and October of 2009. It includes feedback on reported: frequency of fishing; gender; motivation to fish; place of purchase; average purchase price range; price willing to pay for superior hook; and sources of information.

Frequency of fishing

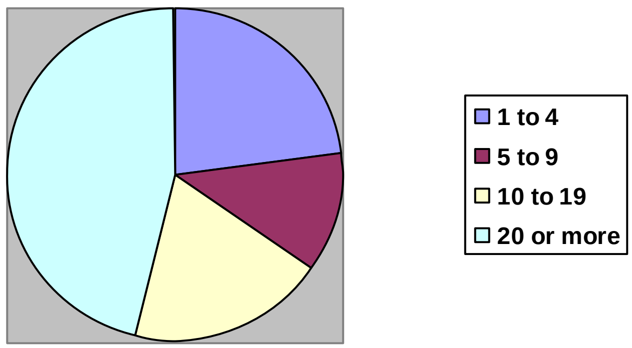


Chart 1. Fishing Frequency Chart

- 20 or more ;- 12people per year
- 10 to 19 ;- 5 people per year
- 5 to 9 ;- 3 people per year
- 1 to 4 :- 6 people per year

Gender

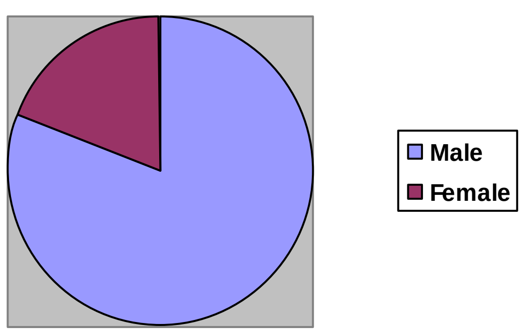


Chart 2. Fishing Activity by gender

- Male : 21

- Female: 5

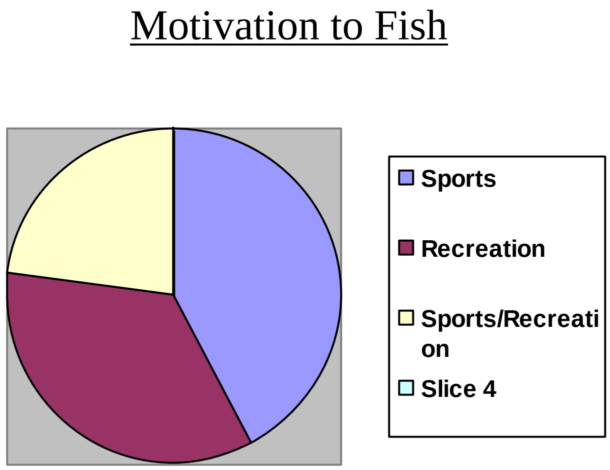


Chart 3. Fishing Activity Motivational

- Sport : 11people
- Recreation : 9people
- Sports/Recreation : 6people

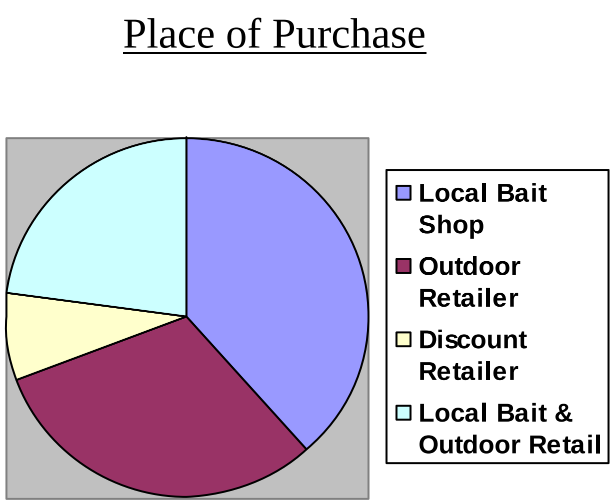


Chart 4. Fishing Equipments Purchase Place

- Local Bait Shop : 10
- Outdoor Retailer : 8
- Discount : 2

- Bait & Retail :6

Average Price Ranges

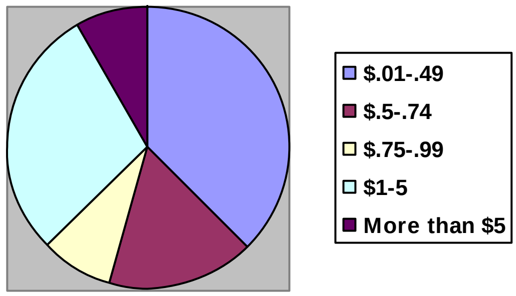


Chart 5. Fishing Hook Price Range

- $.01- .49 :- 9 people
- $0.5- .74 ;- 4 people
- $.75- .99 :- 2 people
- $1-5 ;- 7 people
- More than $5 : 2 people

Price Willing to Pay for Improved Hook

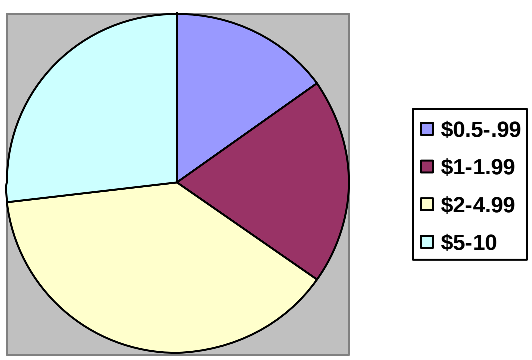


Chart 6. Fishing Hook Commit Pricing

- $.50-.99 : 3 people
- $1-1.99 : 5 people
- $2-4.99 : 10 people
- $5-10 : 7 people

Sources of Information

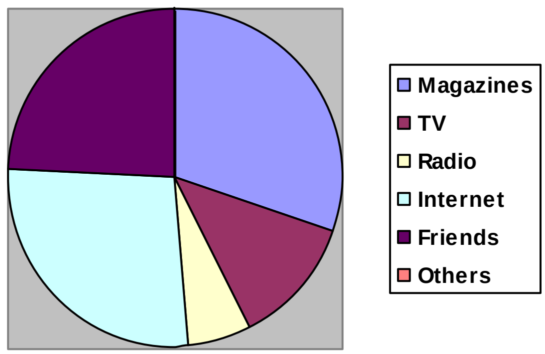


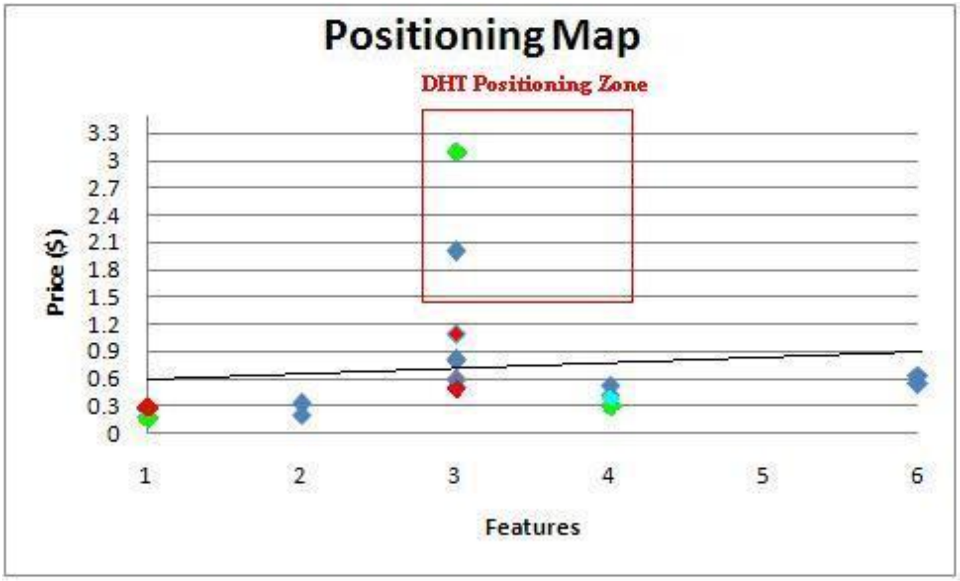
Chart 7. Fishing Related Activities and Equipments Information

- Magazines ;- 20
- TV ;- 8
- Radio ;- 4
- Internet ;- 8
- Friends ;- 12
- Other ;-0

Appendix C – Product Positioning

This Appendix shows the conceptual positioning maps produced by the Business Team. The first map shown is an overall map comparing hooks based on their price and their features. Since features varied greatly, we placed the hooks on an arbitrary scale of one to six. Six being many features, and one being the least, or a basic unembellished hook. For this placement we went off of how each hook was advertised, using the makers descriptions to identify features. The Delta Hook we envisioned having 3 – 4 features (barbless, snagless, safe design, and the interlocking feature, which is unique on the market).

