Empowering and Connecting People with Amputations

BADM 533 | Business Plan
Introduction

The goal of this project is to improve the quality of life of people in India with above the elbow amputations by designing an affordable, off-the-shelf prosthetic device and developing a comprehensive business model for the proposed device. By providing people with a functional prosthetic device, we hope to empower them by re-enabling them to perform physical tasks and increasing their confidence. An off-the-self prosthetic device will allow amputees to return to normal and provide support for their families in a timelier manner and without the inconvenience of traveling to a clinic for custom fitting.

While those living in subsistence marketplaces have the option of receiving free prosthetic devices through clinics such as Mukti or Jaipur foot, it is often difficult for people with amputation to travel to these clinics and custom fitting requires that amputees wait until their residual limb has completely healed. This delay in treatment can make it more difficult for amputees to adapt to using a prosthetic device and return to work. By providing amputees with the ability to support themselves and their families and to contribute to the community sooner and easier, we hope to encourage people to accept prosthetic devices and people with amputations.

In addition to providing people with amputations with a functional prosthetic device, we have created a business plan that works to put people who receive the device in contact with each other and a support system. By showing people with amputations that they are not alone we hope to increase their feelings of social acceptance and give them greater confidence.
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I. Executive Summary

There are 5.5 million amputees in India and less than 5% of these get the prosthetic care they need\(^1\). After analyzing the data and interviews from our field trip in India we identified three main problems faced by amputees in India that contribute to this gap in care.

**3 Barriers**

1. Lack of Awareness
2. Limited Access
3. Delay in Care
First, there is lack of awareness about what a person should do after the amputation, how to adjust to their new lifestyle, and what options they have in terms of devices they can use as well places they can visit for continued care. Second, there is a huge disparity between people who need healthcare and people with access to receive it. In India, 75% of amputees live in rural areas, far away from the few centralized prosthetic care clinics. Even if an amputee is aware of prosthetic arms and wants to learn more or try a prosthetic arm, he is not able to get the help he needs without traveling a great distance. This means that a majority of amputees will not receive care beyond initial emergency treatment in a hospital following their amputation. They are isolated from others who receive care as they are at a rural location where health workers do not visit. Third, even if they do get to a prosthetic clinic, there is delay in care as prostheses are custom made for each amputee and require a casting of the residual limb to be made. Most clinics will only make a prosthetic arm after swelling has been reduced and the amputee’s residual limb has fully healed. The healing process generally takes about 3 to 4 months during which the amputee may be unable to work and provide for his family and more likely to adapt and accept his limited abilities and lowered quality of life. At this point, the amputee is less motivated to seek help at a distant clinic because of the discomfort of adapting to a prosthetic arm that is completely new to him.
We hope to solve the above mentioned challenges with our three part solution.

**Innovative Design:** While our prosthetic arm preserves the functionality of custom-made arms with a grasping terminal device and flexing elbow joint, the socket of our arm sets our device apart from custom-made arms. Our above-elbow prosthetic arm introduces an adjustable socket that comes in sizes of small, medium, and large to comfortably fit a wide range of amputees. The design of our device is such that the patient does not have to be present when the device is manufactured, meaning that arms can be produced in larger volumes in advance and then distributed to the rural areas where amputees are for fitting. Therefore our product is available off-the-shelf to amputees. This assists in immediate physical and psychological recovery for amputees, as our arm can be fit in a matter of days or weeks following an amputation as opposed to months. Due to the adjustable socket, our arm can be fit when an amputee’s residual limb is still swollen and then re-adjusted as their limb decreases in size to ensure continued comfort. This innovative design makes it possible for an amputee to keep using the same product by adjusting the socket when any changes to his arm size occur.

**Decentralized Distribution:** The present challenge of prosthetic care not reaching, the majority of amputees residing in rural India, can be attributed to the current manufacturing process which must be fit and produced on-site. We would take advantage of our innovative design to manufacture larger volumes of arms in advance and then distribute them locally. We will rely on a decentralized distribution system through which we would be able to reach out to amputees living in rural areas. Customers who would be unable to travel to a clinic could receive our product through major hospitals, NGOs, and shipping options through the existing postal service. As the product packaging would contain all training and maintenance material, amputees could use our product efficiently without needing to visit a designated prosthetics clinic.
**Resource Network:** In addition to a usable product, we will provide a network of resources to support amputees across India by allowing them to connect over the phone with a toll-free hotline maintained by IPT. Amputees will be able to call in on this helpline to learn where to get repairs for their prosthetic arm, be educated on living with a prosthetic arm, and get in contact with other amputees like them. Through this resource network, we will establish a connected community in which an amputee is not isolated but included. As IPT cannot be everywhere, partnerships with local hospitals and NGOs play a key part in making this happen. In addition, general awareness of the options available for people with amputations will help us provide more people with our device. The visibility of our device would help in making more people aware about the options amputees have available to them. Over time, this toll-free helpline would serve the dual purpose of providing customer support and facilitating orders for prosthetic arms over the phone.
# II. IPT SWOT Analysis

## Strengths

- Small size of the organization, more control
- Passionate workforce
- Experience, BE product successful
- Support from the University and volunteer student pool
- Field test setup in place in Guatemala/ROMP and India
- Corporate sponsors like Autodesk and Advanced Arm Dynamics

## Weaknesses

- Limited reach
- Finite amount of labor
- Non-profit therefore limited cash reserves
- Dependent on grants and donors
- Not equipped for large scale production
- Standard components like the terminal device and the harness may drive the cost up
- Unknown name, short track record

## Opportunities

- Educate amputees, healthcare professionals and the community in India
- 5.5 total amputees in India; only 5% get prosthetic care they need
- Huge demand for prosthesis due to limited availability of low cost upper extremity prosthesis
- Partner with organizations with similar mission to enhance IPT’s reach
- To connect amputees to make a support network
- Better terminal device and elbow joint needed in India

## Threats

- Simple design can make it easier to copy
- Quality is at risk if manufactured by another entity
- Low awareness about prosthesis in general - >difficult to reach potential consumers
- Other low cost alternatives like custom made prosthesis
**Strengths**

As a small and relatively new non-profit company, IPT has a unique set of strengths. IPT’s small size allows for a greater degree of control and awareness of what everyone is doing, allowing for smoother coordination of organization activities. Additionally, the absence of stockholders with a vested interest in profit allows for more flexibility than a traditional company would enjoy.

While IPT is a small company, the board is composed of people who have experience with low-cost prosthetics and are passionate about the goals of IPT. There is a willing and ready source of creative and free labor available through college students and other community sources of volunteers. The University of Illinois also provides a great deal of support including an office space with a subsidized rent in Enterprise works, resources through the Technology Entrepreneur Center (TEC), Illini Launch, National Collegiate Inventors and Innovators Alliance (NCIIA), Clinton Global Initiative University (CGIU), the University of Illinois Office of Public Engagement, and the knowledge and support of faculty members. Besides university resources, IPT is collaborating both locally and abroad with people with amputations through community members in the Champaign-Urbana area and partnerships with prosthetic clinics such as Range of Motion Project (ROMP) in Guatemala. While the ROMP clinic is one of IPT’s primary contacts in Guatemala, IPT is connected to Jaipur Foot, Mukti, and Rotary Club, organizations which run many prosthetic camps and clinics in underserved areas such as India. In addition to these partners in the prosthetics industry, IPT has cultivated relationships with corporate sponsors such as Autodesk and Advanced Arm Dynamics who provide financial resources and technical expertise.

**Weaknesses**

While being a small company can have many advantages as previously mentioned, there are some weaknesses and limitations associated with having a small organization. IPT has a limited reach and a finite level of energy and labor dependent on its small core of dedicated individuals. As IPT is a non-profit with uncertain future cash flows for investment, IPT has difficulty providing stipends for workers allowing them to focus on IPT-related work. IPT’s reliance on external funding sources such as grants, design competitions, and donors makes for additional work for an already stretched core group as they write applications, travel to competitions, and expend resources to make potential donors aware of their work.

