EnPRO 358

ILLINOIS INSTITUTE OF TECHNOLOGY

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Abstract

Recreational fishing in the United States generates over a billion dollars of economic output and providing well over a million American's with jobs. There are many variations of fishing hooks available that retain the same basic shape and structure, the most popular examples being, the standard J-hook and the standard treble hook. However, there are many limitations associated with existing fishing hooks. One such limitation is that fishing hooks are not able to reliably hold the fish after embedding. Introducing a barb to the hook helps resolve this issue, doing so however creates problems when setting the hook and furthermore, barbs can cause damage to the fish during the removal of the hook. Another concern is that contemporary fishing hooks have problems with snagging on nearby rock formations, algae, weeds, or other vegetation in the water.

The greatest concern with conventional fishhooks is that of the danger facing anglers, especially young or inexperienced anglers. Exposed barbed fishhooks can pierce the skin, lodging the hook into the angler. To remove the hook (because of the nature of the barb) the angler must either push the hook through the body until the barb pierces back through the skin, cut the barb off, and then pull the remaining hook back through the body, or have the hook surgically removed. Among the fishhook manufacturers, namely Gamakatsu, Mustad & Son, and Eagle Claw, there appears to be a scarceness of fishing hooks equipped with barbless, safe and snag-resistant features. These features, will be integrated into Sparrowhawk's innovative fishhook, The Delta Hook Technology (DHT).

The EnPRO 358 team will work with the CEO and entrepreneur behind Sparrowhawk, LLC, Taylor Augy Park, O&G Spring (Chicago, IL), other professional organizations to develop a prototype of the Delta Hook Technology (DHT), which will be showcased at iCAST. iCAST is the premier fishing tradeshow for sport fishing anglers and provides Sparrowhawk with the

appropriate environment to gain entrance in the sports fishing market and establish the company's reputation.

EnPRO 358 offers an opportunity for students to gain experience in developing the components of a business strategy plan, as well as, developing and testing designs and mock-ups that demonstrate the value of innovation and its place in the market

Team Information

The EnPRO 358 roster is located in Appendix A.

Mission Statement:

Create a prototype for the Delta Hook Technology that is safer for the angler, snag free, weedless, more dependably secures the fish to the hook. The prototype will be used to build consumer interest at iCAST. In addition, conduct market research and develop a viable business plan that will bring DHT to the market.

Team Objectives

- Break into product development and business team
- Produce a functional prototype that exhibits the physical and mechanical properties which are ideal for catching Micropterus salmoides, commonly known as the largemouth bass*.
- Create a business and marketing strategy with a finalized financial statement, advertisement and marketing campaign, and a detailed manufacturing procedure
- Emphasize safety and ethics in prototype development and business planning

Background

Augy Park was introduced to IIT's IPRO program in the spring of 2009 following a presentation given to Heartland Angels which was attended by Dr. Ron Kirshner and Professor John Stoner. IPRO 358 was formed in the summer of 2009 and has been offered every semester since. Below are the highlights of each semester's efforts.

Business Development

Summer 2009

The business team had several objectives for the summer of 2009. The three main objectives were to determine the target market, explore possible marketing methods, and conduct a consumer survey. The current market research done by the business team covered several aspects of sport fishing. The research was not limited to possible competitor products, but also included sales information, and national consumer buying habits. Since the current fishing market contains many competing companies, the research became focused on similar bass fishing hooks already in the market. Some key pieces of information discovered about fishing habits in the United States are:

- 40 million Americans recreationally fish. That is more than golf and tennis combined.
- There was approximately $45 billion in retail sales of fishing related items.
- The top five states in terms of revenue are Florida, Texas, Minnesota, California, and Michigan.
- Over $125 billion in overall economic output, including sales of hooks.
- More than one million jobs are supported by fishing (e.g. retailers, manufacturers)
- Approximately 10.3 million anglers fish for black bass, making it the largest species market.

The teams focus was brought to the black bass, which includes largemouth bass. Knowing this, the product development team was able to narrow choices of dimensions for the DHT including both size and holding capacity.

The business team crafted a consumer survey and administered it to one hundred anglers in the Chicago land area. The survey was intended to gauge a person's fishing and spending habits. The survey provided insight on important product features of the Delta Hook and the value of these features to fisherman. Surveys were given at Bass Pro Shop in Bolingbrook, Cabela's in Hoffman Estates, and Henry's Sports, Bait and Marine in Chicago. All three locations were chosen because they are important retailers for the sports fishing market. Both Bass Pro Shop and Cabela's are large nationwide retailers with a wide customer base and huge inventories. Henry's is a small, local shop located very close to the IIT main campus. Henry's is of particular interest to IPRO 358 because a working relationship with a local retailer is a potential launch point for DHT to enter the market. A significant finding came from the survey concerning the question posed for how frequently the person fishes. The option "more than twenty times a year", the survey population asked for a response "more than twenty times a week" which brought into focus experienced angler because of their knowledge and frequent sport of fishing. Another major piece of information gained from the survey was the value of fishing hook features.

Fall 2009

Building on the work accomplished in the summer, the fall team prepared the Delta Hook Technology for launch into the existing market. This was accomplished by means of market research, in the form of surveys, developing positioning strategies, working with pricing and financial data. The team administered surveys at a local fishing equipment shop (Henry's), a retail store (Walmart) and to local anglers fishing along popular piers. Using the information gathered via surveys and online research, the team was able to create several positioning maps. These put value on specific characteristics of the DHT and designated it as a hook for both amateur and professional sports fishermen who are concerned with a safer, snag-resistant and high performance hooks. Attributable to its safety features, the team also felt that it could be marketed to younger anglers. The team was also able to assess promotional concerns; a promotional mix was created for the DHT's launch at iCAST 2010. Advertising on television and also in outdoor magazines was discussed and the tagline "The way nature intended".

Pricing analysis was performed after considering competitor pricing and data collected from field surveys. The primary motive for pricing analysis was to prepare a regression analysis on the value other hooks held in the market. It was determined that the Eagle Claw Lazer Sharp hook design was the closest match to our product. By working in conjunction with the Product Team, it was determined that approximately 7 inches of material would be required per hook including 0.5 inch of waste per hook. After doing research from various manufacturers we found the best price from: http://www.smallparts.com. The direct material costs were valued at $0.33 per hook. The exact manufacturing methods were unknown at the time, the team was able to make assumptions pertaining to labor and processing, particularly that heat treatment would be involved. Using this information the team was able to secure a quote from a heat treatment firm in Ohio, of $0.17 per hook. An average fixed cost of $1 per hook was established, which amounted to a price of $1.50 per hook for production. Data collected from surveys showed that 40% of the sample population was willing to pay between $2 and $4.99 per hook, while 28% were willing to pay more for a superior product such as the Delta hook; putting the price of the hook at approximately $3.25 per hook for sale in the market.

The fall team conducted a financial analysis for the DHT. It was aimed at producing a break-even analysis and a cash flow analysis, which were both calculated based upon expenditure estimates. Which were, $20,000 for marketing and administrative expenses, $50,000 for ICAST costs and a variable cost of $75,000 that was generated from projected sales numbers. All together the estimated expenditure amounted to $145,000. After including fixed expenses they expected the cost of goods sold to amount to $145,000. Revenue was calculated to be $472,500 of which $327,000 would be profit. Based upon these calculations, 26,415 hooks would need to be sold to break even. Under pessimistic, expected and optimistic conditions the ENPRO358 team expected to generate revenues of $287,001.58, $394,121.89 and $660,912 respectively.

Finally the fall team approached the task of establishing a supply chain; however as at the time there was not enough information concerning an actual manufacturing process, the team was forced to make assumptions as to the origin of the supply process, as in where were these hooks to be manufactured. Two scenarios were drawn up for customer order to product

delivery, the difference between the two being that in the first manufacturing is done in China and packaging in the US, while in the second both packaging and manufacturing take place in the US.

Spring 2010:

The spring 2010 EnPRO business development team focused on three main tasks:

1.) complete more surveys for market research,

2.) develop a business plan, and

3.) obtain a quote for packaging the Delta Hook.

Consumer surveys are necessary to understand the customer base Sparrowhawk is targeting; information collected from the survey allowed the comparison of results with data published in the United States Fish and Wildlife Association Report, 2006 (the most recent data available). At the beginning of the semester, the team planned to conduct the survey at three venues:

- Outdoor Retailers (e.g. Bass Pro Shops)
- Internet (e.g. Zoomerang, Facebook)
- Local Retailers (e.g. Henry's Bait shop [Chicago, IL])

The diversity of the venues was to obtain a holistic view of the fishing market (i.e. exclude as few as possible age categories and retail locations as possible). The results were compared and combined with EnPRO 358's summer 2009 results.

The outdoor retailers were reluctant to allow data collection through surveys at their locations. Cabela's (Hoffman Estates, IL) responded with citing that allowing surveys has the potential to create controversy with animal rights activists, therefore they do not allow any surveys to be administered. Bass Pro Shops (Portage, IN) contingently agreed to allow surveys to be conducted, however, the contact person, Duane Ebach, did not respond to multiple emails (3) and phone calls(2). Due to the lack of response, no surveys were conducted at outdoor retailers.