The second factor, price per hook, was determined by dividing the retail price of a pack of hooks by the total number of hooks sold in the pack. Our initial estimates of a high priced Delta Hook were discouraged by this study that showed the most popular hooks were priced under $1.20. Two did cost significantly more, and offered us some evidence to support a higher per unit price. For more information of the price of the Delta Hook, see section 4.2.5.

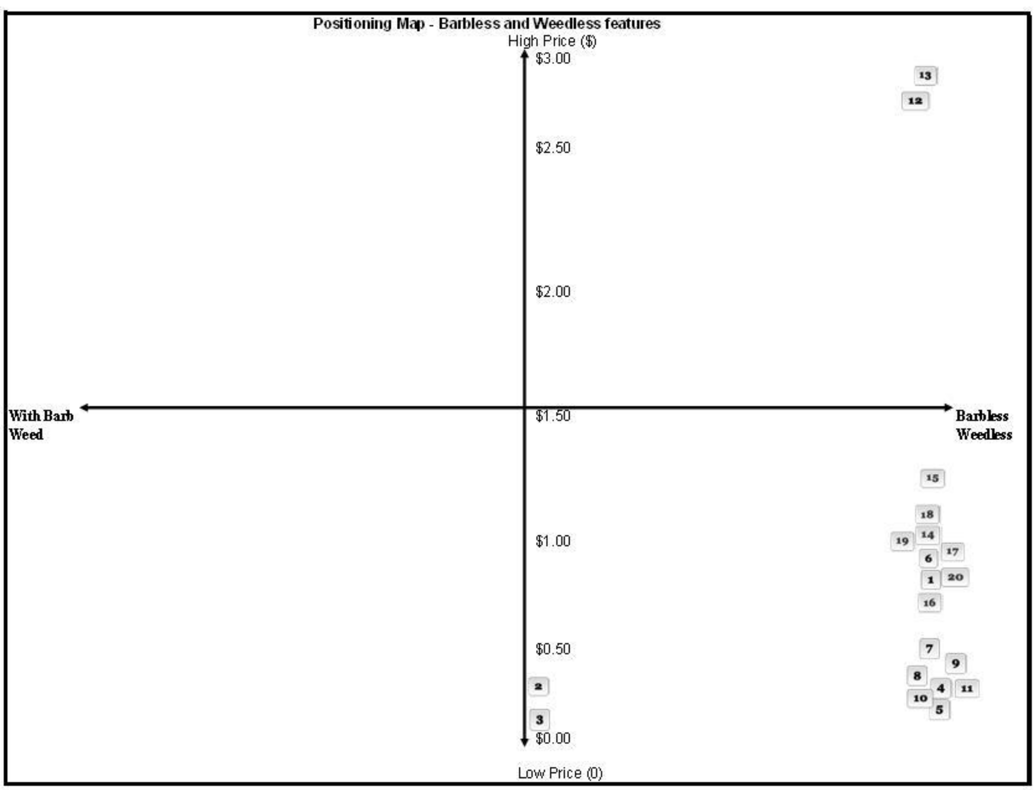


Name	Features # (x)	Price $ (y)
Bill Dance-Advantage Spring (Single)	3	0.8
Bill Dance-Advantage Spring (Treble)	3	0.8
Gamakatsu-Circle Hooks	3	1.1
Gamakatsu-EWG Worm Hook	3	0.58
Gamakatsu-Split shot	4	0.42
Eagle Claw-Kahl Hooks	2	0.32
Eagle Claw-Circle Sea Offset Hook	2	0.2

Eagle Claw- Extra Wide Gap Hook	4	0.3
Mustad Ultra Point Big-Mouth Tube Hooks	6	0.54
Mustad Ultra Point Power Lock Plus Hooks	3	3.1
Mustdad-Utlra Point UltraLock Hooks	4	0.52
Bass Pro- XPS Octopus Hooks	1	0.18
Bass Pro-XPS Magna Superlock Hooks	1	0.28
Mustad-XPS SuperLock Hooks	1	0.18
Owner-TwistLOCK Open Gap Hooks (5132)	3	2
Owner-SSW w/ Cutting Point	3	0.49
Owner-Down Shot Offset Hook (5133)	6	0.64

The red highlighted hooks were found to be the most popular based on a combination of the number of sales and customer reviews. The blue hook was in the second tier of popularity, while the green hooks were in the third tier.

Positioning Map - Barbless / Weedless



Barbless

Hook		Name, Description
1)		**Partridge Fine Wire Czech Nymph Hooks - CZF** $5.99/8 $ per hook 0.74875
2)		**Mustad Signature Saltwater Fly Hooks - S71SZ-34007** Mico-barb $14.99/50 $ per hook 0.2998
3)		**Mustad® Signature Series Nymph/Sproat Hooks - S82-3906B** Mico-barb $5.99/50 $ per hook 0.1198
4)		**Gamakatsu Red Barbless Octopus Hook** Barbless $6.95/25 $ per hook 0.278

5) 

Barbless Dry Fly Hook

Barless

$4.85/25

$ per hook 0.194

6) 

Gamakatsu Barbless Treble Hook

$5.95/7

$ per hook 0.85

7) 

Mustad Ultra Point Octopus Beak Barbless

$3.49/8

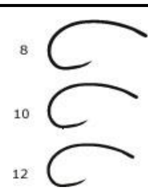
$ per hook 0.43625

8) 

VMC Barbless Round Treble Hooks-Bronze

$5.95/25

$ per hook 0.238

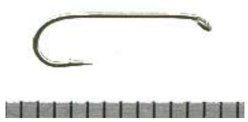
9) 

Partridge FINE WIRE CZECH NYMPH

Barbless

$5.95/25

$ per hook 0.238

10)		**Gamakatsu Barbless Standard Down Eye** $4.95/25 $ per hook 0.198
11)		**Gamakatsu Octopus Hook Barbless** $2.95/10 $ per hook 0.295
12)		**Eagle Claw Lazer Sharp Barbless Hooks** $ per hook $2.59
13)		**Eagle Claw Lazer Sharp Barbless #1** $ per hook $2.59

http://redrockstore.com/Catalog/index.php?crn=172&action=show&sort_by=price_highest