As IPT is a small organization with a limited network abroad and little to no presence on the ground in Guatemala and India, IPT must partner with local organizations. While local organizations can share valuable resources and the benefits of their established manufacturing and distribution networks, reliance requires IPT to give up a degree of control to organizations which may have different visions than IPT. IPT must invest significant time and effort to build relationships with these local organizations in the hope of building future partnerships. IPT as
a brand has poor name recognition among consumers, desired collaborators, and potential sponsors. It has a short history in existence and therefore needs to utilize its partnerships to build credibility within the customer base.

From a manufacturing viewpoint, the small size of IPT means that the organization is not well equipped for large scale productions. At their current size, IPT faces high costs per unit as most manufacturing and assembly is done by hand with a small and highly-skilled labor force. Given the present design of IPT’s Open Socket and preliminary designs for an above-elbow device, IPT must buy standardized components such as the terminal device Hosmer hook and the Alimco elbow unit from outside manufacturers at a high cost, representing the most significant portion of production costs.

Opportunities

80% of total amputees around the world live in developing countries. There are 5.5 million amputees in India and only 5% get the prosthetic care they need. Among this total number, 75% live in rural areas where there is limited knowledge of options available for amputees. Therefore, there are many opportunities for IPT to expand their reach in subsistence marketplaces. As most hospitals in India carry only cosmetic arms, most amputees are unaware of the possibilities for restoring ability with a functional prosthesis. Therefore IPT has a huge space to educate amputees, health care professionals, and the community at large while establishing a precedent for functional prosthetic arms. Through education and increased awareness, IPT can bolster demand for prosthetic arms and be prepared to meet that demand.
Currently, there are very few players in the functional prosthetic arm market with LN4, a low-cost arm developed in the US, being the main player. Overall, IPT is entering a cooperative market with many possibilities for local partnerships, as opposed to a highly competitive space.

As many upper arm amputees in India have limited means for acquiring a prosthetic device, there is an opportunity for IPT to work creatively within and outside of the present prostheses and healthcare networks to give more amputees access to life-changing solutions. IPT has the truly remarkable opportunity to empower amputees by increasing their earning potential and quality of life, in turn positively impacting entire communities. As IPT develops their network on the ground in countries such as Guatemala and India with travelling clinics, toll-free helplines, and additional outreach, they will have the opportunity to connect amputees with each other to provide them with a greater sense of community and to lessen the social stigma currently associated with amputations and prosthetics.

When the prosthetic arm itself is examined, opportunities present themselves for improving upon the design and cost of the currently marketed terminal device and elbow joint in the future. As IPT grows in size, finds new material suppliers, and pursues local manufacturing partnerships, manufacturing costs will be reduced.

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As mentioned previously, the relatively small size and limited experience of IPT can pose threats. The partnership process poses additional threats to IPT. A well-established collaborator has the capability to take IPT’s design and produce it at a larger scale, leaving IPT...
with little control over the product and its distribution. IPT’s choice not to pursue intellectual property protection for its designs and manufacturing processes leaves IPT vulnerable to having an outside group take up that technology and use it for their own purposes. It might be necessary to explore patenting IPT’s technology and make sure that contracts with collaborators are well-written and serve to protect IPT’s interests along with the interests of consumers. If collaborators and competitors are allowed to produce IPT’s device, quality may suffer, leading to a decrease in consumer trust in the product and a growing unwillingness of hospitals and NGO's to distribute IPT’s device.

Another risk to IPT comes from their consumer base that may be apathetic and have limited awareness of available prosthetic devices. As the target consumer group is relatively small compared to the general population, it is imperative that a large percentage of amputees are reached in order to ensure the success of IPT. Current obstacles to reaching potential consumers include the debilitating nature of their disability and consumers’ inflated expectations for a prosthetic device to replace the complex arm functionality they have lost. As effective use of a prosthetic arm requires training and encouragement, some amputees may be frustrated with a prosthesis that doesn't restore complete functionality and overlook the ways a prosthesis enables them to adapt. Many consumers gravitate towards the cosmetic and natural appearance of the arm, which is difficult to preserve as more functionality is added. Without targeted education, consumers may reject an arm based on its appearance before learning of the functionality it has to offer. Family, friends, and community members must be won over as supporters of a new prosthesis, as their opinions heavily influence the decisions of amputees in selecting and using a prosthesis. The effects of a negative maternal opinion about a prosthesis was seen during an interview in India as a mother had discouraged her son from using a prosthetic arm and hand due to her dislike for its appearance. This challenge must be addressed with public campaigns to raise awareness of prosthetic arms and reduce social stigmas.

Potential competition from other low cost alternatives also poses a threat to IPT’s success as these alternatives might be lower in cost at point of sale but higher in cost over the lifetime usage of the product. This might be due to high replacement and repair costs attached to use of these devices over extended periods of time.
Macro environment

**Demographics**
The population of India is approximately 1.22 billion with a growth of 1.33% in 2011. Out of this, close to 29.7% are under the age of 14, around 64.9% are between the age 15-65 and 5.5% are above 65. With 0.6 physicians and 0.9 beds for every 1000 in the population, health care is not in a very good shape especially for low-income and low-literate population living in subsistence.

**Economic/Business**
The World Bank estimates that 41.6% of India’s population lives below $1.25 per day. Therefore, if IPT needs to serve subsistence population then its product needs to be low in cost as well as high in quality in order to have minimal maintenance cost. IPT might need to consider tiny or no margins in order to serve customers in this segment. Due to the huge demand of the device, these tiny profits can turn out to be big profits once the device is successful. Economic growth of India as per 2011 is 6.9% which means India is an emerging market with huge appetite for new products and technology. IPT thus has vast opportunities not only just for above-elbow product but also for other potential products.

**Technological**
Technology is growing fast and is affecting all aspects of health care industry in India. IPT should be prepared to face competition from cutting edge technologies in prosthetics such as myoelectric devices.

**Political/Legal**
Government of India provides support in form of subsidies and tax rebates to NGOs and non-profit organizations especially in healthcare. IPT can take advantage of these opportunities and also collaborate with the government in spreading awareness about amputations and further research and development activities.

**Social**
Due to socio-cultural dynamics, custom made devices have dominated the Indian prosthetics arena so far. Even today though many amputees want to get functional devices they still feel that a normal arm looking device would be better. Majority of the amputees in India within subsistence population are into agriculture, construction labor, small businesses, etc. IPT's offerings should be tailored for the Indian consumer keeping in mind the social setting he is a part of.
Competition

Custom Fit Prosthetic Arms
Custom fit arms are manufactured in the developing world by trained O&P professionals. According to our research, while cheaper than prostheses in the United States, these arms may still cost between $125-$1875. Common materials used include Polyethylene and Stainless Steel.

Pros: The arms are custom fit, which is the current standard to comfort and functionality.  
Cons: These arms still require a prosthettist and specialized components from the US to fabricate and fit each time. Not only does this increase the cost, but it reduces access to the arms due to a small number of O&P professionals in developing regions. Furthermore, it increases the time it takes to obtain a prosthesis.

ICRC (Red Cross)
The ICRC arm is a custom fit fabrication as well, though their training manual seems to be written so that non-O&P professionals can produce and fit the arms. The arm consists of two sockets, the first which goes directly against the skin and the second which slides over the first. The arm makes use of polypropylene, stainless steel, nylon webbing, and a bike brake cable. The ICRC made over 20,000 prostheses in 2010 and supports 83 physical rehabilitation projects in 25 countries. Through conversations with individuals working in developing countries, IPT believes the ICRC system to retail for around $150. The ICRC subsidizes the cost of the arms or provides them free of cost to the amputees.