To overcome this obstacle, an internet survey was conducted through Zoomerang (www.zoomerang.com). The survey was posted 4 weeks and a total of sixty-two (62) surveys were completed.

A link to the survey was posted on nine Facebook groups dedicated to fishing and on Windycityfishing.com, a forum dedicated to fishing in the Chicago land area. Surveys were also emailed out to family and friends of Augy Park.

Local Bait shops were contacted in regards to conducting the survey, however, due to the weather conditions and time of year (January—March), fishing in the Chicago area was at a minimum, and on the advice of the store owner at Henry's Tackle (Chicago, IL) and Freddie Bear's Tackle (Tinley Park, IL), the decision was made not to conduct market research at these locations.

The results obtained from the surveys concluded:

- the majority of anglers are male (98%)
- between the ages of eighteen and forty-four (85%)
- fish with adults (44%)
- fish with adults and children (48%).
- shop mainly at outdoor retailers (58%)
- do not show a brand loyalty pattern (only 19 of the 150 surveyed gave a brand they preferred to buy).
- the most important characteristic in a fish hook is the ability to catch and hold (when compared to snagless/weedless, barbless, and safety).

Furthermore, the business team developed a business plan to present to investors (e.g. Angel Investors) for providing initial funding to Sparrowhawk (the detailed plan is located in igroups under spring 2010 business documents). The business plan covers details including:

- ad campaigns (targeted for specific markets, (i.e. Sparrowhawk Pro and Sparrowhawk Family)

- yearly financial projections
- supply chain strategy

Ad campaigns were produced based on the two product lines; Sparrowhawk Pro and Sparrowhawk Family. Sparrowhawk Pro targets anglers who typically fish with adults, value catch and hold the most, and are concerned with fishing performance of the hook. The Sparrowhawk family targets anglers, who fish with children, are concerned with safety and barbless features and are less concerned about fishing performance (more concerned with safety and satisfaction). Both markets are addressed financially in the business report; for the initial sales 90% of the net sales are given to Sparrowhawk Pro, given the amount of people concerned with catch and hold and fishing with adults, while 10% of the sales are given to Sparrowhawk family, due to the value of safety and the number of people who fish with children. These markets were determined using the survey results (full results are available on igroups, spring 2010). The financial section in the business plan is based upon Gamakatsu USA (Kenesaw, GA) and Owner American (Costa Mesa, CA). The two companies are both multinational companies; however their newest market was the United States (geographically). Because the companies were the newest, EnPRO 358 business team decided to model the financial section on their information (posted to igroups under spring 2010 business).

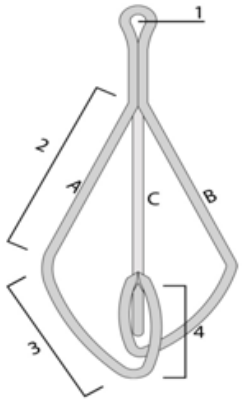
To prepare the Delta Hook Technology for retail sales, a packaging quote was obtained from Sigma Services, Inc. (Mundelein, IL)(www.sigmasvs.com). Initial machine retooling was quoted at $1250.00 USD ; material and labor costs were $0.15-0.30 USD and $0.14 (based on an order of 10,000 packages), respectively. This quote applies to blister packaging and the material cost is assessed using the card stock.

Future business teams should:

- Revisit the business plan and evaluate the financial statements
- Improve the ad campaign
- Inquire for more quotes for manufacturing and packaging

Product Development

In order to best understand the Delta Hook, figure 1 is provided as a reference.



1.	Eye
2.	Shank
3.	Arm
4.	Engagement mechanism

Figure 1 An illustration of the Delta Hook. Segments A, B, and C are the shanks. The eye is the part of the hook that is tied to the fishing line. The shank is the portion of the hook that serves as the flexing, or bending, mechanism. The arm and engagement mechanism work together to both pierce the lip of the fish, as well as hold the fish on due to its uniquely bent angles.

Summer 2009

Many bits and pieces must be considered during production of the mock-ups such as material selection, engagement mechanism, and durability. Originally, Augy Park created a number of mock-ups, as seen in Mock-up A and B in Figure 2. The shank in Mock-up A is made of steel cable. It was found that the cable allowed movement of the hooks in directions that caused them to tangle. Replacing the cable with flat steel remedied the tangling issue but an issue arose in its strength properties. The hook snapped between the arm and the engagement mechanism at the bend. Summer 2009 EnPro 358 created Mock-up C that addressed both the directional movement of Mock-up A as well as the strength issue in Mock-up B by using a pre-manufactured fish hook to prevent breakage between the arm and engagement mechanism and flat steel for the shank. The white epoxy used to join the hook proved to be too bulky and prevented the hooks from fully pushing past each other and engaging the hooks properly. Mock-up D fixes the bulkiness of Mock-up C, but did not meet the strength requirement.

Figure 2. A brief pictorial history of the Delta Hook. Mock-up A and mock-up B are from Mr. Park. Mock-up C is the first materialized design that this EnPro has made. Its strength is in its ability to flex with ease, but is weakness is in the bulkiness of the epoxy. Mock-up D is a slimmer design with its strength again being in its flexibility, but failing in its ability to carry a large load.

The Summer 2009 semester of IPRO 358, created their own mock-ups and each mock up was analyzed for flaws and re-engineered. The team's first mock-up consisted of six parts: three flexing shanks (labeled A, B, & C in Figure 1) made out of flat hair clips, and three hooks bent from safety pins, bonded with an epoxy. The team decided to create the base out of a cap mold created from epoxy putty. The shape and material chosen for the flexing unit worked as expected. The flat shank material allowed the engagement mechanism to flex only in the planar directions (Figure 3, Mock-up 1). The second mock-up (Figure 3, Mock-up 2) incorporated a new epoxy base, but due to the bulkiness of epoxy, the shanks were unable to over-flex, a key attribute of the original design for the DHT. The mock-ups created by the summer team may be seen in figure 3 along with a traditional treble hook for size comparison. The mock-ups created by the summer team may be seen in Figure 3 along with a traditional treble hook for size comparison.

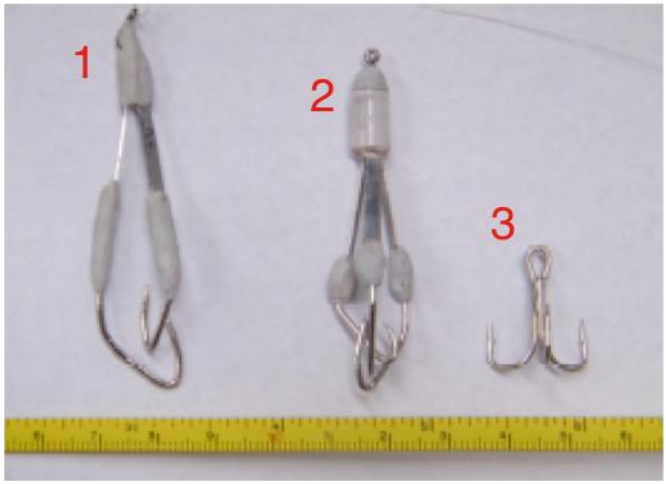


Figure 3. Mock-ups using epoxy to join the shanks and arms: Mock-ups 1 and 2 along with a traditional treble hook are shown. Mock-up 1 is a two-piece design, joined by epoxy; Mock-up 2 is a two-piece design with smaller epoxy joints. The third hook from the left is a treble hook; it is displayed for scaling purposes.

To alleviate problems created by the bulk of the epoxy, the Fall 2009 team explored a one-piece design that avoided the need to join the shank and the arm of each hook. This was accomplished by constructing each shank and arm out of a single piece of wire. The flattened shank, which effectively promoted uni-planar motion in the previous mock-ups, was created by flattening the shank region of the wire (Figure 2, Mock-Up D).

Hardness and rigidity in the wire were introduced through heat treatment, and tempering. The fall team bent wire into the shape of the Delta hook, which was then heat-treated and quenched. After processing of the bent hooks, an increase in strength was observed, however the mock-ups were still not comparable to existing hooks in terms of strength. This is in a large part due to the fact that the steel wire used in these mock-ups, ASTM 1006 and 1008, proved to be difficult to temper, due to the low a carbon content. A steel wire of higher carbon content, ASTM 1080, would be required for the heat treatment to be effective.

The wire was bent accurately and rapidly into the shape of the Delta hook using a jig. The first jig used was very basic; a piece of wire was bent around a series of nails which had been

hammered into a plank of wood. It was slow and inaccurate, thus the team cut out a set of molds on a CNC milling machine, which was located at the Fab Lab in Chicago's Museum of Science and Industry. A piece of wire was pressed between the two molds and the wire was bent into the desired shape. The molds were made out of wood and therefore the molding method only worked for softer wire (lower carbon content, ASTM 1006 - 1008). The present challenge is to develop a new method that can shape more rigid wire (higher carbon content, ASTM 1080).