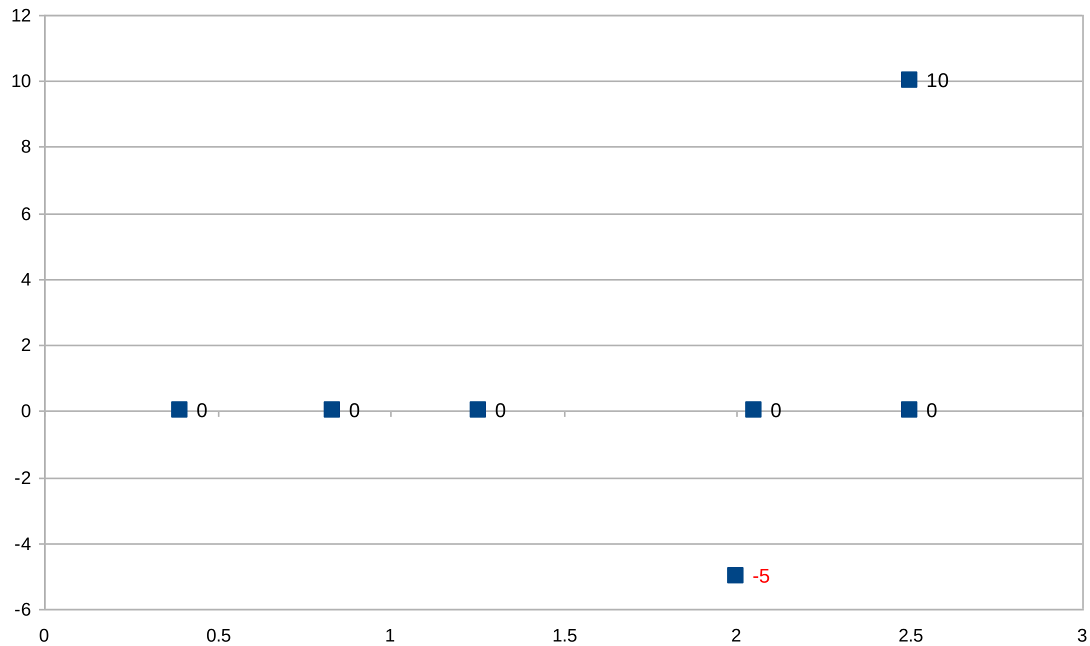
Weedless

Hook		Name, Description
14)		**Bass Pro Shops® XPS® Weedless Tube Heads** $4.19/4 $ per hook 1.0475
15)		**Gamakatsu® Hooks - Wire Guard Worm** $4.69/4 $ per hook 1.1725
16)		**Eagle Claw Model 449W Weedless Hook** $2.95/5 $ per hook 0.59
17)		**Mustad® Weedless Worm Hook - Model W3369A** $1.69/2 $ per hook 0.845
18)		**Owner® Weedless Wacky Worm Hooks** $4.19/4 $ per hook 1.0475

19)		**Mustad W3551 Treble Weedless Hooks** $4.99/5 $ per hook 0.998
20)		**Matzuo Weedless Treble Hooks** $10.99/20 $ per hook 0.5495

http://www.cabelas.com/

Positioning Map - Safety

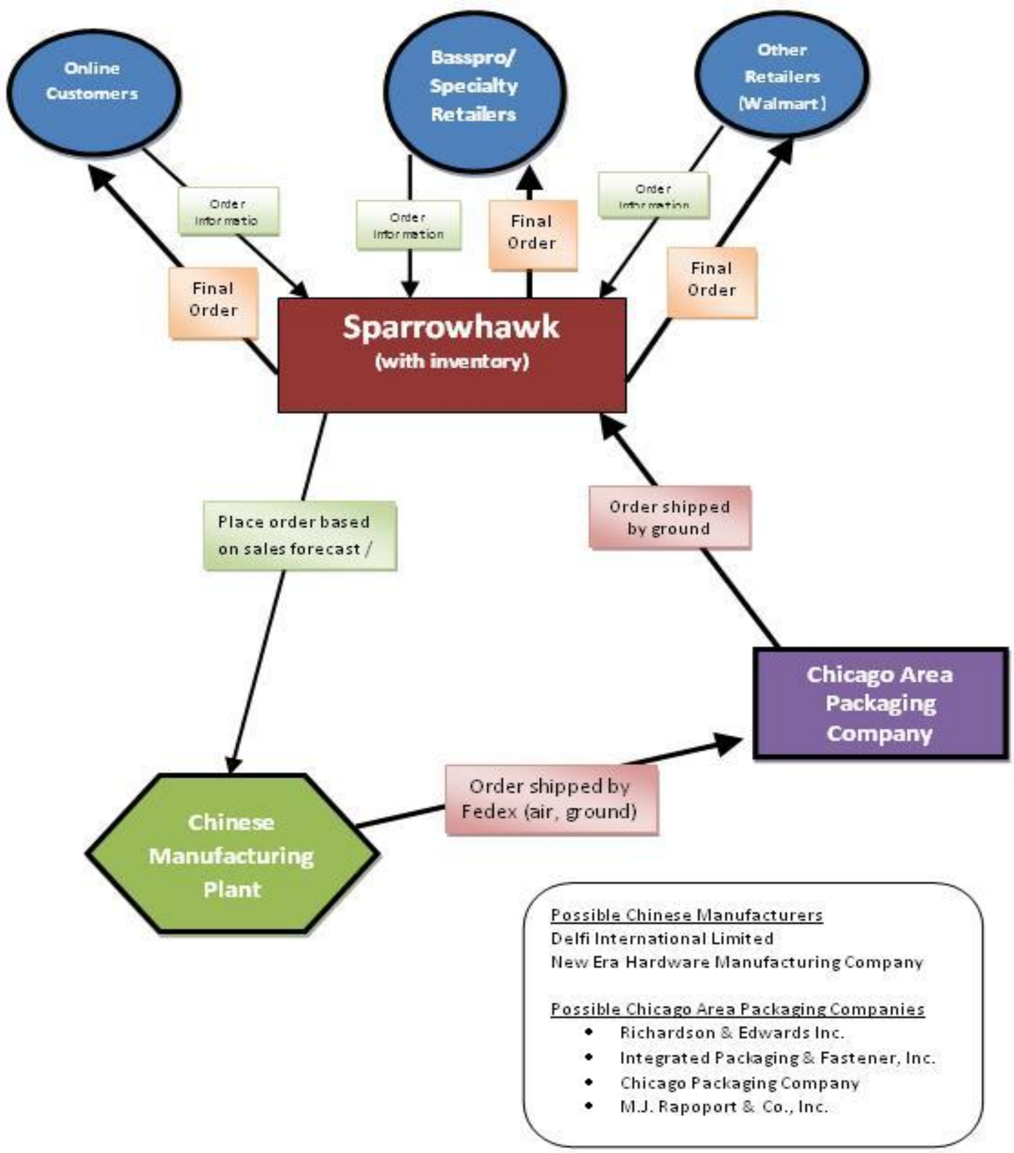


	Hook	Safety Rank	Price	Number/ Pack	Price / Hook
1	**sparrow hawk**	10	7.5	3	2.5
2	**eagle claw**	0	2.5	3	0.83
3	**lake fork tackle**	0	3.77	3	1.256
4	**daiichi**	0	2.77	7	0.39
5	**mustag**	0	6.15	3	2.05
6	**owner**	0	7.5	3	2.5
7	**Trokar**	-5	10	5	2