Pro: The system provides for a custom fit and the possibility of easier re-fitting  
Con: The system still requires a professional to take a mold and construct the arm and uses materials not readily produced in the local area.

ITAL (Physionetics)
ITAL stands for International Transradial Adjustable Limb and is the closest competitor to IPT. The polymer construction device is lightweight, rapidly fit, and comes in three sizes. The price of the device ranges from $125-$350. The device also comes with a variable pressure hook. We have yet to find data on how widely distributed the arm is.

Pros: Rapid fitting prosthetic arm  
Cons: Some potential issues with comfort for short residual limbs, and cost could be edged down a bit. Solely plastic structure also limits the device in terms of strength.

An informational video can be found on YouTube
**LN4 (Rotary Club)**

The polymer construction LN-4 hand is produced and distributed by the rotary club. The arm costs $50 to produce and is purchased by donations and given free of charge to amputees around the world. The hands are distributed using traveling Rotary Club members, and does not seem scalable.

**Pros:** Very light-duty, rapid fitting prosthetic arm  
**Cons:** Requires use of other hand to operate, potential to be a very poor fit and uncomfortable

[Video](#) demonstrating use of the hand  
[Map](#) of where LN-4 hand is used  
[Brochure](#)  
[Fitting Instructions](#)

**Prestige Health Care Technologies Arm**

This simple metal and plastic construction arm was the project of Ruth Clark and Chaz Holder. The limb was to be sold in the United States to subsidize distribution in developing regions. US cost was to be $1,000 - $1,300.

**Pro:** Simple to construct.  
**Con:** Overly simple design, poor fit, business plan seems unsustainable
III. Mission/Objective

Mission

IPT strives to improve the quality of life for amputees in developing countries through a prosthetic device that is functional, sustainable, and comfortable.

Objectives

- Establish relationships and product awareness through distributing 250 IPT units in the first 18 months.
- Refine the IPT product, develop a hotline, and distribute 500 IPT units in the next 18 months.
- In the next 24 months, leverage relationships to connect communities and distribute 2000 units throughout India.
- Give all amputees in India the awareness of IPT’s prosthetic device and the opportunities to receive one.

Profits

Because IPT is a non-profit organization without shareholders, profits may not seem as important to IPT’s survival as for many for-profit organizations. This is only partially true as it is the goal of IPT to be constantly growing, expanding, and continuing research on new initiatives and projects. IPT’s goal is to generate stable and reliable amount of profits that will allow the organization to have a safety net for the future, as well as to hire more staff members to further research on potential new products and markets for expansion.

People

IPT seeks to empower people with amputations by providing prosthetic devices that allow for increased functionality and employability. For this reason, IPT is focusing on a functional prosthetic arm as opposed to a cosmetic arm. By enabling amputees who are living in poverty to increase their earning potential and improve their quality of life, IPT is indirectly helping their families and communities that will benefit as a result of amputees increased productivity.
Planet

IPT’s main goal is focused on empowering people, but IPT has responsibilities towards the environment they operate in as well. By creating a durable product that will last for upwards of five years, IPT can ensure that material and energy is not wasted through the disposal and replacement of prosthetic devices, reducing the ecological impact of this consumer product. The current standard of care requires custom-made prosthetic devices which must be replaced when minor changes to the shape of the residual limb occur. With the adjustable socket design of the IPT device, less prosthetic devices will need to be made and less waste will be produced. IPT will strive to use materials that are ecologically friendly to produce and locally available, with the end goal of producing prosthetic devices close to the area in which they will be distributed, reducing the carbon footprint associated with shipping devices.

Prototype

The goal for IPT for this course is to design a basic level above elbow (AE) prosthetic device to which additional features can be added in the future. Components that were considered include the socket, harness, elbow, forearm, and terminal device. The current design for the socket includes an adjusted fit that leaves the shoulder free for movement with the goal of having an off the shelf harness that people with amputations could try on immediately upon arriving at the clinic. Weight disbursement is the main focus of the harness because the AE prosthesis is considerably heavier than the below elbow (BE) prosthesis and as such may cause more discomfort for the consumer. As the current Alimco elbow joint adds significant weight, the goal in the new prototype is to reduce the weight and cost with a simpler elbow joint. Several designs are under consideration for the elbow unit, including a simple elbow unit that utilizes a sliding support. Weight is an important consideration in the design of the forearm, which will be minimalist in design and made of a lightweight material. In future prototype iterations, the consumer may be able to customize the look and accessories of the forearm to increase their sense of ownership. The terminal device, a Hosmer hook, will be purchased as a standardized component but will be interchangeable with other terminal devices given the uniform socket threading of the forearm interface. In the future, IPT may consider producing a different terminal device, but the investment of time and resources required is currently prohibitive. Hosmer hooks are a functional alternative to cosmetic hands and are more durable than combination hands, which seek to be both functional and cosmetic.
IV. Field Research and Product Development

A. Virtual Immersion

During the fall semester, our team took part in virtual immersion to gain a better appreciation for the context of poverty, especially as it relates to rural areas of India. We began immersion by reading The Blue Sweater by Jacqueline Novogratz, a critical look at current efforts to tackle global poverty. In Novogratz’s novel, we saw the benefits of ‘patient’ capital investments which partner with local initiators of change to carefully plan and implement new businesses. While reading the book Nickel and Dimed: On (Not) Getting by in America by Barbara Ehrenreich, we learned about the daily struggles of a minimum wage earner in the United States. Though the narrator of this book was living with the constraints of barely making it in the US, her fragile state of stability that could be disrupted by a moment’s emergency. This condition of living on the knife’s edge of survival was highly applicable to amputees we met on our trip to India who were getting by day to day.

Our team took part in a poverty simulation where we took on a new family identity and set of constraints and were given the task of surviving with limited resources for a month. Through this exercise we saw how valuable time is to someone with low income and how quickly time can be taken away while waiting in lines at businesses with poor service, relying on public transportation, and seeking out government assistance for financial or medical help.
Professor Viswanathan provided our team with a number of interviews, videos, and images from subsistence consumers in India for us to analyze. We were able to identify the external environmental factors and internal mindsets that perpetuated their positions of poverty such as low literacy and a lack of confidence in the marketplace. Our class studied and debated a number of case studies involving organizations promoting social good in India such as Unilever’s Annapurna salt and Jaipur Foot.

Our takeaways from these virtual immersion activities were valuable for framing our research and development as we moved forward. We learned that unlike the impersonal and standardized marketplace we encounter in the US, Indian subsistence consumers are navigating a very relational marketplace where there are many small buyers and sellers sympathetic to each other because of the similarity of their circumstances. A shop owner may be a lender of credit and a neighbor all at once. Though subsistence consumers are seeking goods in a range they can afford, they are willing to spend in the high end of that range if they perceive a product to be high quality. Word of mouth is highly influential in this context and can either build trust or ruin a business. Similarly, social acceptance and reputation is of paramount importance to subsistence customers as their wealth is found in social capital as opposed to material goods. Our team has benefited from keeping these characteristics in mind as the assumptions we would draw from our own experiences sometimes run counter to what is true for Indian subsistence consumers.

B. Preparation for Emersion

Prior to the trip to India, our team researched what is currently available to amputees in India, brainstormed concepts for prosthetic solutions, and prepared interview questions for our meetings with amputees and visits to prosthetic clinics.