In addition to bending the wire with a jig, a method was needed which could scale the Delta Hook to a smaller size; the team could not effectively bend the acute angles on a scale necessary for a final prototype using the existing jigs. To resolve the bending of rigid wire, a professional wire bending company, Master Spring and Wire Form Company, was contacted. A dialogue was established, and remains an important agenda item to be accomplished in the spring 2010 EnPRO.

Joining the bases of the hooks was the final challenge in the fall 2009. Soldering the three hooks together was used successfully for large-scale mock-ups; it is not a sufficient method to join a properly scaled prototype. As a soldered connection is not of sufficient strength for field-testing and also at the scale the joint would not be large enough to be effective.

All of the product development was centered at a dedicated test bench. The bench was utilized to conduct fatigue testing and flex testing. The other two necessary tests, unbending and sharpness, are quite standard, and campus facilities were utilized to perform these tests. Figure 3 gives a brief history of the Delta Hook.

Spring 2010

The main challenge facing the Spring EnPro 2010 team was material selection. Since a single-piece hook design had been chosen, a continuous piece of metal needed to exhibit flexibility in the shank, and rigidity in the arm and engaging mechanism. In order to obtain higher strength, high carbon steel was chosen (ASTM 1080) at the suggestion of Professor Mostovoy (IIT, Associate Professor of Materials Engineering). To promote shaping of the ASTM 1080 steel, it

was annealed for 72 hours at 720◦C. ASTM 1080 steel wire was strengthened through heat treating, quenching and tempering (815◦C for 5 minutes followed by 300◦C and 1 hour), adjusting the tempering temperature to find a useful combination between strength and ductility. Increasing the strength through heat treating, quenching, and tempering decreased ductility (the amount of permanent deformation before it breaks) of the Delta Hook. The compromise between strength and flexibility is again at the center of the tempering question. After strength testing (i.e., loading/unloading of the bend of the hook with a tensile machine) of the tempered steel, the flexibility of the shank was unsatisfactory; exploration into improving the flexibility of the hook is now the greatest priority, because the strength of the 1080 steel was proven through testing.

To meet design constraints, each hook must demonstrate flexibility in its shank region. Currently, there are three options being explored to increase flexibility: 1) test alternative materials with lower Young's moduli (e.g., Ti 6-4 as opposed to 1080 steel); 2) move the pivot point toward the joining region of the hook; 3) change the geometry of the flexing arm. Ti 6-4 (aka titanium grade V) was recommended by Professor Phil Nash (Mechanical and Material Engineering, IIT). Titanium grade V was chosen because it would be more ductile (without annealing). Research into using titanium was not exhausted in the spring 2010 semester and is a starting point for future semesters. Another option was to move the flexing motion from the shank to the joint. A rubber ball was used to join the three hooks together and because of its elastic properties, provides the flexibility for the DHT. Because of time constraints, this design could not be investigated further, which makes it a primary starting point for the summer of 2010. Changing the cross-section geometry had been attempted in previous semesters' without notable success. In utilizing the materials lab, pressures of up to 15,000 psi were put on the shank of the Delta Hook, effectively flattening the originally circular cross-section to a flat rectangular cross-section. It was observed that the change in geometry weakened the shank.

Social and Ethical Considerations

In dealing with the innovative hook technology, EnPRO 358 will have to consider several unique ethical challenges. The first consideration deals with the secrecy surrounding the specific

design details of the hook—EnPRO 358 should be careful not to disclose information that has not yet been patented. It is up to the group members to ensure that they do not forfeit the trust of their sponsor. Another ethical consideration deals with the use of material in the hook itself. From an environmental standpoint, the material should be non-toxic, and the hook should cause minimal damage to the fish which bite down upon it. On a similar note, one of the goals of EnPRO 358 is to create a hook which is safer to humans than traditional options. Team members must strive to achieve a high level of safety to not only meet their goal, but also simply to create a product that is not a danger to its users. EnPRO 358 will address the social and ethical considerations while working to bring the Delta Hook Technology to the market.

Team Value Statement

All group members participating in EnPRO 358 acknowledge and agree to adhere to the following principles of professional and ethical conduct:

- Complete their assigned tasks in a timely manner and trust in their fellow team members to do likewise
- Seek help and/or clarification when needed to understand what is required of them
- Remain informed of all topics and important issues addressed by the group
- Treat each of the group members with courtesy and respect as dictated by professional standards
- Communicate clearly and effectively when sharing information with the group
- Be present, on time, attentive, and open-minded during group meetings so as to achieve maximal participation and comprehension
- Resolve any grievances among group members quickly and peacefully, thereby maintaining focus on their primary objective
- Provide/accept constructive criticism to/from other group members politely

Absence/Tardy Policy:

All team members are expected to fully participate in IPRO 358. Class begins at 3:00 p.m. promptly. Any team members who are more than 15 minutes late will be counted as tardy. Two tardies will be equivalent to one absence, resulting in a 5% reduction from that team member's final class grade.

Each member is allowed one personal unexcused absence without any academic penalty. All other absences must be petitioned one week prior to the expected absence. The petition must be presented in front of the group for group approval.

- If the absence of that team member is approved:
- A task will be assigned (pertaining to the individual's sub team)
- A written and oral presentation will be assigned
- The hour does not count toward out of class work
- The team member will present their findings to the class
- In the case where a team member has more than one personal unexcused absence, a penalty will be incurred. Each class missed will result in a 2.5% reduction of that team member's final grade.

As it relates to the decision-making process, relevant decisions are to be voted upon, with majority rule. There will be a provision for allowing decisions that were struck down to be reconsidered for discussion after a vote. The motion will be set forth by one individual from the majority party. Up to five minutes will be set aside for discussion before the final vote. This will be the decisive vote. There will be communication established in group meetings, as well as outside of meetings. There are many portals we will utilize for discussion: discussion boards on iGroups, Gmail, Google Documents, etc.

Conflict Resolution

In order to relate to one another in a manner that is fair, equitable, and honest, EnPRO 358 members must keep open lines of communication. They need to be aware of each other's comfort zones and treat each other with respect. A conflict resolution statement has been

developed that will dictate the necessary steps required to identify and mediate problems within the group. Conflicts may arise over issues such as distribution of work, classroom attendance, or simple differences in opinion. By adhering to the conflict resolution plan, and maintaining dedication to cooperation, EnPRO 358 will overcome challenges and become a high performing team during the spring 2010 semester. The points below act as a guideline to resolving any conflict that may arise during the course of the semester:

- Identify the conflict
- Approach persons involved to discuss problem
- If conflict remain unresolved, the team leader and/or professors will mediate
- To ensure a democratic solution, group discussion will ensue to review and ensure that the conflict has been resolved

Work Breakdown

Business Development

ENPRO 358 business team has set itself three major goals and targets for the Summer 2010 semester. All work completed by the team throughout the semester will lead towards the completion of the major tasks. The tasks that the business team have set themselves are:

- Final marketing strategy
- Accurate financial figures
- Watertight business pitch to investors

Marketing

The EnPRO 358 business development team will be working on improving the marketing component of the business plan. In particular, developing sophisticated product placement and pricing strategies. The Pro and Family brands should be positioned substantially different as to maximize profit by discouraging cross brand substitution. Research in current lure and hook competitors will be conducted in order to come up with a viable pricing structure.

The Business team will also be addressing the advertising campaign that will be utilized when the product launches and penetrates the existing market. This will involve negotiating prices with established Bass publications and using of social network advertising tools (e.g. Facebook). The possibility of packaging free DHT's with magazines is also something the team will spend time investigating.

Financials

The EnPRO 358 business development team will work to compile the information from the surveys that are taken along with current information from the market to identify suitable sale prices to target different market segments (Sparrowhawk Pro and Sparrowhawk family). The business team will use this information to construct an accurate statement of financial figures that will give Sparrowhawk a detailed profit and cost structure to be presented to future investors. A breakdown of how much profit Sparrowhawk will make from the DHT in the first three years of production will be produced. Working with the product team, the business team will get reliable figures for the cost of production or variable costs for the DHT. General, administrative and selling costs will be calculated to construct a viable income statement. These numbers will be essential to how much profit the DHT will produce.

When the EnPRO 358 business development team has accumulated these financial figures, a financial pitch to potential angel investors will be constructed. The team will be confident in explaining how the DHT will generate revenue, making future forecasts and showing what the EnPRO 358 team has accomplished to date. The EnPRO 358 group will know how the DHT will succeed in the current economic climate and show the advantages of investing in a growing, dynamic company. The business team will outline what Sparrowhawk needs from the investor to make the business a success and what we, as a business, are looking for in a potential investor. The message will be portrayed to investors that the DHT will hit financial milestones and that an investment in Sparrowhawk will show healthy returns and help it grow a significant step.

Advertisements

In order to display a clear message in its advertisement, the business team will work with the product team to specify the strengths of the DHT. After that, corrections will be made to the advertisements that cater toward the needs of the target markets (e.g. catch and hold, safety, etc.). The business team will research fishing magazines and the internet for advertisements of similar products and implement beneficial aesthetic changes to the DHT advertising campaign. Using Adobe Photoshop, revisions of the previous semester's advertisements will be made in addition to creating new advertisements. Specifically, the team will focus on layout, readability, color choices, and having an overall meaning that is understandable to the viewer.