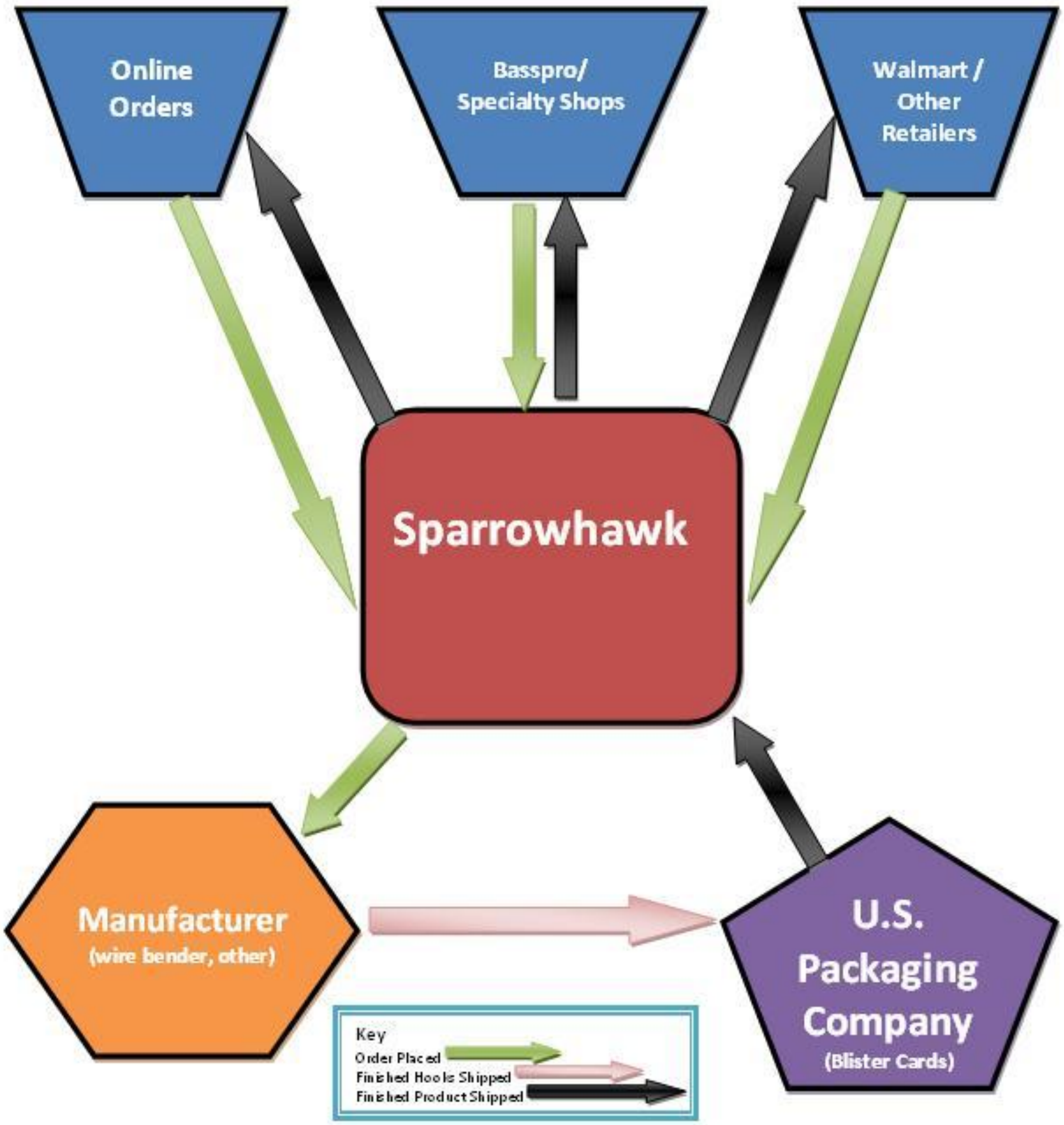
Appendix D – Supply Chain Analysis

This appendix shows two visual depictions of possible supply chains for Sparrowhawk LLC, based on two separate scenarios. The first implies manufacturing is done in China, before being shipped to the U.S. for packaging and distribution to customer through Sparrowhawk. The second scenario implies manufacturing is done in the U.S.

Scenario 1: Production in China with Packaging in U.S.



Scenario 2: Production and Packaging in U.S.



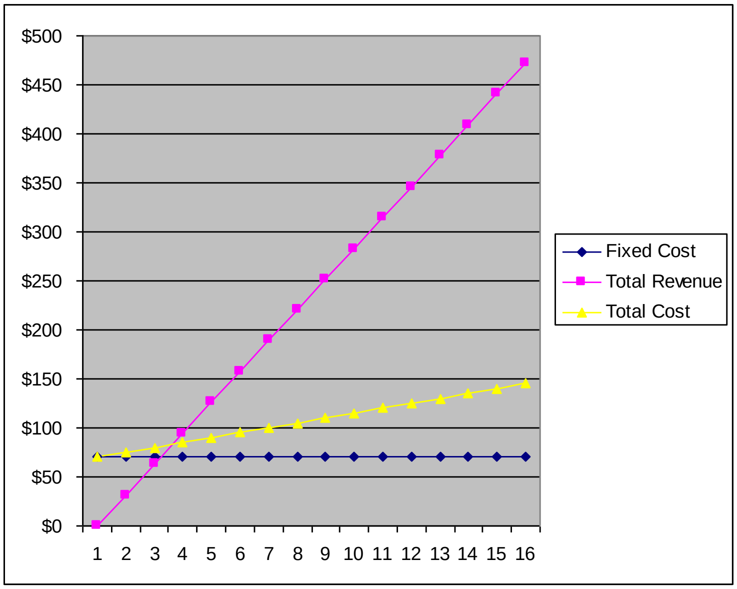
Appendix E – IPRO 358 Team Profile (Fall 2009)

This Appendix depicts a breakdown of IPRO 358's team members, showing each member's major and year in school. It also lists any relevant skill sets, as well as describes primary assignments during the course.

Name	Major	Year/ Level	Skills	Assignments
Erik Egland	Mechanical Engineering	4	Microsoft Office Suite, CAD, Solidworks, Communication skills, Fishing skills	Project plan, DHT interview/research, sub-team leading, final report, poster, final presentation lead.
Nathan Howard	Mechanical and Aerospace Engineering	3	Microsoft Office Suite, AutoCAD, Solidworks, NX5, Matlab, Maple, Automotive repair and design	Project plan, DHT interview/research, final report, poster, final presentation, Notebook lead
Yungjung Kim	Finance	4	Experience on Financial Analysis, Market Research, Accounting, HR, Operation Management.	Project plan, DHT interview/research, final report, poster, final presentation, abstract/brochure co-lead
Sewon Lee	Finance	4	Market research, strategy planning, and Industrial Analysis	Project plan, DHT interview/research, final report, poster co-lead, final presentation.
Andrew Lichaj	Business Administration	4	Microsoft Office Suite, Precision Tree, Communications, Quicken and Team Structure	Project plan, DHT interview/research, final report, poster, final presentation lead.
Nikhil Madan	Business Administration and Finance	4	Microsoft Office Suite, Quick Books Peach Tree, SAP, Quicken and SAGE Timberline. PNL Statements, Balance Sheet.	Project plan, DHT interview/research, sub-team leading, final report, poster, final presentation, notebook lead
Maggie Ng	Human Resources	4	Market research, strategy planning, and Industrial Analysis	Project plan, DHT interview/research, final report, poster lead, final presentation.
Keegan Springfield	Business Administration	4	Finance, Business planning, Marketing, Human Resource. Administering Surveys.	Project plan, DHT interview/research, sub-team leading, final report co-lead, poster, final presentation, abstract/brochure lead
Izmir Yamin	Aerospace and Mechanical Engineering	4	CAD, CAE, CAM, CATIA, CFD Star Design/CD/CCM, Matlab Simulink, Prototype development and testing.	Project plan, DHT interview/research, final report lead, poster, final presentation. Abstract/brochure co-lead.
Shaad Zaidi	Architecture	5	Rhino, AutoCAD, 3DS Max, mock up and prototype developments,	Project plan, DHT interview/research, sub-team leading, final report, poster lead, final presentation co-lead.

Appendix F – Revenue Projections

This Appendix shows a breakdown of Sparrowhawk's revenue projections. Based on Number of Units Sold, it shows Fixed Costs, Total Costs, and Total Revenue.



Fixed Costs vs. Total Revenue (all numbers in Thousands of dollars)

Units		Fixed Cost		Total Cost		Total Revenue		
------	------------	------------	------------	------------				Profit
0		$70		$70		$0		($70)
10000		$70		$75		$31		($43)
20000		$70		$80		$63		($17)
30000		$70		$85		$94		$9
40000		$70		$90		$126		$36
50000		$70		$95		$157		$62
60000		$70		$100		$189		$89
70000		$70		$105		$220		$115
80000		$70		$110		$252		$142

90000		$70		$115		$283		$168
100000		$70		$120		$315		$195
110000		$70		$125		$346		$221
120000		$70		$130		$378		$248
130000		$70		$135		$409		$274
140000		$70		$140		$441		$301
150000		$70		$145		$472		$327

Revenue Projections

Appendix G - Corrosion Rates

The corrosion rate can be determined by subjecting the specimen to corrosive environments over long periods of time and measuring the mass lost after the specimen has been cleaned. This mass lost is translated to surface area lost which is the unit of corrosion rate, inches per month. The corrosion rates are different for different kind of materials. The chart below gives examples of several types of components and their corrosion rates. Similar charts are available on various websites detailing a vast number of materials and components along with their corrosion rate.

TABLE 1

ASTM G28 A Corrosion Rates

Sample		Corrosion Rate
#	Description	(inches per month)
1	Open butt weld	0.0051
2	Butt weld with backing	0.0061
3	Corner fillet weld	0.0036

Appendix H– Customer Satisfaction Forms

From the table below, several sets of customer satisfaction data will be acquired. For a set period of time, the ratio of fish landed to the number of casts that had activity (e.g. nibbling, bites, etc…). Activity can be felt as vibrations from the lure transmitting through the line and rod. According to our sponsor, there is a say in fishing, "when in doubt, set the hook". The form will exclude casts that appear to not experience any activity. Since more experienced anglers are familiar at distinguishing different types of activities, the results will be standardized. The form will also take into account the area of the large-mouth bass's mouth the hooks were engaged and which hooks. In addition, the amount of snags will be recorded.