C. Ability Challenge

Our team was able to conduct an Ability Challenge in class to observe how varying degrees of elbow flexion affected the ability of our classmates to perform a range of tasks. We divided the class up into five groups; missing an arm, arms fixed in at a 90 degree elbow angle (handshake), arms able to be adjusted between three positions (180, 90, and 40 degrees), arms able to be adjusted to any position, and using both arms normally. These groups moved through stations where they were asked to fill and drink from a cup of water, pick up a box, button a shirt, and open and eat a Hershey’s Kiss. Our team facilitated the activity and observed what tasks our classmates struggled with. We saw that while there was a marked increase in ability going from no elbow flexion to some flexion, the difference between having elbow flexion to three positions and flexion to unlimited positions was not remarkable. Most tasks could be accomplished with the elbow joint in one of the three initial positions.

A major take-away from the Ability Challenge was the importance of tools to adapt how amputees accomplished different tasks. As it was difficult for our ‘amputees’ to tilt their wrists
and bring their cups close enough to their mouths to drink, we realized that straws were a simple solution to this problem. Our classmates struggled to get a grip on the smooth sides of the box and we saw that a box with loop handles on either side would allow an amputee with a hook for a terminal device to use both arms in lifting. As the terminal devices sacrifices fine motor control, the challenge of buttoning a shirt was awkward for our classmates and would have been easier if we gave them a bent wire to hook and ‘thread’ the button through the hole. The candy task was an example of how amputees must adapt other parts of their body as tools to compensate for their missing arm. Our classmates found that their teeth and good hand were sufficient to open a small candy wrapper. Adapting other body parts as tools was true for the box lifting challenge as well, where numerous students used their hips and good arms to squeeze and lift the box against their bodies. Here we saw that the extra length afforded by a prosthetic arm provided functionality beyond that seen with no arm at all, as the forearm and elbow could be used as moving surfaces to prop the box against.

These observations led us to a toolkit concept that could potentially be sold to amputees or sponsored for distribution by a NGO. The toolkit would be a box with handles containing tools such as a straw and button aid to perform basic tasks. Education materials on the arm could be provided in this toolkit along with information on repair and support group resources.
D. Brainstorming Design
As our team explored possible designs for the prosthetic arm, we came up with ideal
parameters for the prosthetic arm, which are listed as a series of design inputs and outputs in
the table below.

<table>
<thead>
<tr>
<th>Design Input</th>
<th>Design Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>Terminal device is an off-the-shelf component such as Alimco hand or Hosmer hook.</td>
<td>Wrist unit must have standard ½-20 threading to be a compatible interface with different terminal devices.</td>
</tr>
<tr>
<td>Elbow joint flexion greatly increases AE amputee ability.</td>
<td>Elbow joint must rotate between at least 3 positions; 180, 90, and 40 degrees</td>
</tr>
<tr>
<td>The elbow joint should be able to support the forearm and terminal device at various degrees of flexion.</td>
<td>The elbow joint must incorporate a locking mechanism that can be engaged and disengaged through independent control.</td>
</tr>
<tr>
<td>Scarred tissue on the amputee’s residual limb is sensitive and can cause user discomfort.</td>
<td>The socket should not apply pressure greater than 90 mmHg, the low end of systolic blood pressure.</td>
</tr>
<tr>
<td>Amputee’s residual limbs will be a range of lengths and girths.</td>
<td>The arm must come in sizes of small, medium, and large and have an adjustable socket.</td>
</tr>
<tr>
<td>The harness will be load-bearing and responsible for control of the terminal device and elbow joint.</td>
<td>A shoulder pad should be added to the Figure 8 harness to distribute load and increase comfort.</td>
</tr>
</tbody>
</table>
E. Description of idea generation and screening

Throughout the course, the team actively brainstormed in order to best determine what should be included in our design. Towards the beginning of the process brainstorming was focused on the various tasks that must be done each day with an arm and especially the tasks which must be completed by those living in our target consumer group.

This general knowledge of the needs of consumers was then used to brainstorm potential aspects of the prosthetic device that might be useful. In addition to the device itself, plans were discussed for the most effective manufacturing, distribution, and education of people both with and without amputations. These ideas were first screened on feasibility. Many ideas initially sounded intriguing but were proved to not be physically possible upon reexamination. Following this initial screen, the weight, cost, and potential for breaking were all considered. As a product that must be constantly carried with the consumer, it is important to try and reduce weight where possible at all. Additionally, as the device’s target consumer is subsistence marketplaces cost was an important consideration. While complex ideas may offer additional functioning, it also makes the device more expensive and vulnerable to breakage.

Ideas for distribution and advertising were ranked according to what was culturally appropriate, feasible, and relatively low-cost. It was important to think through the various phases of the distribution and how these would affect the success of the distribution.

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Weight</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Function</td>
<td>0.2</td>
<td>Terminal device grip, elbow flexion</td>
</tr>
<tr>
<td>Ease of Use</td>
<td>0.12</td>
<td>Operation, putting it on</td>
</tr>
<tr>
<td>Comfort / Fit</td>
<td>0.12</td>
<td>Socket &amp; harness</td>
</tr>
<tr>
<td>Production Cost</td>
<td>0.2</td>
<td>Materials, complexity</td>
</tr>
<tr>
<td>Durability</td>
<td>0.075</td>
<td>Lifespan (yrs), repairs</td>
</tr>
<tr>
<td>Weight</td>
<td>0.075</td>
<td></td>
</tr>
<tr>
<td>Aesthetics</td>
<td>0.05</td>
<td>Cosmetic design</td>
</tr>
<tr>
<td>Social Acceptance</td>
<td>0.15</td>
<td>Community perspective</td>
</tr>
<tr>
<td>Environmental Impact</td>
<td>0.01</td>
<td>Materials &amp; device turnover</td>
</tr>
</tbody>
</table>
F. Charu’s India Trip

In November, Charu had the opportunity to visit a government prosthetics workshop and a bilateral AE amputee. At the workshop, Charu observed a manufacturing process similar to that used at Jaipur, where the limbs were formed from HDPE and the elbow joints and terminal devices came from Alimco. She spoke with Suneel, a 20 year old arts students who had lost both of his arms from electrical shock at the age of five. Following his amputation, Suneel’s parents had abandoned him at the hospital, but a kind sponsor took Suneel in and raised him. Now Suneel has learned to use his feet for writing, using the phone or computer, and painting. Though he tried a functional prosthesis during his teenage years, he was frustrated by the limitations of that device and decided not to use prostheses. Though he has adapted well with his feet, there are still tasks he requires assistance with like eating food, buttoning clothes, and going to the bathroom.

G. Interview Questions

As our team planned for interviews with amputees, we focused on building trust early in our conversation and gradually progressing from casual to more intimate, and potentially painful, questions. We determined a few central points that would be valuable to get amputees’ opinions on; specifically their observed changes in lifestyle and quality of life before and after their amputation, their exposure to and acceptance of prosthetic devices, and their aspirations for the future.

After breaking the ice by talking about cricket or our interviewees’ trips to meet with us, we directed the conversation towards their work or family using the following questions as a loose outline.

Tell us about your home and family
a. Who do you live with?

b. Where do you live?

c. Is it difficult to transport yourself or groceries to your home?

d. Do you have a support system?
   i. Have your close friends and family changed from since your amputation?
   ii. How does asking someone for help or having someone assist you make you feel?

Tell us about the last meal you ate
a. Was it difficult?

b. Did you receive assistance?

c. What do you usually eat? Has this changed from before & after your amputation?

Tell us about getting ready in the morning (can expand to daily routine)

a. Which tasks were the most difficult?

b. Did you receive help at any point?

Tell us about your education

a. How many years did you go to school?

b. Have your education plans changed because of your amputation?

Tell us about working

a. What was your job before your amputation?

b. Are you still working in the same occupation?
   i. If yes: Have you had to make adjustments in your daily job following your amputation?
   ii. If no: What do you now & why did you make the change?