Production

Manufacturing Strategy

The Summer 2010 EnPro 358 team will contact a wire bending company to order and produce the parts of the DHT in accordance to the specifications designated by the product team. Assembly of the parts may need to occur at another site depending on the rubber ball component of the final prototype; should this be the situation, the business and product team will collaborate in finding another company to complete such task. Costs of raw materials, manufacturing and shipping (be it directly back to EnPro 358 or to another company for assembly) will be taken into consideration for the appropriate pricing of the final DHT product with respect to making a profit.

Packaging Strategy

Making revisions to the rough packaging design from the spring 2010 EnPro 358 project, the business team will contact a packaging company to obtain more quotes. The existing design will be geared towards the professional angling market while a new package that is targeted more towards children and families will be designed as well. Having special designs for the different targeted audiences will help to emphasize specific aspects of the DHT that will be most attractive to the professional and children/family markets.

Product Development

Currently, there are multiple different mock-ups of the Delta Hook. Two new ideas have been proposed this semester including the rectangular wire design and the swing design. Additionally, another design that is being continued is the ball mock-up (from spring 2010).

Rectangular Wire Design

Using the plans and dimensions of the previous semester, the EnPRO 358 product team will investigate using rectangular wire to gain the planar motion in the shank of the Delta Hook. The material (ASTM 1080 steel) will not change and nor will the annealing or tempering process. The significant gain is bypassing the shank flattening, an opportunity for improvement as identified by previous EnPRO 358 teams. Additional processing of the rectangular wire is required in shaping the hook. The hook will undergo a forging process (the hook and gape region, while the shank will already have inherent planar motion due to the new geometry of the wire. Currently, a manufacturer who stocks standard rectangular wire is being pursued.

Figure 4. The proposed swing design first mock-up.

Swing Design

The swing design is a DHT that functions in a purely mechanical fashion. Design addresses the need for flexibility, identified by the spring 2010 team. The swing method features DHT hooks that hang from the core of the head section of the DHT as shown in Figure 4. The hooks swing between the engaged and non-engaged modes, but are restricted from swinging too far outward by the cap, and too far inward by the flat springs. The flat springs provide the flexibility. As inward pressure is placed on the hooks, the flat spring, which is attached to the hook, opposes the force and as soon as the pressure is removed, the flat spring forces the hooks back into their non-engaged mode. The motion is also restricted from side-to-side due to

the swinging joint (see appendix B for schematics). A problem that may arise from this design is weight (too heavy) and manufacturing costs.

Rubber Design

The rubber ball prototype addresses the problem of flexibility. In the traditional design of the Delta hook, the source of the rigidity was the joint. The rubber ball takes the joint and makes it flexible. The 3 hooks are inserted into a gum rubber ball (gum rubber is flexible and tear resistant, both well suited for this application). Weather resistance is being investigated through exposure testing. The rubber ball design is still in a crude form and other shapes and placement of rubber are being explored.

The following tests will be performed on the Delta Hooks (in addition to unbending tests).

Hook Sizing Effects

Tensile tests will be used to test the strength of various hooks using different length of shank and altering the diameter of the wire. In addition to strength measure, the flexibility of the hooks will be evaluated by measuring the force needed to bend the hook up to the level that is needed for DHT to be engaged. The discovered data will be recorded and entered into the chart. The chart will be created in the following order: horizontal axis will have varying diameter of wire and the different lengths of shank will be set on vertical axis. The corresponding open boxes within the chart will be filled with the information that was discovered throughout testing procedure.

Snag Testing:

In the summer 2009 EnPRO 358, snag testing was done on the Delta Hook. Snag testing is pertinent to the DHT because of the natural habitat Largemouth Bass tend to feed in. Weed beds and shallow waters are both feeding and breeding grounds for the Black Bass. In order to validate the snagless/weedless claim, the Delta Hook Technology will be field tested. The testing will be accomplished by casting the Delta Hook mock-up into an area with high density underwater vegetation and retrieving the lure with a fishing line. Each time the hook is

retrieved, a record will be made of catching the vegetation or not, comparing the Delta Hook to a standard treble hook. This test will verify the snagless/weedless claim that the Delta Hook promises.

Accelerated Ageing Tests

The natural deterioration of the under the action of heat, light, cold, water, etc. is termed as 'ageing'. The service life of a product is too long to wait for getting information regarding the performance of the product under the influence of the above mentioned agents. It is therefore necessary to test the product, under conditions which can produce accelerated ageing effects, to get some idea of the service life and performance of the products. The testing is done usually, by keeping the test samples under the influence of high or low temperature, for a specified period and then determining the physical properties like hardness and brittleness or just the visual appeal. The change in properties from the initial value or the change in appearance gives an indication of the resistance of the rubber to that particular factor.

Low Temperature Test Methods:

Brittleness Point Test:

Brittleness point is the lowest temperature at which rubber materials do not exhibit brittle failure when impacted under specified conditions. When testing, test pieces in the form of strips are clamped as shown in Figure. 1 and then immersed for 5 min in a cold bath. After 5 min they are subjected to a single impact blow, then examined to see if they show any cracks. If they have failed, new test pieces are tested at a temperature 2°C higher. The test is then repeated at higher temperatures until no failure is observed. This temperature is recorded as the temperature limit for brittleness. A schematic showing the test set up is shown below.

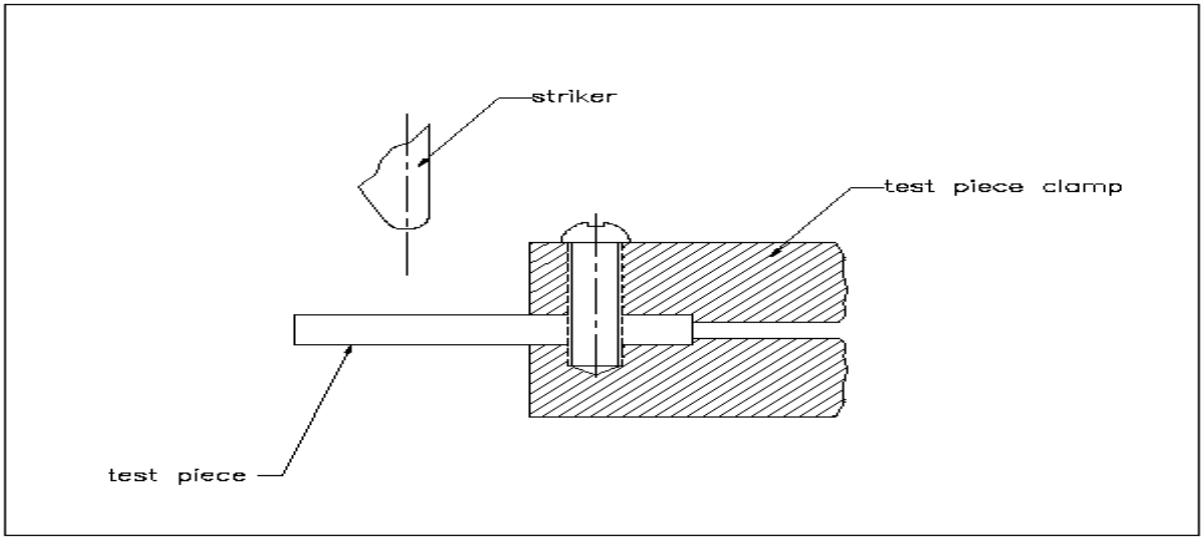


Figure 1. Schematic of the set up to be used for determination of brittleness point.

Increase in Hardness Test

Hardness test involves the measurement of the depth of penetration of an indenter of specified dimensions under the application of a load either by a dead weight or by a spring. The indentation hardness is a measure of the elastic modulus of the material under conditions of small strain.

This method describes a test based on hardness measurements for determining the progressive stiffening of rubber with time, caused by crystallization.

The test pieces are placed in a cold chamber at the test temperature and the first hardness measurement is done after 15 min conditioning time. The hardness measurements are then repeated after 24 and 168 h storage. If a curve is to be plotted, measurements can be made at intermediate times. There are different types of instruments used for measuring the hardness, one of the most popular being the shore A Durometer.

Abrasion Tests

Abrasion resistance may be defined as the resistance of the rubber to wearing away by rubbing or impact during service. The principle involved in the test is to rub the test sample against standard rough surface, such the sandpaper for a specified time. The loss due to this rubbing is then calculated and expressed as loss in weight.

Catch Per Unit Attempt

In order to market and compare the DHT with other fish hooks and its main competitors a base of success or a way of measuring the catch and hold must be established. Based on research through popular angler forums and higher education dissertations it has been determined that two things classify an angler's success, the quantity and quality of his catch. In order to compare and quantify the catch and hold of the DHT a series of experiments will be set up to test and assess its relative success. These tests will be based off the catch per unit bite analysis and will measure for every bite how often a catch is had. In order to truly prove the superiority of the DHT the catch and hold analysis will be tested on a number of hooks and all tests will be performed in a way to try and maximize the similarities between each test and its procedures so as to properly gauge where the DHT stands amongst its competitors, to propel it in the fishing industry and prove it is a superior accessory necessary for every fishers tool kit; regardless of his skill level.