Type of Hook: **Location:** **Years of Experience:**			
Number of Casts with Activity	**Number of fish landed**	**Bait (B) or Lure (L)**	**Snags**

*Use tally marks

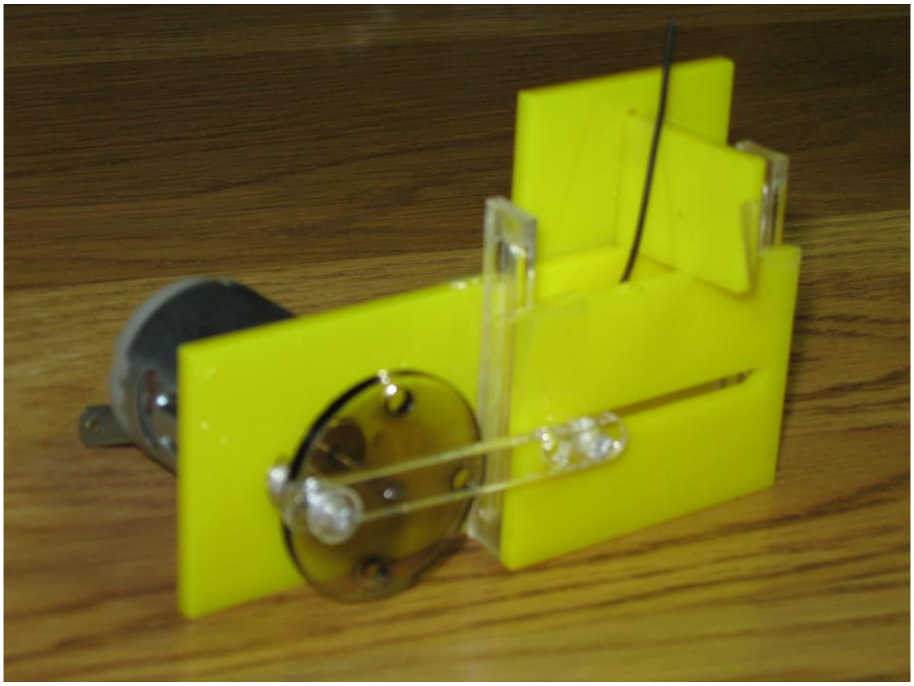
*Mark where hooks engaged

Hook 1	Hook 2	Hook 3

Appendix I - Fatigue Test Result Form

Fatigue testing utilizes a machine to apply a cyclic load on a specimen. More advanced fatigue testing machines can cycle through loading and unloading millions of times a second as well as varying the force of the load. These tests are done to better understand how vibrating and oscillating forces can weaken a specimen. Fatigue life is measured by the number of cycles of loading and unloading before a specimen fails under a certain load. The damaged caused by fatigue is not fixed when the loading and unloading ceases.

To test the fatigue life of the base due to the constant engaging and disengaging of the hook we would have to manually engage and disengage the hook itself. The design of the hook requires the third hook to be deployed if 2 of the hooks are engaged. To engage the hook during testing procedures we attach the hook to the apparatus, viewed below, and the horizontal rod pushes the shank of the hook. Once the stroke of the rod is complete it returns to its original position and removes the force upon the hook shaft which also returns to its resting position.



Fatigue testing apparatus. Parts include a small electric motor with an acrylic structure.

Trial	Number of cycles until failure (String)	Number of cycles until failure (Ring)

Appendix J– Hook Setting Result Form

This test is used to see the effect of the Delta hook engagement mechanism compared to other hooks on the market. Utilizing this test will allow researchers to better understand where on the fish the hooks become engaged the most. Some of the hooks can slip out of the mouth or not have enough pressure in order for them to cling to the fish's mouth. There is also an additional criterion to test which is whether the hooks would catch a fish on the outside of its body. The test requires the researcher to anchor a fish to the table and attach movable platforms to the fish's mouth. The DHT would then be placed into the fish's mouth and the platforms adjusted to apply a force similar to that of a largemouth bass. The DHT would then be set to observe where the hooks engage on the fish. This data is recorded for later analysis.

Specific Test			
Position With Respect to Jaw			
Trial number	**Pressure on Jaw (and whether open or closed)**	**Number of Catches**	**Number of Hooks Engaged**
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			

Appendix K – Snag Test Result Form

The snag test is performed to observe the snagging tendencies of the J-hook, treble hook, sponsor provided mock up, and the IPRO developed mockup. A snag is defined as a situation in which the hook is difficult to retrieve if at all possible due to engagement or entanglement in any obstacle. This test will determine whether or not the IPRO designed DHT will actually have less occurrences of snag. The test involved dropping the test subject into either a simulated or natural environment or observing the occurrences of snag. The hook would then be attempted to be retrieved.

Testing Environment:				
Line Strength (lb test):				
Hook Style: J Hook / Treble / Mock__ / Sponsor Mockup				
Cast	Snag but Retrievable? [Y or N]	Snag and Irretrievable? [Y or N]	Obstruction Type	Comments
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				

Appendix L – Tensile/Unbending Result Form

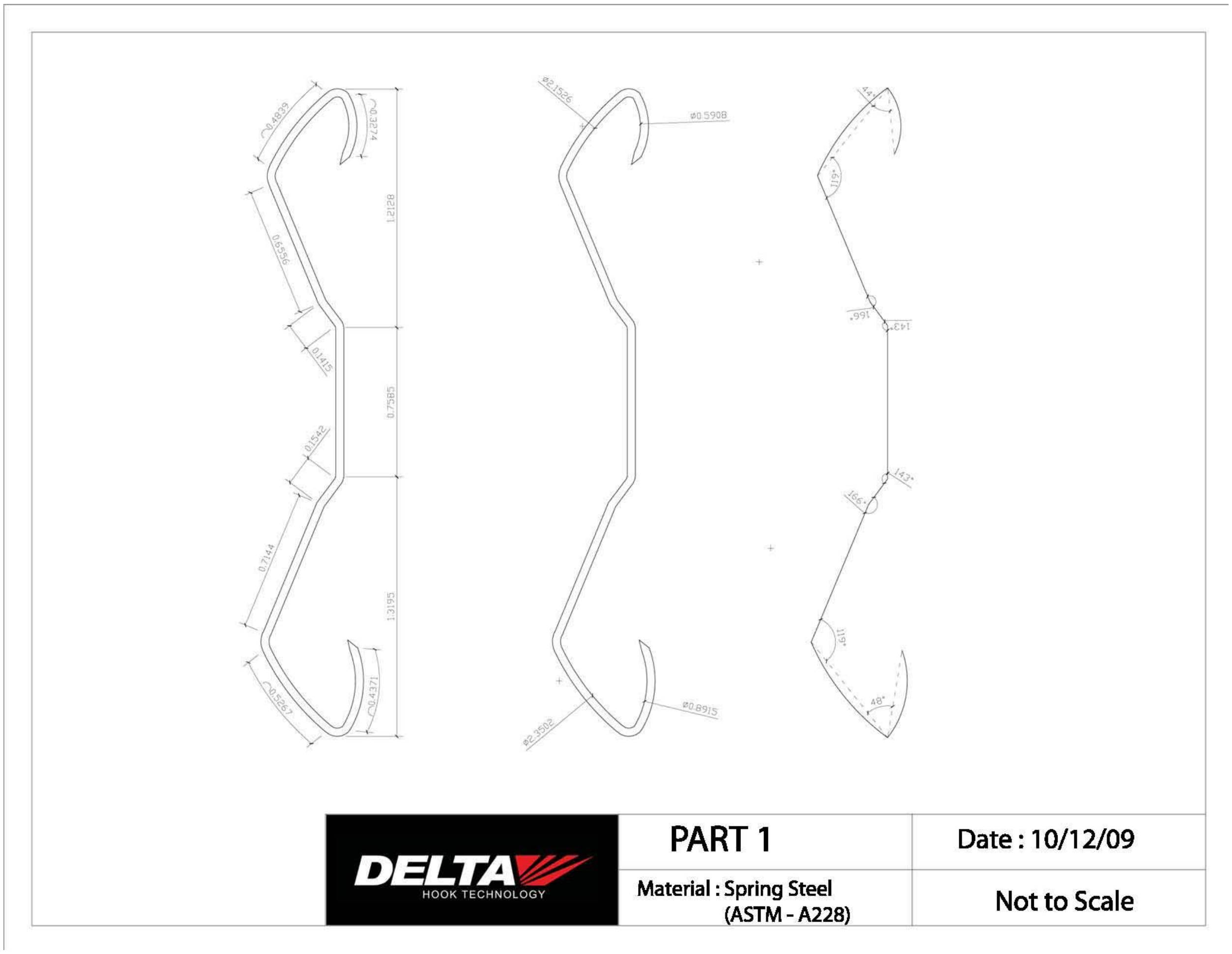
In most tensile tests, the point of failure is defined as the Ultimate Tensile Strength (UTS). The point of total deformation in the unbending test is regarded as the point of deformation of the fishing hook, equal to the bite length, likely before the UTS. This is regarded as such because after this point, the fishing hook becomes useless for fishing. There are many other factors that can be measured with the unbending test. The slope of the stress-strain curve before the UTS will provide a measure of the elasticity (Young's Modulus) of the fishing hook. This is a measure of the stiffness of the fishing hook, which will be further explored in another testing method. Also, the yield strength can be measured as the force is applied during the unbending test. This defines the property of a material to return to its original shape after a force is applied. This value, the resiliency of the object is shown in Equation 1 and is one of the properties that must be considered when determining material properties of the object.