As we asked our interviewees about lifestyle and work changes due to their amputation, more details would come out about their amputation which we helped them expand upon with the following questions. These questions led into our exploration of their preferences for a prosthetic device and their familiarity with the technology available to assist them.

Tell us about your amputation

a. What was the cause of your amputation?
   i. Did you have other injuries at that time?
   ii. Do you still have pain from your amputation or other injuries?

b. How long have you been living with this amputation?

c. Have you changed how you dress or how you act in public because of your amputation?
   i. Do you hide your amputation? Why or why not?

d. Has your amputation caused you to have other injuries?

Tell us about the treatment of your amputation

a. Where were you treated?

b. Were there complications?

c. Were you charged for this treatment? How much?

d. Do you have a prosthetic device?
If no prosthetic:
  a. Do you want one? Why?
     i. If yes, what has kept you from getting a device so far?
  b. How much would you be willing to pay for a prosthetic device?

If they have a prosthetic:
  a. How did you learn about prosthetics?
  b. Where did you go to get a prosthetic?
     i. What was were the steps when you got there?
     ii. How long did it take?
  c. How many hours a day do you wear your prosthetic?
     i. How many times do you take it off & on in a day? Why?
     ii. Are you able to put your prosthetic on by yourself?
  d. What kind of cleaning routine do you have for your prosthetic?
  e. Do you know / can you identify what skin care problems would arise from wearing a prosthetic? (Explain treatment options if unfamiliar)
  f. What about your prosthetic makes you happy?
     i. What about your prosthetic makes you sad?
     ii. Are there specific tasks you can’t do with your prosthetic?

Both:
  a. What is more important to you in a prosthetic: what it can do or how it looks?
     i. What tasks should a prosthetic help you do on your own?
     ii. What should a prosthetic look like? Color / shape / size?

How do you hear about medical info?
  a. Where do you hear medical advice (radio, TV ads, billboards, word of mouth in community)?
  b. Who / where do you go to with questions about a certain sickness or staying healthy?
     i. How far are you willing to travel?
     ii. How much are you willing to spend to get answers?
  c. How often do you visit a doctor? Amount of travel & payment involved?

In general, how do you feel about your life; happy, sad, angry, etc?
  a. Has this changed from how you felt before your amputation?
  b. What things make you feel sad?
     i. What things make you feel happy?

We recognized that even with this framework, our interviews would be best as conversations, rather than as a rigid set of questions. As we would be communicating through a translator, we planned for flexibility in our order of questions and how much we would be able to go in depth with each interviewee.
H. Market Research

While little published information is available on India's population of people with amputations, government research and surveys of people with disabilities have been generally helpful in estimating the size and characteristics of this population.

I. Disability in India

A report by the World Bank in May of 2007 estimates that there are between 40 and 90 million people living with disability in India, a group that makes up between 4 to 8 percent of the population. This is an increase from a 1991 countrywide disability study conducted by the National Sample Survey Organization (NSSO) that identified approximately 16.15 million people with disabilities, or 1.9 percent of the Indian population. Though the population size dramatically increased between these studies, such changes may be largely attributed to the scope of the study conducted, the resources available to those conducting the study, and their categories to qualify disabilities. The World Bank’s report recognized several categories of disability: mental, visual, speech, hearing, and locomoter disability while the NSSO study only divided people by visual, hearing, and locomoter disabilities. According to the World Bank report, the parameters of their visual disability category were broader than those of the NSSO report while their locomoter category was narrower than that used by NSSO. In the NSSO study, of the total population of people with disabilities, approximately 57.5% or 10.6 million were noted to have a locomoter disability. The World Bank, with its more narrow definition of locomoter disabilities, estimates locomoter disabilities to make up approximately 27.9% of the
total disability population, projecting that a range of 11.2 to 25.2 million people have locomotor disabilities in India.

Locomotor disability is defined as “the loss or lack of normal ability of an individual to move himself/herself and/or objects from one place to another.” Potential causes of locomotor disability include paralysis, loss of limbs, or a deformity or dysfunction of the limb or joint. Currently, India is undergoing a significant shift in the causes of locomotor disability as better preventative measures are taken to combat polio. The rising cause of locomotor disabilities is burns and injuries, the majority of which would likely result in amputations, though a category of ‘amputation/amputee’ is not specifically used. The World Bank report found that 28.5% of locomotor disabilities were caused by burns and injuries. When one considers the contribution of polio, diabetes, infection, and congenitally missing limbs to the population of amputees in addition to burns and injuries, it could be estimated that nearly 40 percent of locomotor disabilities are due to a missing limb. This places the number of amputees in India, calculated from the World Bank disability population, in the range of 4.48 to 10.1 million people. This is consistent with a projection of 5.5 million Indian amputees which is cited frequently throughout the prosthetics literature as an estimation from Jaipur Foot. If one applies the statistics observed elsewhere of upper limb (UL) amputations making up approximately 15 percent of amputations, and then 30 percent of UL amputations being above elbow (AE) as opposed to below elbow (BE), we are left with a projected market size of 250,000 AE amputees. Of this group, many amputees will have adapted to life without an arm and will find it difficult, even disabling, to start to use a prosthetic arm. Therefore, it is important to attend to the people who are presently getting amputations each year, as they have not settled into a lesser quality of life yet and can benefit the most both physically and mentally from using a prosthetic arm.

The majority of UL amputees will lose their limb under traumatic circumstances, such as a traffic accident, farming equipment accident, or a problem in an industrial work setting. Depending on the area, buried landmines contribute to amputations as well.

While the last two decades have seen the passage of progressive legislation in India to provide social and economic assistance for people with disabilities, these measures are just starting to be implemented and their reach is very limited. A significant piece of legislation passed in 1995 is the Person’s with Disabilities Act, which is primarily overseen by the National Institute for the Orthopaedically Handicapped. This act provides aid assistance incrementally in proportion to a percentage disability assigned by a doctor. As employment for people with disabilities is a primary concern, the act sets aside three percent of positions in the government sector for people with disabilities, one percent for the three primary disability types: locomotor, hearing, and visual. The act requires that the private employment sector set aside positions for people with disabilities as well though this is undoubtedly difficult to enforce and largely unregulated. Similarly, public educational institutions are required to reserve three percent of seats for persons with disabilities. In order to oversee efforts to provide aid, commissioners are appointed for each state and a Chief Commissioner manages this bureaucracy. It is unclear from public record whether or not this infrastructure has been fully implemented with commissioners appointed for each state. Currently there are no sanctions in place for non-compliance and no evidence of incentives awarded for compliance.
J. Emersion: India Trip

The IPT group learned a great deal during the two week immersion trip to India. The group became much more familiar with Indian culture, marketplaces, and home life. The group was able to interview seven male amputees from different backgrounds. These interviews have become extremely valuable to the group and to the concept generation and evaluation process. The interviewees provided a deeper understanding of their culture and needs in relation to their amputation and the viability of a prosthesis.

The following key phrases show the dominating sentiment of each amputee and have been distilled out of the interview analysis, found in Appendix 1.

**Vishwa** | 32 Years Old | Above Elbow Left Amputee
I am sad I can’t provide for my family and I feel cut off from my community.

**Gautam** | 58 years old | Above Elbow Left Amputee
I have adapted with my feet and am proud of what I can accomplish.

**Rami** | 36 years old | Below Elbow Left Amputee
My life is precariously balanced and any change could mean going hungry tomorrow.
**Prabhu** | 48 years old | Below Elbow Right Amputee  
My family is fragmenting and there is nothing I can do about it.

**Steve** | 44 years old | Below Elbow Right Amputee  
Finding a sense of purpose following my accident has made me content.

**Kumar** | 49 years old | Below Elbow Left Amputee  
Years of hard labor have worn me own. I am only surviving because of government aid.