Academic Resources

The EnPRO team will maintain contact with Professor Sheldon Mostovoy whose expertise lies in the field of materials engineering. He has and will continue to provide insight to pertinent materials issues including choice of material used to make the hook, the properties of these materials (i.e. stiffness, strength, elasticity, etc.), and in the stress and force analysis of the hook, as well as providing a link to the on-campus testing resources, such as the hardness testers. Information gathered from Professor Mostovoy will be via individual meetings and will be documented in writing as well as voice recordings.

Water Chamber Flume:

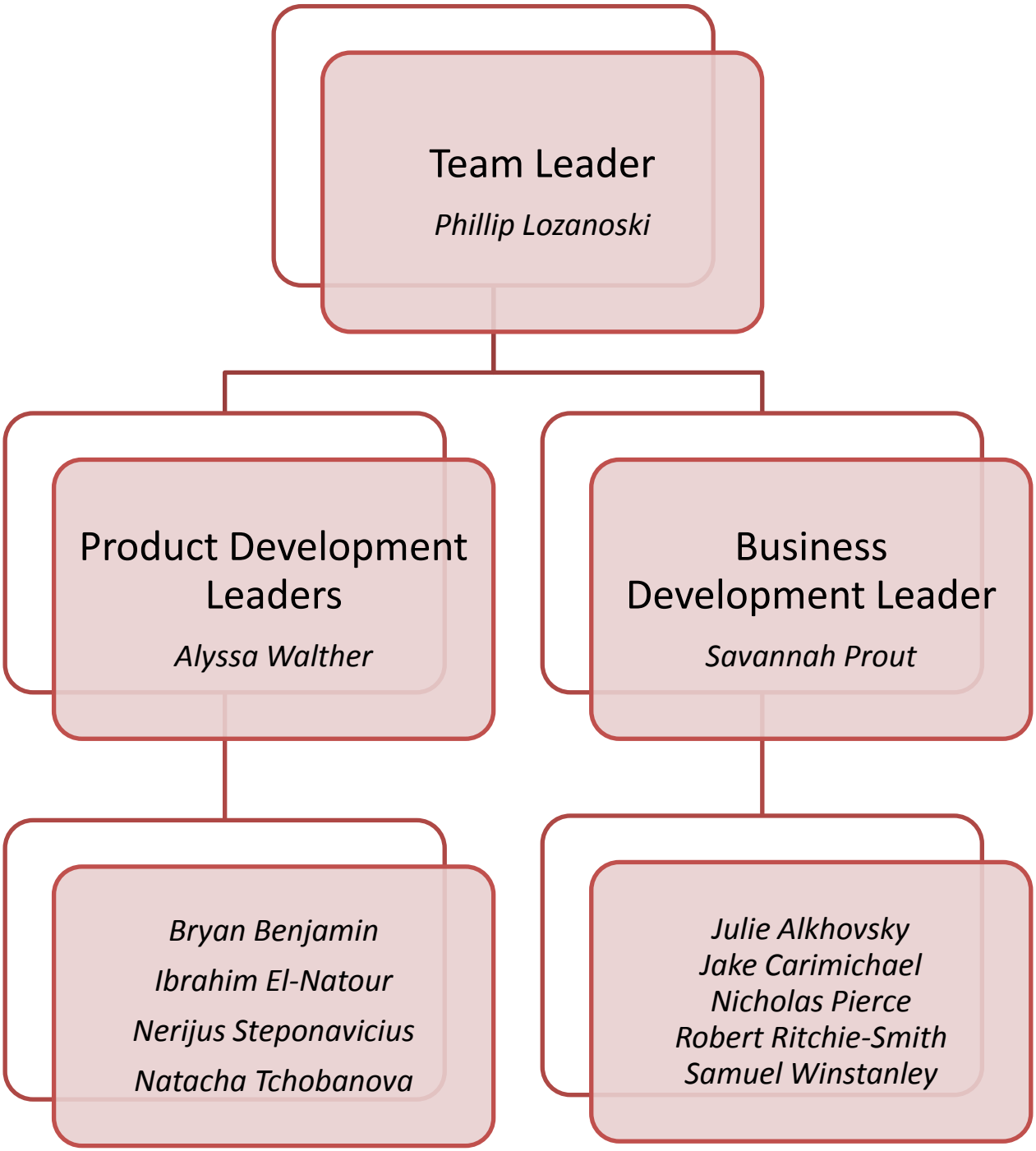
The Delta Hook's fluid dynamics and other competitive commercial hooks will be analyzed for water flow profiles. By analyzing the fluid mechanics of commercial hooks the team will be able to measure the "action" (the way the hook moves through the water) and compare to other competitive commercial hooks. If the Delta Hook's movement is unique, further analysis will ensue to understand the hook's ability attract largemouth bass. Additionally, knowing the movement pattern of the Delta hook will aid in ultimate design of the lure, in particular, where the hook should be placed on the lure.

Professional Resources

Bass Pro Shop:
Bass Pro Shop is one of the leading outdoor retailers and specializes in the sale of fishing equipment. Retailers like The Bass Pro Shop offer SparrowHawk the opportunity to demonstrate the capabilities of the Delta Hook. Bass Pro Shop has facilities for testing out fishing equipment in a glass tank in front of a customer

Fishing Connection
Fishing Connection is a local retailer of fishing equipment. Fishing Connections (Tinley Park, IL) draws anglers from both novice and professional backgrounds. Fishing Connection will serve as a location to conduct surveys and gather insight into the fishing market. Fishing Connection may also serve as a potential site to launch the DHT.

Team Structure



Expected Results

The product team plans to actively pursue the tasks outlined in the work breakdown. Each design will be pursued for the entire semester in order to maximize research. As mock-ups of the new design are built, they will undergo a series of tests staggered towards weeks three through six (in order to complete mock-ups).

Gantt Chart

ID	Task Name	Duration	Start	Finish
1	**General Product Development**	**35 days**	**Fri 6/11/10**	**Wed 7/14/10**
2	Annealing	4 days	Fri 6/11/10	Mon 6/14/10
3	Bending	4 days	Mon 6/14/10	Fri 6/18/10
4	Strengthening	4 days	Fri 6/18/10	Tue 6/22/10
5	Assembling	5 days	Tue 6/22/10	Sun 6/27/10
6	Testing	8 days	Sun 6/27/10	Sun 7/4/10
7	Alterations	5 days	Mon 7/5/10	Fri 7/9/10
8	Retest	5 days	Sat 7/10/10	Wed 7/14/10
9	Compile Information	5 days	Sat 7/10/10	Wed 7/14/10
10	**Rubber Hook Design**	**37.25 days**	**Fri 6/11/10**	**Fri 7/16/10**
11	Design/Prototyping	10 days	Fri 6/11/10	Sun 6/20/10
12	Testing	10 days	Sun 6/20/10	Wed 6/30/10
13	Finalizing Design	8 days	Wed 6/30/10	Wed 7/7/10
14	**Business and Marketing**	**37.25 days**	**Fri 6/11/10**	**Fri 7/16/10**
15	Conduct Surveys	8 days	Fri 6/11/10	Fri 6/18/10
16	Analyze Survey Data	3 days	Fri 6/18/10	Mon 6/21/10
17	Prepare for Midterm Presentation	6 days	Fri 6/11/10	Wed 6/16/10
18	Midterm Review	1 day	Thu 6/17/10	Thu 6/17/10
19	Finalize Cost Research, Ads	4 days	Sat 6/19/10	Tue 6/22/10
20	Finalize Research for Ethics Bowl	8 days	Wed 6/23/10	Wed 6/30/10
21	Make a Pitch for Investors, Ethics Bowl	9 days	Wed 6/23/10	Thu 7/1/10
22	Prepare for Final Presentation	14.5 days	Fri 7/2/10	Thu 7/15/10
23	IPRO Day	1 day	Fri 7/16/10	Fri 7/16/10
24	Fishing Trip	2 days	Sat 6/19/10	Sun 6/20/10

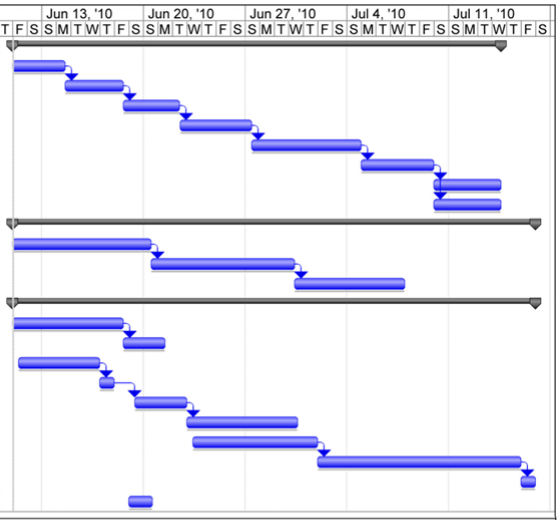


Figure 5. The Gantt chart depicts the major tasks that the product and business team will accomplish along with the expected time to complete each task.