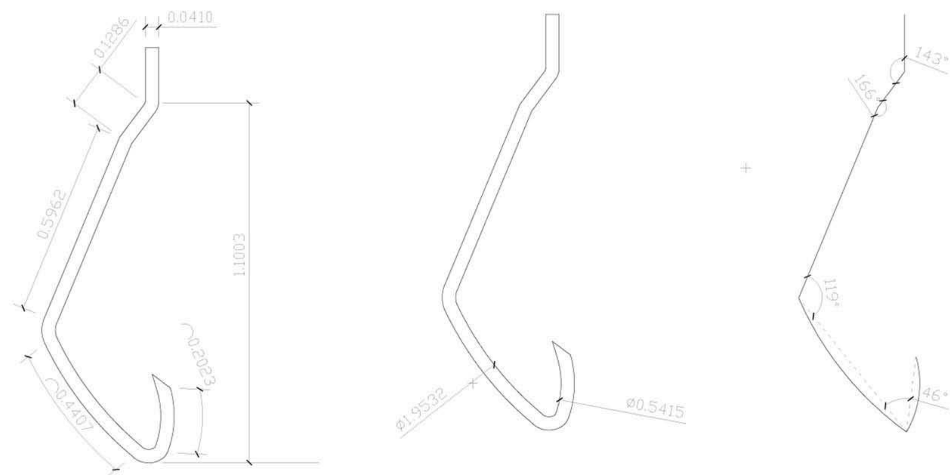
To perform this test, one must axially the specimen in tension and increases its force until it fractures. The applied axial loads and the corresponding deformation of the sample are measured, which allows one to calculate the stress and the strain. It is generally recommended that the universal testing machine, UTM, is turned on twenty minutes prior to experimentation. When operating the UTM, the fishing hook is loaded onto the machine using the appropriate grips. The dimensions of the specimen would also have to be found before the test can begin so the information can be use later as the test will deform the subject.

Trial	Yield strength (MPa)	Tensile strength (MPa)	Elastic modulus (MPa)	Stress (MPa)	Strain	Ultimate Tensile Strength (MPa)	Young's Modulus (MPa)
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							

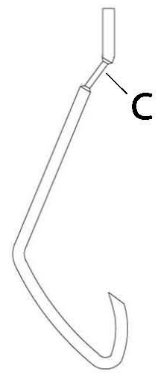
Appendix M – Schematics

This appendix depicts the schematics produced by the Product Development Team which were produced for, and sent to, Mr. Ice during his time in China, for the purpose of courting possible manufacturers.



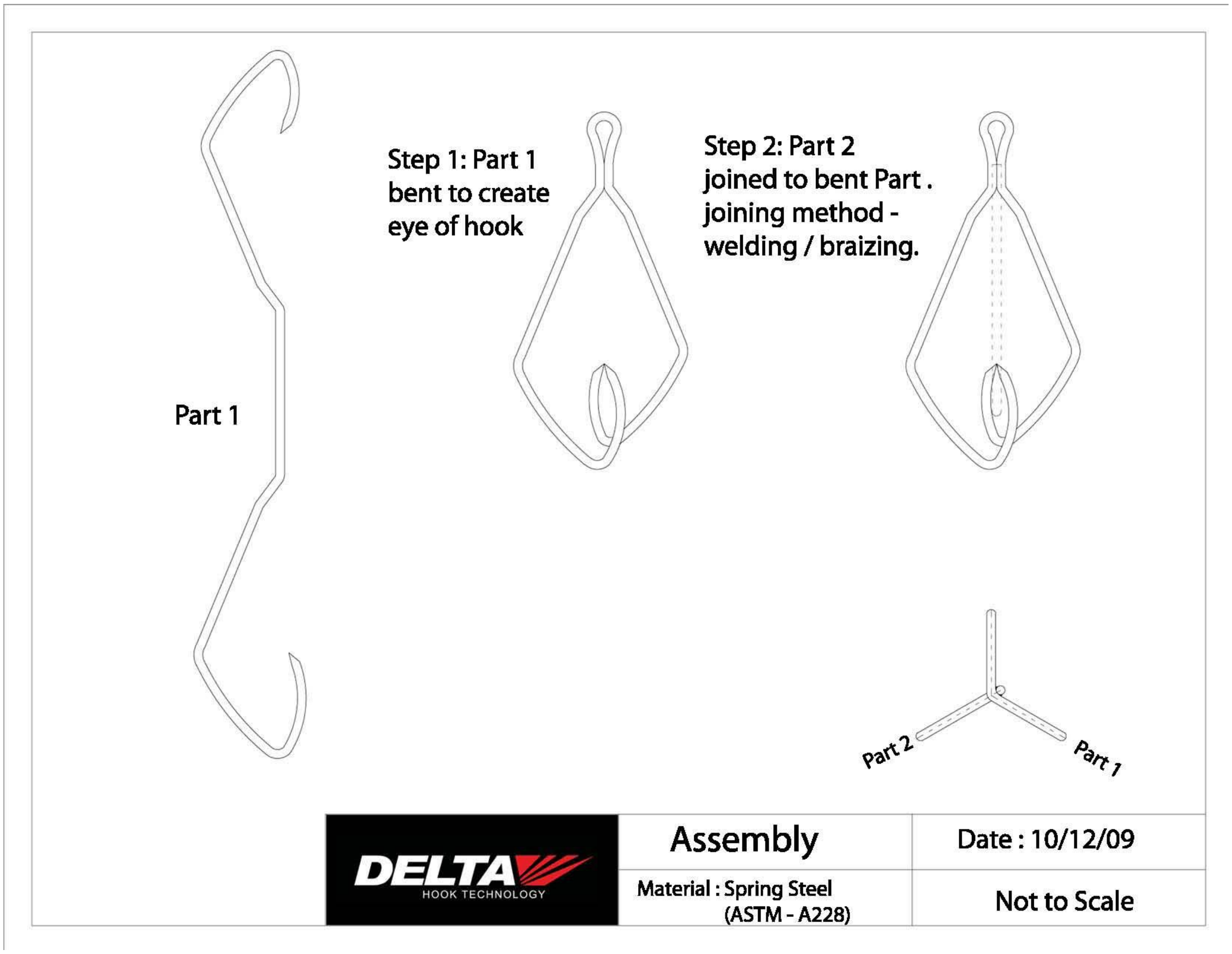


DELTA HOOK TECHNOLOGY	PART 2	Date : 10/12/09
	Material : Spring Steel (ASTM - A228)	Not to Scale



Region A, B and C will be flattened (cold forming) to 1/2 the width of the diameter of the spring steel rod, which is .041". The resulting width of the flattend piece will be .02". The purpose of this piece will be to allow for lateral movement.