**Azad** | 34 years old | Below Elbow Left Amputee  
Why would I worry? I’m the boss here and my family provides for me.

From each interviewee's story we formed a large picture of where amputees are challenged, where they thrive, and how prosthetic care plays into all of this.
K. Learning and Reflection from Field Research

These interviews identified reasons why amputees in India might not be using a prosthesis. One reason had to do with access to a prosthetic workshop/clinic. Many amputees did not have the time or money to travel to a clinic or to pay for a prosthetic device. For many amputees that live in rural areas, prosthetic clinics are far away and means of transportation are not easy to come by. Travelling to a clinic may mean losing a couple days worth of work and money as well. Other reasons for not using a prosthesis were on a emotional level. For some amputees, wearing a prosthesis reminds them of what they are missing. Some amputees were influenced by their family members who discouraged the use of a prosthetic device. Other amputees have only been exposed to cosmetic devices and have deemed those devices, and subsequently all prosthetic devices, as not being useful. A successful prosthetic device in India must meet differing expectation levels.
The interviewees also identified ways that a prosthesis would be helpful. Some activities they discussed were lifting boxes to run a business, riding a motorcycle, carrying vessels for cleaning, washing clothes, and reaching items that their feet cannot. One interviewee also mentioned that with a prosthetic device he could double his productivity at work by lifting two bags instead of one. This insight demonstrated that while some people may feel like they do not need a prosthetic device, because they can already lift a bag, they may not realize the value of the device in allowing them to do these tasks better or more efficiently.

The interviews generated significant insight into potential prosthetic device user values. General user values for Indian male amputees include: support family, independence, earning a comfortable wage, feeling useful, and ownership. The interviews also allowed the group to identify challenges to the potential prosthetic device users. There is a degree of lack of creativity among the amputees interviews. It was observed that many amputees were not being creative in learning how to function as an amputee and not learning how to earn a living in new ways. Another challenge was the lack of education. Many amputees were not properly educated on prosthetic options or had not thoroughly considered the benefits of what a prosthesis could offer them.

During the trip to India the group visited many different organizations which were very helpful in understanding general business operations in India and specific businesses existing relating to prosthetics. Visiting a Jaipur office and Mukti office were extremely beneficial to the group in learning about the current prosthetic options. Jaipur and Mukti both focus on below the elbow prosthetic devices and have a quick custom fit process. Both organizations were very interested in above the elbow prosthetic technology the IPT group talked about. Jaipur and Mukti conveyed that there is a large and open market currently for above the elbow prosthetic devices because of the great need and limited options available. Full business profiles of each organization the IPT group visited can be found in Appendix 2.

"Why not use a Prosthesis"

There were many diverse reasons that people with amputations were not currently using a prosthetic or did not chose to seek out prosthetic devices. Many of the amputees we spoke with were unaware of the potential for a functional prosthetic device and were only aware of cosmetic arms which they did not see as useful.

Price was also a perceived barrier to obtaining a functional prosthetic device. Several of the men we spoke with stated that they were living on a precarious balance with their salary only covering the necessities of their daily lives. They felt that obtaining a prosthetic device would require them to take out and loan which would very difficult to pay off. Similarly, many of the amputees felt that the did not have the time or transportation necessary to seek out a prosthetic device. Just as many of the amputees lack the financial stability to pay for a device, many of them lacked the resources to travel to clinics or were unable to miss work.
In addition to time and money constraints, many amputees had familial and psychological issues with prosthetic devices. One amputee we spoke with had received a prosthetic device from Jaipur foot and was not using it because, among other reasons, his mother did not like the way it looked, commenting that it looked like an animal claw. Another amputee received support from his family and was afraid that seeking out a functional prosthetic arm would offend his family by implying that their help was not enough for him. In addition to family member input, many amputees had personal feelings that prevented them from seeking prosthetic devices. One amputee felt that if he had a prosthetic device he would be constantly reminded of his amputation of loss of limb whereas adapting to life without a prosthetic device allowed him to avoid feeling like he has a disability. Among those who had used prosthetic devices, a common complaint was that it did not restore function that their natural arm once had. It is possible that many amputees did not have a realistic idea of what function prosthetic devices offered. It is important for amputees of all situations to realize that their prosthetic device is a tool and not a replacement for their natural arm.

“With a Prosthesis I could”

While the situations faced by the many amputees we interviewed were very different, many of them shared the same desire for their prosthetic device: they wanted it to be functional enough to help them to provide for their families. Specific tasks included lifting, boxes and bags at work, reaching what feet cannot, and being able to clean surfaces more easily. Outside of the workplace, many amputees were interested being able to perform basic tasks at home including taking their families on motorcycle rides and washing clothes. Having a better idea of what the amputees valued gave us a better idea of what was important when designing our product.

Bottom-up Problem Deconstruction

I have lost the ability to do many things, losing confidence and I am being viewed differently by family friends and community. My quality of life has decreased. I don’t have any resources/device to improve it, except to adapt.

Top-down Problem Deconstruction

How to get amputees the prosthetic care they need, connect them to fellow amputees, educate them on resources and increase awareness among the community?
## L. Needs/Drivers/Context Framework

<table>
<thead>
<tr>
<th>Needs</th>
<th>Drivers</th>
<th>Context</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low Cost</td>
<td>Transportation</td>
<td>Illiteracy</td>
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<tr>
<td>Support</td>
<td>Understanding</td>
<td>Poverty</td>
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<tr>
<td>Cosmetic</td>
<td>Family</td>
<td>Social Obligations</td>
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<tr>
<td>Preparation</td>
<td>Provider</td>
<td>Infrastructure</td>
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<tr>
<td>Balance</td>
<td>Pride</td>
<td>Poor Health-care</td>
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<tr>
<td>Comfortable Fit</td>
<td>Social Acceptance</td>
<td>Isolation</td>
</tr>
<tr>
<td>Training</td>
<td>Capability</td>
<td></td>
</tr>
<tr>
<td>Access</td>
<td>Survival</td>
<td></td>
</tr>
<tr>
<td>Functional</td>
<td>Distance from Source</td>
<td></td>
</tr>
<tr>
<td>Availability</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Happiness</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## M. Concept generation and evaluation

<table>
<thead>
<tr>
<th>Needs</th>
<th>Metrics</th>
<th>Benchmarks</th>
<th>Specs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Function - Elbow Flexion</td>
<td>degrees of rotation</td>
<td>0-160 degrees elbow flexion</td>
<td>0-120 degrees</td>
</tr>
<tr>
<td>Function - Terminal Device</td>
<td>lbs able to carry</td>
<td>3.5 lb / 7 lb pinch-force by Hosmer Sierra 2</td>
<td>TBD</td>
</tr>
<tr>
<td>Function - Ease of Use</td>
<td>minutes used</td>
<td>1 minute (estimated avg. time to take on and off prosthesis)</td>
<td>5 minutes/day total</td>
</tr>
<tr>
<td>Comfort/Fit</td>
<td>ratings on 1-10 scale</td>
<td>None</td>
<td>8 on 10 = no complaints, 1 = very uncomfortable</td>
</tr>
<tr>
<td>Production Cost</td>
<td>dollars</td>
<td>$80 (IPT below elbow device)</td>
<td>$130</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$5,000 (U.S. lower limit cost of prosthesis)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$300 (avg. annual income of many rural families)</td>
<td></td>
</tr>
<tr>
<td>Durability</td>
<td>years of use</td>
<td>3-5 years (average replacement time for adults)</td>
<td>10 years</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6-12 months (average replacement time for children)</td>
<td></td>
</tr>
<tr>
<td>Weight</td>
<td>lbs</td>
<td>4 oz. adult Hosmer hook for light-moderate wear</td>
<td>2-4 lbs total</td>
</tr>
<tr>
<td>Acceptance - Aesthetics</td>
<td>ratings on 1-10 scale</td>
<td>None</td>
<td>8 on 1-10 scale of 10 = very attractive, 1 = very unattractive</td>
</tr>
<tr>
<td>Acceptance - Social</td>
<td>% improvement</td>
<td>None</td>
<td>150% (Rating before and after prosthesis of 2/10 to 5/10)</td>
</tr>
<tr>
<td>Environmental Impact</td>
<td>common carbon metric</td>
<td>TBD</td>
<td>TBD</td>
</tr>
</tbody>
</table>
N. DETAILED CONCEPT

There are currently several concepts in development for this project. Our current goal is to have a working prototype by the end of the course sequence that incorporates new ideas and allows for the incorporation of ideas that may be envisioned in the future.