The business team will spend the most time on perfecting the advertisement because the ads can be turned into digital media (useful in online target marketing). Additionally, the packaging and manufacturing will be investigated in order to update the business plan created in the spring 2010 semester (see business development history). The financial review was left for last because the packaging, manufacturing, and advertisement costs will all be calculated into the financial analysis.

Business Development

The Business team of Enpro 358 will complete three main goals for Summer 2010, to help launch the DHT (Delta Hook Technology) into the market and be able to pitch the product to potential investors. The team will review previous semester's work and surveys while presenting new research and findings through surveys and interviews on sales pricing, market trends and advertising and sales costs.

By the end of Summer 2010, the team will have in place a final comprehensive marketing strategy. With research to be conducted on various areas, including online (Facebook, Google), magazine advertisements (Basshook Pro), giveaways, sponsoring events and instore promotions. The team will also created a business plan with accurate financial information, including marketing, manufacturing, packaging and shipping costs along with predicted financial revenue and profit statements.

Enpro 358, business team working together with the product team, plans to have DHT prototype and business plan ready to pitch to investors and the mock up ready for manufacturing by the end of Summer 2010.

Product Development

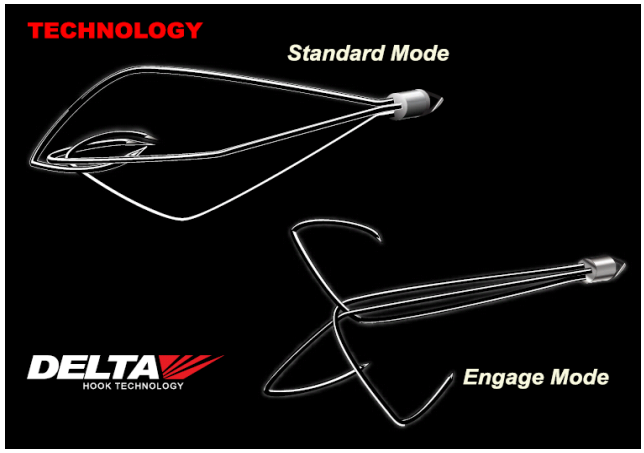


Figure 6. The sponsor's depiction of the fully functioning Delta Hook.

The main priority of EnPRO 358 is to complete the design of Delta Hook Technology's new innovative fish hook and develop a functional prototype to present to our sponsor and investors. Figure 6 is the ideal prototype and the ultimate goal. By the end of the semester, after the Delta Hook has undergone numerous quality tests, it will be ready for placement in the iCAST 2010 (July 14-16, 2010, Las Vegas, NV).

With the flow of information from group to group the team hopes to accomplish functional teamwork. As an EnPRO, goals outside of the initial scope of the project have been set up to benefit the individual needs of its members. Effective communication between group members, public speaking and professional business experience were all important qualities that the team's members hoped to improve throughout the course of the semester. As the semester progresses, there will be more and more of a demand for interpersonal relationships between team members and outside sources, and it is the hope of this team that the professional bonds that are formed help raise the level of work this team is capable of.

Risks and Potential Failures

With any new innovation, there are risks, and potential failures. This is the case with the development of the DHT because some unchartered territory is being explored. There is currently no product similar to the Delta Hook on the market to work from, everything is new. The following items are a description of risks potential failures relating to the steps that need to be taken to develop DHT.

Business Development

The project proposes a disruptive technology. An incremental technology continually progresses and improves its market over the calculated time. However, DHT requires a careful preparation as it has a potential to create completely new markets or destroy existing markets.

The project will face hardships on establishing manufacturing, packaging, and distributing costs. This can be overcome by gaining adequate funding from investors.

Moreover, there are many difficulties in the marketing research phase. A high-quality survey needs to be created and distributed. Thorough research on competitors is must so DHT is prepared for any positive or negative reactions from the competitors.

To protect the information related to DHT, the Non-Disclosure Agreement form will be signed by all the parties that work with EnPRO 358 team and will restrict access by third parties.

Last but not least, time is the key to the completion of the project. If all the deliverables get completed on time, the project should be successful.

Other Identified risks and difficulties include:

- Establishing manufacturing, packaging, and distribution resources at an effective cost
- Gaining initial exposure w/ consumer
- Gaining initial funding from investors
- Disruptive technology
- Survey length/ willingness to complete
- NDA protection
- Competitor reaction

Product Development

Bending / Hook Forming:

The risk associated with manual bending/hook forming is possible injury to the wire bender because the wire is difficult to work with and has sharp edges. These risks can be reduced by obeying proper safety methods. Potential failures during this process include: not being able to find an adequate material, not being able to bend the wire to the required dimensions either manually or professionally, and not being able to streamline the bending process.

Flattening/Swaging

The most disconcerting risk associated with flattening/swaging is possible injury to the wire bender while using hammers or heating torches. These risks can be reduced by obeying proper safety methods. Potential failures include: not being able to find an adequate material, not

being to flatten/swag the wire to the required dimensions, either manually or professionally, and not being able to streamline the flattening/swaging process.

Base Joint Assembly

The risk in manually joining the base with the use of brazing or welding is injury to the worker because of high temperatures created from the process. This risk can be reduced by obeying proper safety methods. Possible failures in this process include: not being able to find a brazing material that is strong enough for the joint, not being able to braze or weld the joint without degrading the properties of the hook material that is used, not being able to manually braze or weld the joint, and not being able to braze or weld the joint without changing the dimensions of the hook.

Testing

The risks involved in testing hooks include injuries that can occur from lifting heavy weights, dropping heavy weights on body parts, and projectiles ejected from hooks being tested. These can be reduced by obeying proper safety methods. Possible failures in the testing process will most likely be failed tests in which something went wrong, either operator error or testing method error.

Analysis/ Research

The only apparent risk in research is exposing intellectual property to outside resources. The potential failures in analysis/research of the product regard finding information applicable to the Delta Hook development.

Budget

Item	Description	Cost
Travel expense	Visiting professional services	$100
Professional Services	Wire form manufacturer	$1,000

Material and Supplies	Mock-up material---$300 Literature---$25 Clipboards ---$20	$345
TOTAL		$1,445

Budget Detail

The proposed budget for EnPRO 358 spring 2010 is aimed at attaining professional services and utilizing outside resources to expedite the production of the Delta Hook. Travel expenses are focused on trips to wire form companies; currently two new companies in are being pursued. O&G Spring (Chicago, IL) and Mid States Wire Form (Chicago, IL) are being pursued in regards to production capabilities, minimum order, and turnaround time. The professional wire bender is of utmost importance to the team; a contract with O&G Spring or Mid States Wire Form would allow for mass production of the Delta Hooks, a necessary component of realizing the manufacturing and distribution goals of Delta Hook Technologies. The $1000 price tag is associated to the wire form manufacturer based on contact with Master Wire and Spring (River Grove, IL). A $500 retooling fee is assessed to begin the production with $500 for placing a first order. After a lack of interest by Master Spring (River Grove, IL) last semester, EnPRO 358 will once again attempt to secure a manufacturing contract. The funds allotted for the spring and wire form company will be used to order function prototypes for both destructive and field testing (outlined in product development work analysis). The material and supplies budgeted moneys will be used to purchase mock-up material including:

- Aluminum 6061 36" length rod w/ diameters of 1/4", 3/8", & 1/2"

17.20+24.26+32.14

- PTFE-Filled Delrin Rod length 24" w/ diameters 1/4", 3/8", 1/2"
- ASTM Shim Stock Spring Steel

length:6"
width:25"
thickness: .012", .025", .032"

- Stainless Steel Rod Annealed

Length:36"
Diameter: 1/2"

Additional funds will be used on pertinent literature (i.e. biomechanical study of largemouth bass behavior, business case studies from the Harvard Business Review), and clipboards, to administer surveys.

Designation of Roles

iGroups Moderator:

Phillip Lozanoski will be responsible for on-time posting of deliverables and editing the project calendar.

Agenda Maker:

Natacha Tchobanova will be responsible for preparing agendas for both the Tuesday and Thursday regularly scheduled meeting times. The agenda is to be posted on iGroups by 5:00 p.m. on the day preceding the regularly scheduled meeting times (Mondays and Wednesdays by 5:00p.m.).

Minute Taker:

Julie Alkhovsky will generate meeting minutes and document meeting agenda items and the action taken on those items. Items will be posted to iGroups immediately after each meeting.

Time Keeper:

Ibrahim El-Natour will keep the group on task and remind the group leader of timing in order to accomplish all agenda items efficiently.

Appendix A

Julie Alkhovsky (jalkhovs@iit.edu)
Third year Psychology Major
Julie started at IIT studying architecture, and therefore has knowledge in AutoCAD, Adobe Photoshop, and Illustrator. She is also proficient in MS Word, Excel, and PowerPoint. After the switch to Psychology, she has gained knowledge in how people think, that will help in the advertising portion; focusing on the overall meaning of the product (what kind of people would use it, why they would use it, etc.). So far, she has taken two business courses at IIT so far (Marketing and Economics), which give her insight into the development of products and the mathematics of calculating costs and profits, and she plans to become stronger in this area over the semester. She also hopes to understand the engineering/materials side of the project more clearly throughout the semester. She is interested in this ENPRO because she used to fish with her family and remembers the dangers of kids carelessly playing with hooks and would like to work towards reducing, if not eliminating these dangers.