DELTA HOOK TECHNOLOGY	Flattening	Date : 10/12/09
	Material : Spring Steel (ASTM - A228)	Not to Scale


Step 1: Part 1 bent to create eye of hook
Step 2: Part 2 joined to bent Part . joining method - welding / braizing.
Part 1
Part 2
Part 1
DELTA
HOOK TECHNOLOGY
Assembly
Date : 10/12/09
Material : Spring Steel (ASTM - A228)
Not to Scale

Appendix N –

The International Convention of Allied Sportfishing Trades, better known as ICAST, is the world's largest sportfishing trade show. The 2010 show, being held at the Las Vegas Convention Center, Las Vegas, Nev., July 14–16, 2010, is the cornerstone of the sportfishing industry, helping to drive sportfishing companies' product sales year round. It is the ultimate goal of IPRO 358 and Sparrowhawk to introduce the DHT to the fishing community at ICAST 2010. ICAST drew the attention of the team for release due to the nearly 7,000 representative of the sportfishing industry, 2,000 buyers, 455 registered members of the media, and 800 international attendees from 55 countries that attend the event annually. More information regarding the ICAST 2010 event may be found at the event's homepage: http://www.asafishing.org/shows_events/icast/

Appendix O – Weekly Status Reports Template

This appendix provides a template of the document each sub-team was required to complete by 7 pm Monday nights. This was done to give each class member enough time to review the goals, progress, and activities listed, as well as to keep the instructors apprised of the class's progress. This appendix also contains a sample Weekly Status Report, written by team leader Erik Egland.

Weekly Status Report

Team Name:

Writer: *Teammate who is writing this report*

Date:

Problem Statement

Write problem statement here (this is a general problem statement, not specific to the weekly progress)

Last week's goals & progress made

- **Goal 1:** state the problem (teammates responsible for this task)
  Outcome 1: state status and outcome of the action

↓

- **Goal X:** state the problem (teammates responsible for this task)
  Outcome X: state status and outcome of the action

Additional accomplishments

- **Action 1:** state the problem and action (teammates responsible for this task)
  Outcome 1: state status and outcome of the action
- ↓
- **Action X:** state the problem and action (teammate name)
  Outcome x: state status and outcome of the action

Difficulties

Describe any difficulties here. Explain your team's plan for addressing them.

Communication

Describe the steps taken to incorporate information provided from the opposite sub-team

Activities

Name	Activities	Time (hours)	Running time (hours)

This week's goals

- Goal 1 (teammates responsible)

↓

- Goal N (teammates responsible)

(this week's goals should reflect last week's goals/action items)

Project timeline

List the next 2 or 3 key project milestones-includes goal dates and teammate name(s)

Expenses *(if none, indicate it)*

Date	Item	Source	Cost

Weekly Status Report

Team Name: Product Team

Writer: *Erik Egland*

Date: November 16, 2009

Problem Statement

Work towards creating a prototype that will be accepted by a contract manufacturer to obtain a quote for professionally producing Delta Hooks.

Last week's goals & progress made

- **Goal 1:** Complete heat treating matrix using the previously determined heat treating protocol. ***Outcome 1:*** The team will be meeting Russell Janota on Tuesday (11/17/09) to use an oven located in the Engineering 1 building. Russell will assist in completing the previously determined heat treating matrix. The heat treated specimens will then be tested for mechanical properties using a universal tensile machine (unbending test) and the fabricated fatigue apparatus.

- **Goal 2:** Determine a way to produce hooks consistent in geometry in an efficient manner ***Outcome 2:*** A trip to the MSI FabLab was made where the ShopBot was used to make male and female jigs. A piece of low carbon steel wire (1006-1008) was found to easily form into the proper hook geometry when clamped tightly between the two jigs. Nathan created approximately 75 individual hooks all of relative uniform size and shape. These hooks will be used in the above mentioned heat treating matrix.

- **Goal 3:** Determine/Create the testing equipment (unbending, fatigue, sharpness) ***Outcome 3:*** During the trip to the MSI FabLab we also determined and created the basic components of the fatigue testing apparatus. The parts included a small electric motor, several discs, and connecting rods. The structure will turn rotary motion from the motor into linear motion needed to flex the hook from the standard mode to the engaged mode in a repeating fashion. By determining the rpm of the motor and the time the hook is tested will provide an endurance limit for the DHT.

Additional accomplishments

- **Action 1:** Permission to reach out to contracting companies has been granted

Outcome 1: After a conversation with Augy, permission has been granted to reach out to wire bending contracting companies that show a professional reputation and are willing to sign an NDA. No further action has been taken regarding this matter.

Difficulties

This week it has come to the attention of the product team that the wire they have been most recently working with was actually not ASTM a228. It was in fact ASTM 853 with alloying content of only 0.06-0.08 % carbon. This will require reviewing the previously completed material selection as well as ordering new materials. By completing the heat treating matrix and protocol in the meantime with the ASTM 853 results will be provided and a decision can be made to move on with this material or to drop it and switch to a new material. Until the results come back from the tensile test, work will continue with the ASTM 853.

Sub-Team Communication

Earlier in the semester it was determined what current industry hooks should be used for comparison in the unbending test. The three hooks are the Gamakatsu-Circle Hook, Gamakatsu-EWG Worm Hook, and the Bass Pro-XPS Magna Superlock Hooks.

Activities

Name	Activities	Time (hours)	Running time (hours)
Erik	-FabLab(Fatigue apparatus construction) -Heat treating setup	7	62
Izmir	-FabLab(Fatigue apparatus construction)	4	59
Nathan	-FabLab(Jig making) -Hook making	10	65
Shaad	-FabLab(Jig making)	4	59

This week's goals

- **Goal 1** Setup tensile testing machine. This includes a scheduling time slot to perform the test as well as constructing a jig to fit the testing machine and hold the heat treated hooks in place.
- **Goal2** Review material selection data to determine what material to analyze next. The next steps will include repeating the heat-treating matrix with the new materials as well as the fatigue and tensile tests.
- **Goal 3** Finish the fatigue testing apparatus so results will be available for iPRO day.

Project timeline

Have the results from the heat treating process compiled for analysis. This includes load vs. displacement graphs for each specimen tested as well as a value for the load that caused failure in each case. (11/25/09)