There are several aspects of the arm which our new prototype will both incorporate elements from existing designs and novel concepts developed by our group.

We plan on creating a new elbow which uses a sliding locking mechanism. The point of this change is to reduce the price and weight of the current elbow. While Alimco elbows are relatively low cost when compared to American models, there is room for improvement and the weight of the arm is a large consideration when attempting to create a prosthetic device that people with amputations will want to wear and use.

We are considering redesigning the harness in order to more equally distribute the weight. Possibilities include creating a harness that connects to a belt and better spreading the weight of the harness on the opposite shoulder and chest area.
O. Technical specifications and Detailed Drawings

The prosthetic arm can be broken down into components that are interfaced together.

Terminal Device
This will be a stainless-steel Hosmer adult hook weighing approximately four ounces and measuring about five inches long. The proximal end of the hook has standard $\frac{1}{2}$-20 threading that is tightened in to a threaded socket in the wrist unit. This hook can exert a variable pinch force depending on the number of rubber bands employed to increase resistance, with each additional rubber band adding around 1lb to the pinch force. The average user will use anywhere from 2 - 7 rubber bands, resulting in a 2-7lb of pinch force.

Wrist Unit
As the interface between the terminal device and the forearm, the wrist unit aligns the terminal device with the forearm, anchors the terminal device in a threaded socket, and serves as a point of rotation for the terminal device relative to the forearm with a system of a washer, rubber ring, and nut.

Forearm
The forearm must be strong and lightweight, characteristics which can be achieved with a simple rod or a molded hollow shell of aluminum or a sturdy plastic material. A rod can be made of two inset, telescoping cylinders with incremental fastening points so as to be of adjustable length. A hollow shell can be molded in different sizes for compatibility with small,
medium, and large versions of the prosthetic arm. The distal end of the forearm houses the wrist unit while the proximal end is securely fastened to the lower hinge of the elbow joint.

**Elbow Joint**
The elbow joint serves as an interface between the forearm and socket as well as a point of flexion. Flexion of the elbow joint greatly enhances the functionality of the arm as it enables the user to bring the terminal device from their side to near their head. A pivoting hinge and locking mechanism will be employed to achieve incremental degrees of elbow flexion between the lower and upper hinge arms, which will be attached to the forearm and socket respectively. These sub-assemblies will likely be made of metal components to withstand loading and high wear on the joint.

![Elbow Joint Image](image1)

**Socket**
As the user’s residual limb will fit in the socket, this component is highly adjustable in its girth and length. The socket encases the residual limb to properly align the prosthetic device relative to the rest of the arm and body. Though the socket itself is not primarily load-bearing, it transfers load to the shoulder support and harness system to support the weight of the prosthetic device. As the socket will be in close contact with sensitive scar tissue, this component will incorporate padding and cloth linings over rigid supports.

![Socket Image](image2)

**Shoulder Support**
This component is the primary load-bearer for the prosthetic device and is positioned between the user’s shoulder and neck. The support has a curved shape following the contours of the body to distribute load in a way that is comfortable to the user. It is made of a thick plastic
surrounded by padding beneath and cloth on top. Webbing connects the socket to the shoulder support and the harness system runs from the shoulder support around the upper torso, distributing loading across both shoulders and the back.

Harness System
Made of webbing and buckles, the harness is the most adjustable component in the device given the variety in size of upper torsos it must accommodate. The harness runs from the top of the prosthetic device, across the back, and loops around the other shoulder and arm to distribute load across the upper torso.

Cable Control System
The terminal device is operated by a cable line running up the arm and across the shoulders as part of the harness system. When the user stretches forward their prosthetic arm or moves their shoulders forward, the cable is pulled toward the body, working against the rubber band resistance to open the hook. When the user relaxes their arm and shoulders, the cable is no longer under tension and the hook closes.

P. CUSTOMER NEEDS/ATTRIBUTES - TECHNICAL SPECS (METRICS/VALUES)

For potential customers, a number of factors affect their acceptance of the prosthetic arm.

Functionality
Arm functionality arises from the terminal device, forearm, and elbow joint. The terminal device needs to provide a substantial pinch force ranging from two to seven pounds when the grip is closed. This force range allows users to hold anything from a pen or eating utensil to a bucket handle or rope. The elbow joint needs to provide flexion of the forearm relative to the socket in the range of 0 – 160 degrees. This flexion allows users to move their forearm and terminal device through a wide range of positions to accomplish different tasks. When the arm is hanging down at their side, they are able to carry a bucket. If the arm is straightened out in front of their body, they may use the forearm as a supporting surface to lift a box. With the elbow fully flexed, the terminal device is near their head and may be used for eating, holding a cell phone, or bringing both hands together to meet someone with the traditional greeting. The locking mechanism for the elbow joint must be robust and able to withstand forces from 35 - 80 pounds to keep the arm in a fixed position for lifting and carrying tasks.

Appearance
The dimensions and general shape of the prosthetic arm should follow the natural form and size of the human body so as to draw less attention and appear symmetrical with the rest of the
body. The prosthetic arm should be orientated relative to the body in the same manner as a natural arm and the length of the prosthetic arm should be similar to that of a natural arm. The length of the terminal device should be roughly equivalent to that of a human hand, at approximately five inches long. If the forearm is a rod, it should be of adjustable length, whereas if the forearm is a molded hollow shell, it should be molded in incremental sizes. The elbow joint is a standard size, though its interface with the forearm and socket may be adjusted to be compatible with different sizes. As users will have residual limbs in a wide range of lengths and girths, the socket must be adjustable yet maintain a smooth profile with the rest of the device. Residual limbs fitted may be cut anywhere from directly above the elbow joint to immediately below the shoulder joint, so the socket length will be the most important factor to adjust in maintaining a uniform appearance. The shoulder support and harness are designed to fit around the shape of the user’s upper torso and can be worn above or below clothing. As these components may be worn over clothing for increased comfort, they should be made available in neutral colors so as to be better disguised.

Comfort
If the prosthetic arm is not comfortable for the user, that will be a strong disincentive to acceptance of the arm. Therefore some components will incorporate cloth covering and padding that would be unnecessary on other components of the arm. Padding will be particularly important on the socket as it will be in contact with sensitive tissue and on the shoulder support as that will bear most of the weight of the device. The socket fit overall will be a large determinant of user acceptance. The adjustable fit socket must apply no greater pressure than 1.4 psi, which is average diastolic blood pressure for blood to flow freely through major vessels. Though the average arm of a fit 40 year old weighs 10.6 pounds, the prosthetic arm should weigh less than this. The external attachment of the prosthetic arm to the body makes a smaller weight more uncomfortable to support than a larger weight attached through skeletal and muscular structures.