Bryan Benjamin (bbenjami@iit.edu)
Fourth Year Mechanical Engineering Major
Bryan is returning for a second semester of EnPRO 358 to continue working towards the realization of this fishing innovation and to partake once again in the fun of EnPRO 358. Bryan is experienced in welding/brazing and metal forming, which will help in the production of testable prototypes. A genuine interest in fishing will provide motivation to assist the team in finishing the task. Bryan is hoping to bring knowledge of this project to the group of new students and learn more about what is takes to work as a team.

Jake Carmichael (jcarmich@iit.edu)
Fourth Year Business Major (Marketing Specialization)
Jake, as fourth year business student, plans to use his knowledge and experiences from previous projects to help sort and organize the business side of the project, including marketing ideas and direction, business plans and financial planning with projected revenues. He has experience in MS office, including Word, Excel and PowerPoint, and will use these skills to best benefit the team. Jake looks to gain insight business relationships and networking, while hoping to gain a better understanding of the manufacturing side of a business.

Ibrahim El-Natour (ielnatou@iit.edu)
Third Year Mechanical Engineering, Materials Engineering Major
Ibrahim seeks to help in the selection of a material and its processing to move towards a final working prototype. He is a speaker who enjoys public speaking and is extremely experienced with all aspects of computers from hardware to software and will use his skills to benefit the team as they see best. He really looks forward to either deciding on a final material and creating a working and possible final prototype that meets team goals and expectations or at

least deciding on a final material and developing an experimental prototype. He has plenty of experience in Photoshop, MS Office, Adobe Suite, Matlab, and many other computer programs.

Phillip Lozanoski (plozanos@iit.edu)
Fourth Year Biomedical Engineer Major
Phillip is returning for a second semester in EnPRO 358; he has knowledge in the fields of biology, chemistry, and engineering. He will use his previous experience from the spring 2010 business team to help the business team along with use his engineering background to advance the product team. Moreover, as a returning student, he will provide leadership to the team. Phillip will use his knowledge of formal document writing to help the group produce the deliverables. He hopes to gain experience working in material selection for the prototype and gaining experience in the engineering and design aspects of the Delta Hook.

Nick Pierce (npierce1@iit.edu)
Fourth Year Business Major
Nick has knowledge in the fields of physics and business. He is skilled in Microsoft Office (Word, PowerPoint, Excel). He will use his skills and knowledge to assist EnPro 358 where they are needed. Nick joined enpro 358 to gain experience in product development as well as developing a marketing strategy for a new product to enter the market. Nick also wants to further develop his team building skills by working together with his peers in EnPro 358.

Savannah Prout (sprout@iit.edu)
Fourth Year Business Administration and Applied Sciences Major, Specialization in Mechanical Engineering
Savannah hails from both a business and engineering undergraduate background with experience specifically in finance and accounting, business procedures, business law, material properties, formal writing, and group leadership. She intends to learn more about the details surrounding the promoting of a new product into a market as well as the design and testing of that product before it's initial launch into said market. She also plans on gaining experience in public speaking and product expertise in regards to the promotion of such product. Savannah joined this EnPRO because she felt that she could contribute her hard work and skills towards making the final stages of this innovative project successful ones.

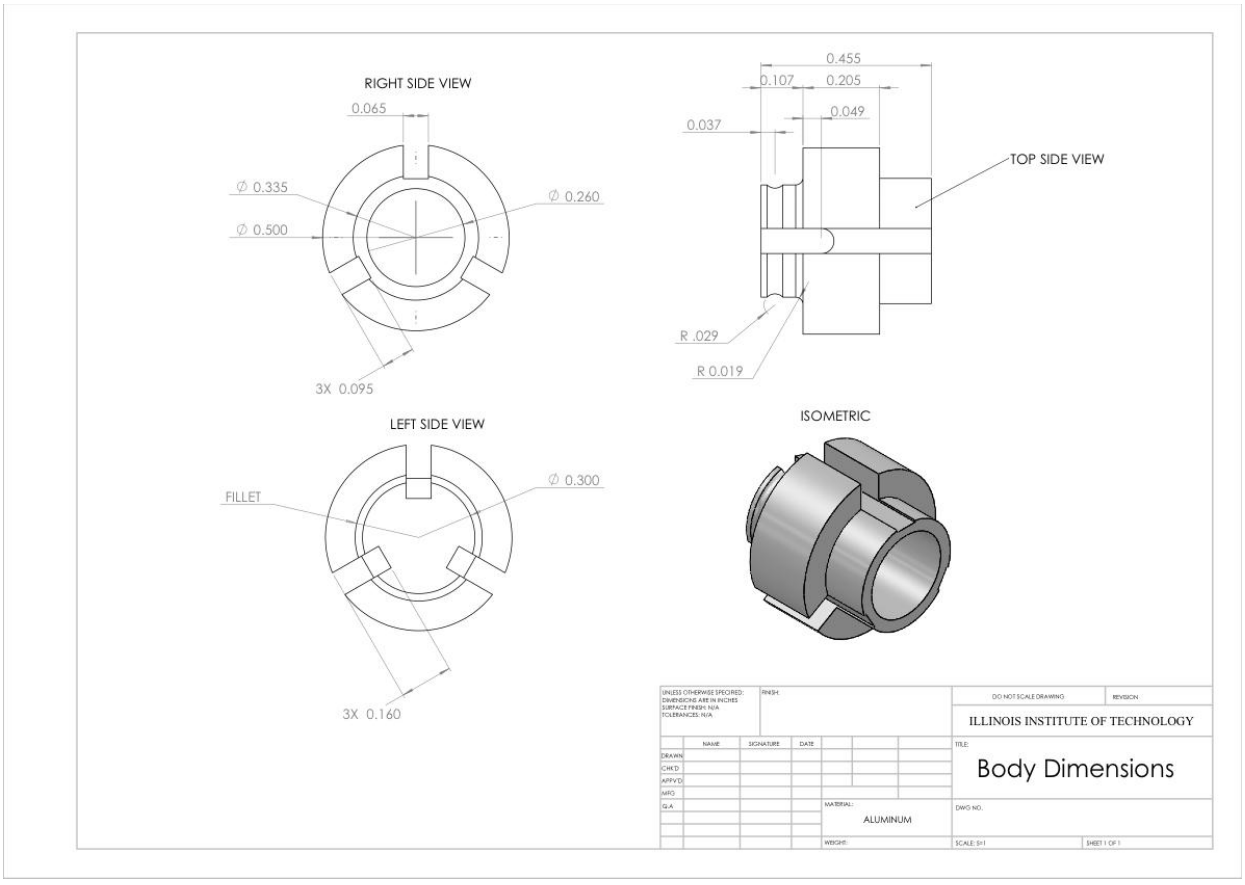
Robert Ritchie-Smith (rritchie@iit.edu)
Third year Business Major specializing in Finance
Robert has knowledge of financial management and managerial accounting. He feels the skills he has learned would be best applied to the financial side of this project. His strength lies in assessing budgets and future revenue figures which will help the team to build a solid business plan to present to possible investors for this project. He is looking forward to gaining genuine, real world business experience. He is very competent working with Microsoft Office software and Autocad. He feels this EnPRO may help him with some of his weaker skills such as public speaking and writing.

Nerijus Steponavicius (nstepona@iit.edu)
5th Year Architecture Major
As an architecture student he has strong skills in design and problem solving. Nerijus is efficient with CAD, Photoshop, Illustrator software programs. In addition to these skills he has already completed Construction Management Minor degree and has good understanding of scheduling, estimating and contracting. He also has been working full-time for an engineering company over the last two years. Through this position he has learned to efficiently work within a team and efficiently be part of big projects.
He is interested in this IPRO because of the opportunity to be involved in product development. He joined this IPRO because he likes fishing and summer is a great time for that.

Alyssa Walther(awalther@iit.edu)
Fourth Year Mechanical Engineering, Aerospace Engineering Major
Alyssa will apply her knowledge to the development of the product, specifically force and stress analysis and materials selection methods. She has experience in MS office (Word, Excel, and PowerPoint). She would like to enhance her experience by working with engineering materials and testing. She hopes to gain insight into business development. Ultimately, the experience will give Alyssa insight into her professional goals.

Sam Winstanley (swinstan@iit.edu)
Third Year Business Major
Having completed his sophomore year as a Business Administration major, Sam brings many valuable ideas to the table, both in terms of product ideas and marketing. He is proficient with the Microsoft Office package and possesses high-level communication and leadership skills. He believes his weaknesses, which he is looking to improve over the course of this EnPRO are his product design and working with materials skills.