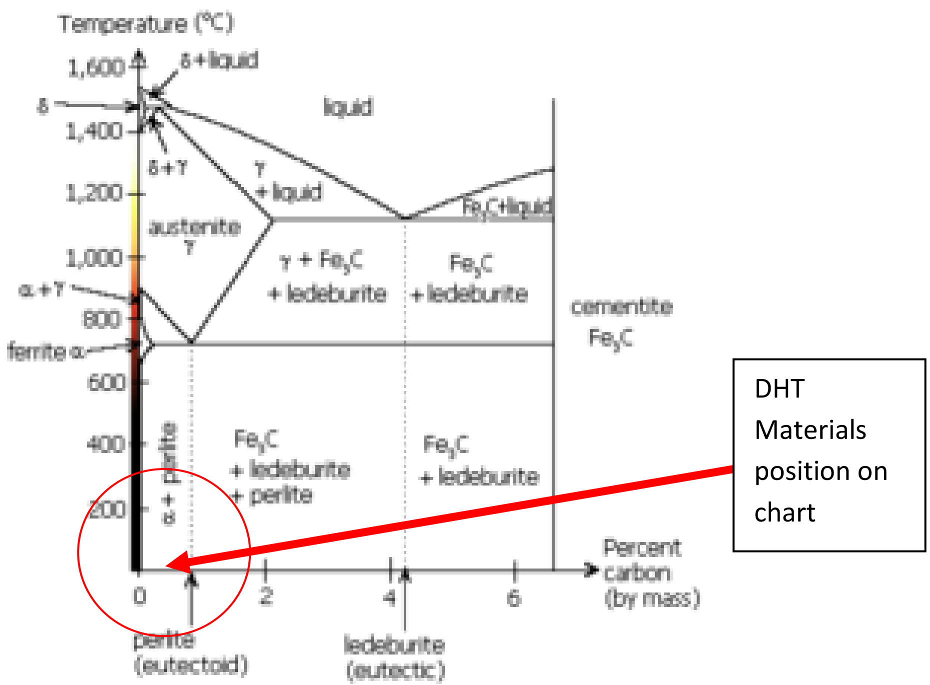
Expenses

Date	Item	Source	Cost
11/16/09	Various ASTM standard wires	McMaster Carr	~$10.00

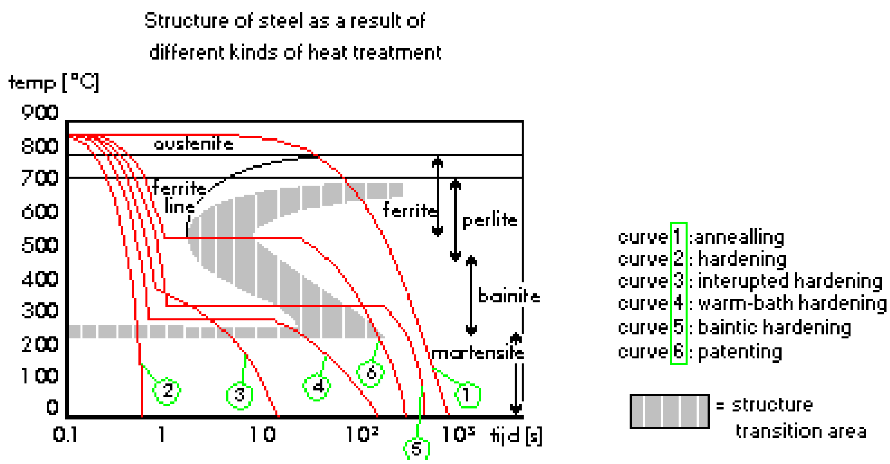
Appendix P – Heat Treatment Procedure

Step	**Heat Treatment Protocol**
1	Heat steel to austenite temperature (910ºC) for 30 mins
2	Rapid quench in water to obtain martensite. Hold for 10 mins.
3	Reheat to 150ºC. Hold for 10 mins
4	Remove from heat and allow to air cool to achieve tempered martensite

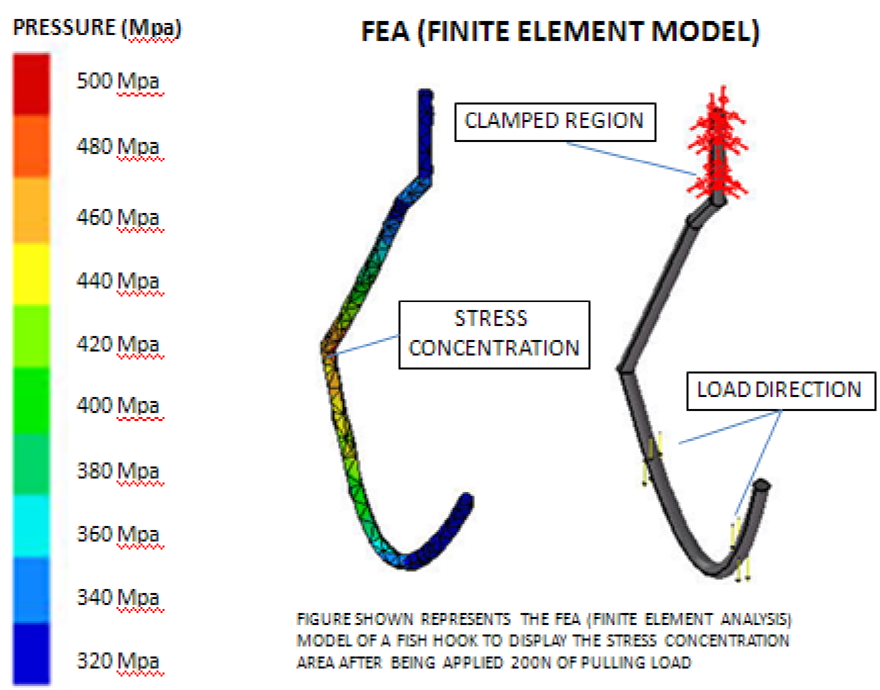
Appendix Q – Iron Carbon Phase Diagram



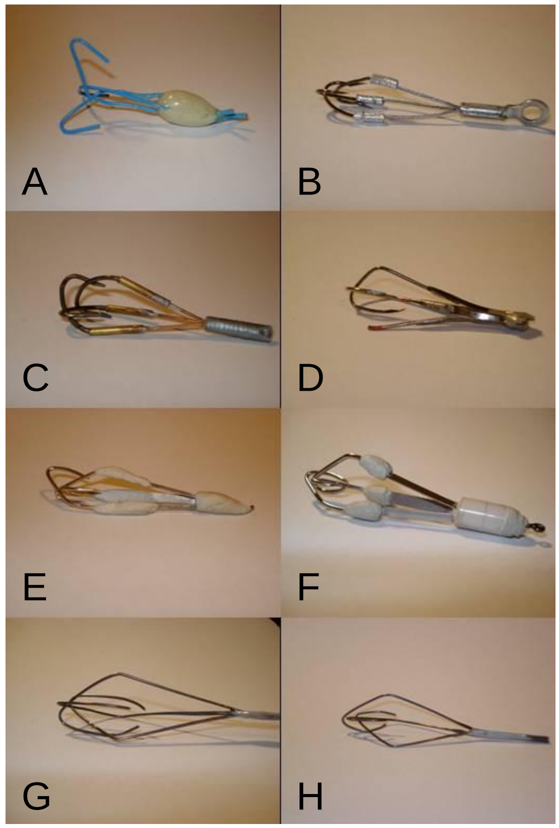
Appendix R – Time-Temperature-Transformation (TTT) Diagram



Appendix S – Finite Element Analysis



Appendix T – Mock-Up Creation



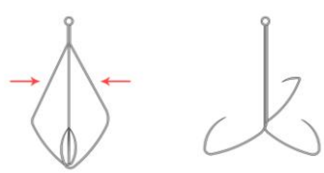
Mock-up Creation. A. constructed by summer 2009 team B.-D. sponsor provided E.-F. constructed by summer 2009 team. G-H constructed by fall 2009 team

Appendix U – Mock-Up Creation

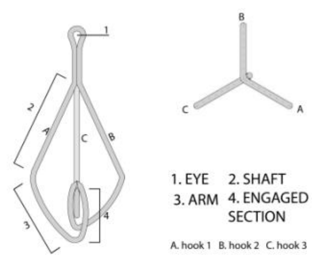
From left to right mock-up E, mock-up F, and the standard treble hook

Appendix V – Mock-Up Creation

'J' hook & Treble hook

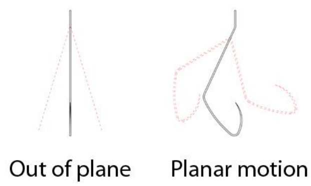


DHT Deploy Mechanism

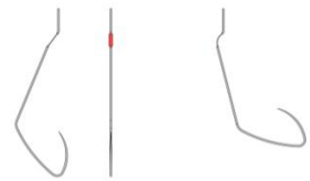


DHT Drawing

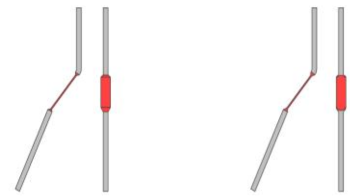
Appendix W – DHT Drawing and Mechanism



Planar Motion

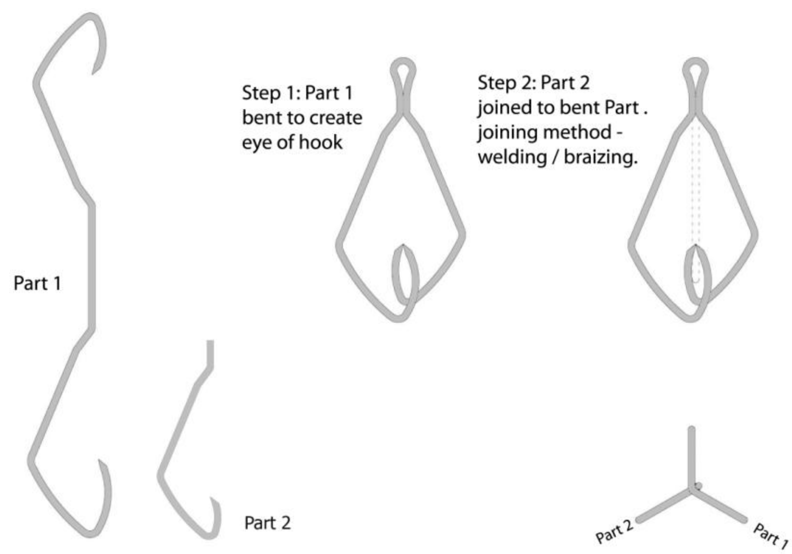


Flattened portion depicted in red



Right side image depicts correct area to be flattened

Treble hook



Assembly