Appendix B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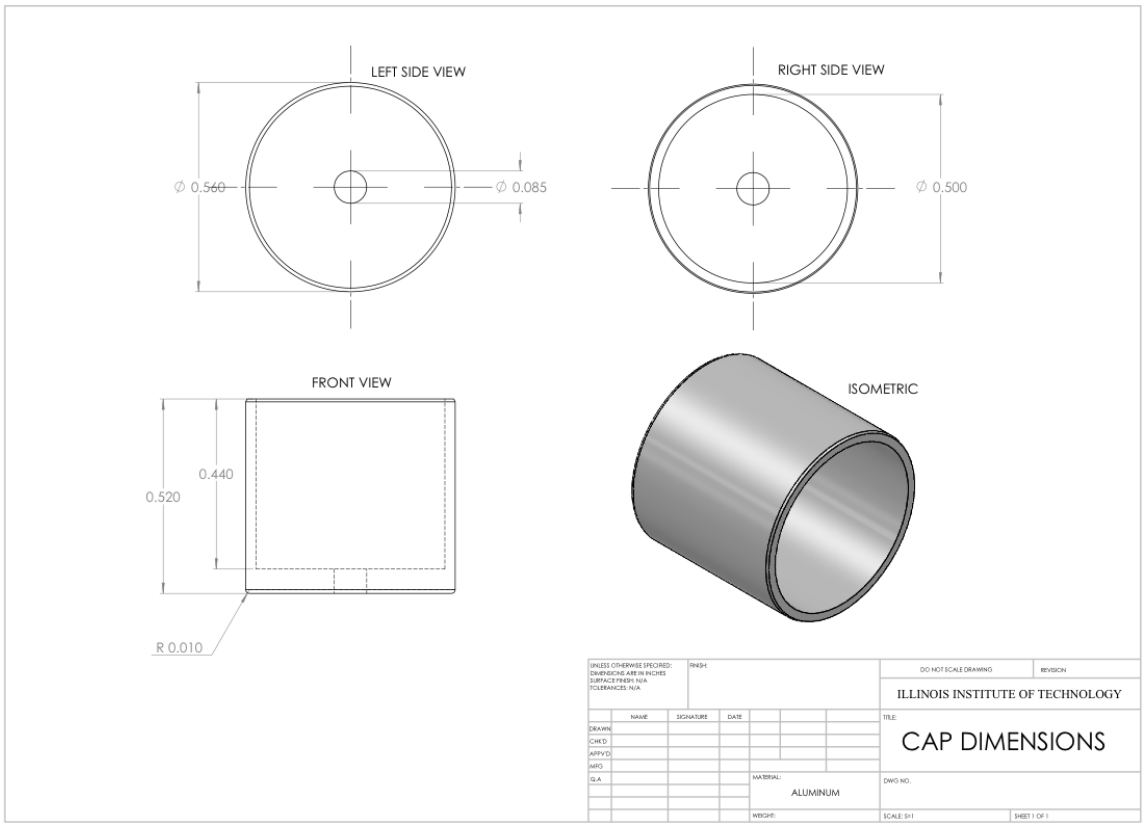
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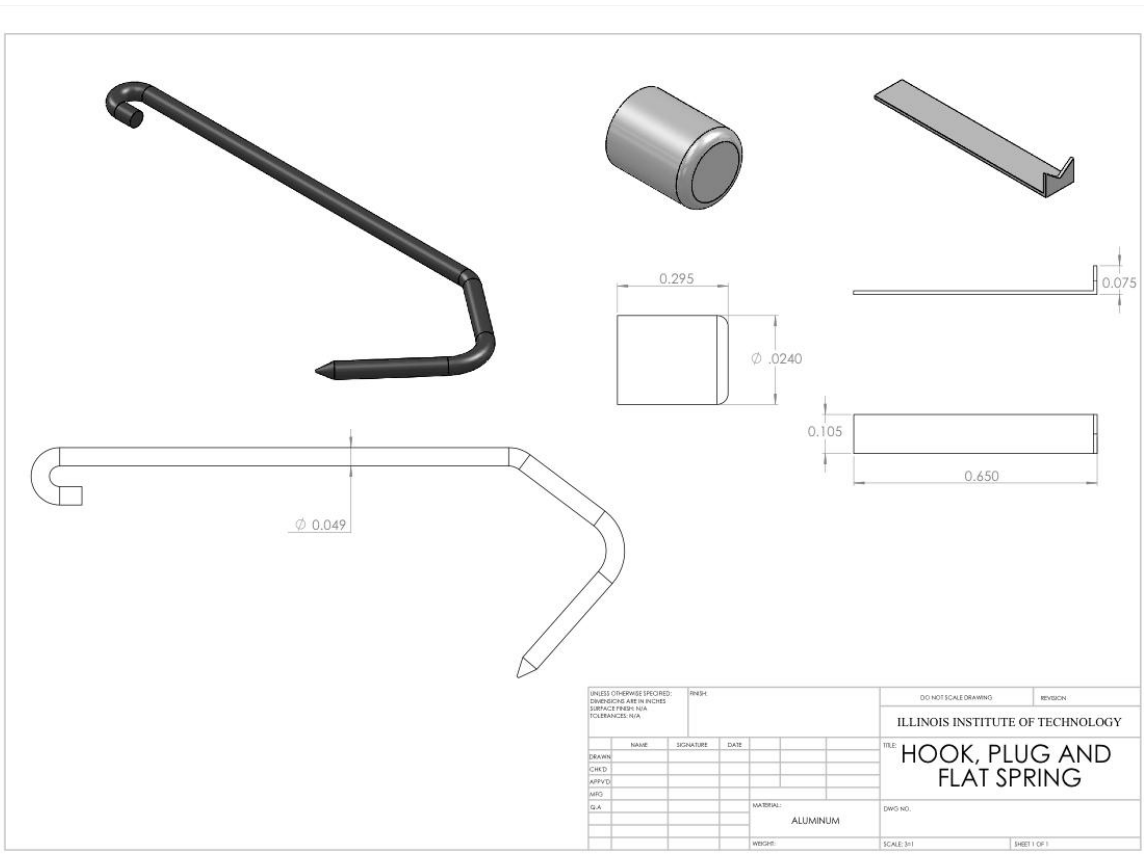
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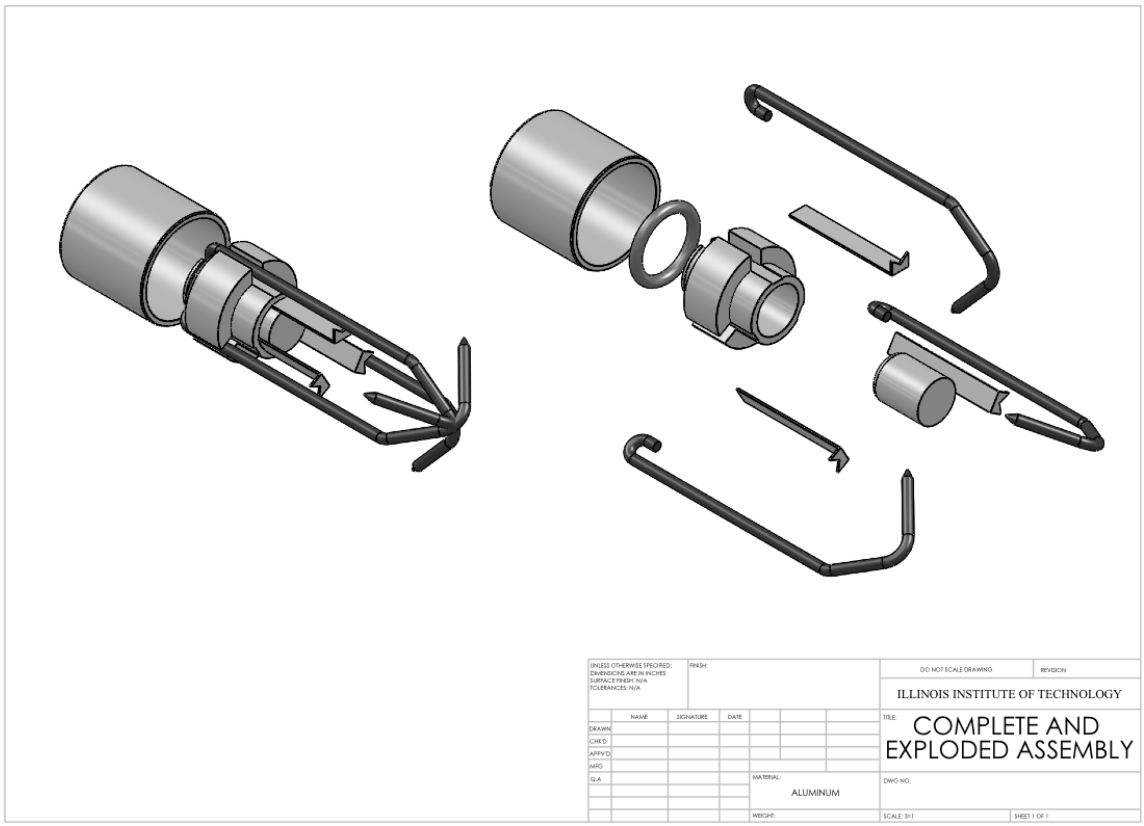

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