Ease of Use
While superior pinch force and elbow flexion can be built into the prosthetic arm, this functionality is only as good as the ease with which the user can operate pinching and flexion. Though training will be provided to familiarize users with the cable control system for the terminal device and elbow joint, operation of these components should be intuitive and avoid unnatural contortions of the body. The terminal device will be operated by forward and backward motion of the shoulders, a control mechanism that is well established with current prosthetic arms. Pending concept testing with potential users, the locking mechanism of the elbow joint will be controlled either by dropping one shoulder down, using teeth to grab a pull tab, or using the other healthy hand to unlock the elbow joint.
V. Marketing Strategy

A. Target Market Selection

The market for upper arm prosthetic devices is very unsaturated. There are few options currently available. The options that are available are less than adequate. A custom made arm, which could be found at a clinic like Mukti, is not often provided for amputees and many people do not have access to a clinic like this. Also, a custom made arm is functional, but amputees may need to go back to the clinic for a new arm several times over the course of a couple years if the size of their residual limb changes. A cosmetic arm is another option, but this option provides very little benefit for amputees since it is not a functional device. Amputees may feel slightly more comfortable in limited social situations, but they will not be able to take care of themselves or their families any better. Another arm manufacturer LN4, attempts to make prosthetic devices that are more accessible, but has not been very successful thus far, and has sacrificed much of a device’s functionality in order to make the arm more accessible.

With the entire upper arm prosthetic device market being under served, IPT has a great opportunity in any segment of this population. The versatility of the open socket design makes the prosthetic device appealing and applicable to a large number of amputees. There are 28,000 new amputees added each year in India. Out of these 2500 are above elbow amputees. This is one segment which IPT can potentially serve. There is another huge segment of amputees who
have already been through their amputation stage and have now learnt how to live with their amputation. They have already found out ways to do routine activities either themselves or with the help of others. Though this population is huge and under served as well, this is harder to reach as they do not visit hospitals on a regular basis. There is a small population with congenital amputations as well. The device can be useful for men and women and people of all ages. Since the types of people who would be interested in the IPT device are great and quite spread out, IPT must start off by targeting a specific group of people. By targeting a specific group, IPT can more easily direct their efforts in one direction instead of attempting to bring awareness to everyone in need at one time, which may not be possible. When IPT is successful in helping a segmented group, they can then broaden their reach and direct resources elsewhere.

When determining which target market would be most appropriate, the need, likelihood of adopting, and ease of distribution were the most important factors to consider. IPT’s overall goal is to help every person who would benefit from its device. Since IPT will not be able to help everyone initially, the best strategy is to target a segment that would make the most business sense as well as give the most benefit to the consumer who would serve as future advocates of the devices. These people tend to be those who have just had an amputation, because they have not yet had time to adjust to doing tasks with one arm. Additionally, people who have just had an amputation can be reached more easily than those who have been living with an amputation for some time. People with a recent amputation have one important factor in common; everyone needs to visit a hospital to receive an amputation. A hospital can be an important point of contact between IPT and amputees to both spread awareness of prosthetic devices and to receive them.

While the open socket prosthetic device can be beneficial to most above the elbow amputees, by narrowing the focus to new amputees who have lost a limb through a traumatic injury, IPT can more effectively help the large number of amputees in India. This target market is chosen for two main reasons:

The first being those with recent amputees are most likely to be open to trying a prosthetic device. Those who have had an amputation for many years may have adapted to not having a functional arm and may be less likely to choose to use a prosthetic device, or to even have the need for one. Interviews with amputees in India specifically showed this sentiment. One person had adapted to having an amputation so well, that he was uninhibited through using his feet to do functions hands and arms normally would. Additionally, one main advantage of the open socket design is that it can be fit to recent amputees who may still have significant swelling or will continue to experience changes in the size or shape of the residual limb.

The second reason for targeting this device to recent amputees is that logistically it is easier to bring awareness and distribution to recent amputees. Amputees are very spread out throughout India. Many amputees live in rural villages and may be the only amputee in that village. How to effectively bring awareness to these people is a large challenge for IPT. One place all amputees have in common is a hospital. If the prosthetic device is available or information about the device is displayed in hospitals throughout India, everyone with a new
amputation will see this information and know that an IPT prosthetic arm is an affordable, functional option. Targeting hospitals as a primary means of outreach is a good way to reach a large number of amputees.

B. Sustainable Marketing Mix

Sustainable Product Design
IPT is committed to delivering products to users that are made of quality materials and to using processes that have minimal effects on the environment. The open socket device is inherently more sustainable than current custom arm options, because of its ability to be used for longer periods of time. While a custom arm might need to be replaced often due to residual limbs changing in size, the IPT open socket device can adjust to fit these changes. Because of this design, less material is used, and less manufacturing time is needed.

Packaging is minimal for this concept. A multi-functional recycled and reusable bag could be used for this purpose. Training directions are important for this concept and would be included with the prosthesis as a brochure. As a user may need repairs for their device at some point in the future or guidance on how to most effectively use the device, packaging will include information for an 800 number for an IPT helpline. This number can be engraved either on the device or included in the device instruction manual. Calling this number will connect amputees with information on the prosthetics clinic closest to them as well as with other resources such as tips on how to care for their residual limb and prosthesis.

Price
In order for the IPT prosthetic device to reach people in need throughout India, it needs to be affordable for people in need. IPT will partner with an NGO in India to make this happen. IPT should charge amputees a small amount for the device, as they can afford it, so that the device is still seen as an object to be valued by amputees. If a device is given away for free, people may not see it as importantly as they would have if they worked hard to save money for the device. The NGO will provide support to IPT, and IPT will in turn work with hospitals to distribute the product at an affordable price for amputees. It is also important to take into consideration that the IPT device will not need to be replaced as often as a typical custom made arm. For this reason, the IPT device should be valued higher than the custom arm.

Place
IPT has a very large market and for this reason will need to break it down and effectively target each group of people with the help of NGO’s. NGO’s who work throughout India will be helpful for IPT to reach as many people as possible. NGO’s that are specific to certain regions in India will also be helpful for IPT, as they will have better knowledge of local hospitals and supply/distribution companies. IPT will not only focus on bringing prosthetic arms to amputees; IPT will work to do this in a way that benefits the entire community and makes
Amputees feel more comfortable in their community and home. A prosthetic device will only be helpful if amputees and the community understand what it is made for and how it can be beneficial. IPT’s process in India is not only to bring amputees functional prosthetic devices, but also to empower amputees within their communities and give them a chance to contribute to the community.

**Promotion**

One of IPT’s greatest challenges is to bring awareness to people in India about prosthetic arm options, especially those people who live in rural villages. IPT will promote their product in several ways: brochures, word of mouth, radio and television advertisements. IPT will design brochures that can be distributed in hospitals and community centers. People who have just had an amputation at a hospital can read a brochure after the operation about IPT’s prosthetic device. IPT could also develop a video that demonstrates someone using this device. The brochures can also be distributed at various community areas to spread the word to a larger audience. IPT will work with NGO’s to develop relationships with hospital workers. These hospitals workers will have knowledge of IPT’s device and can talk about this option with their coworkers. Looking forward, IPT can also pay to advertise on the TV and radio. This type of advertisement would reach a broad audience and would target those people who have been living with an amputation for some time and might be interested in using IPT’s product.
Where to find the IPT prosthetic device

Connect with others

Has you or your loved one had a recent amputation?

Try the IPT prosthetic device!

Contact the toll-free IPT number to find a location near you.

IPT currently distributes in the following regions:
- Uttar Pradesh
- Maharashtra
- Bihar
- West Bengal
- Andhra Pradesh
- Madhya Pradesh
- Tamil Nadu
- Rajasthan
- Karnataka

Workshops
June 30th
address / phone

August 30th
address / phone

www.supportipt.org/connect
Life with a Prosthesis Design

Illini Prosthetic Technologies
www.supportipt.org
Has you or your loved one had an amputation?

A prosthetic device can help

Contact IPT to find a location near you.

IPT currently distributes in the following regions:
- Uttar Pradesh
- Maharashtra
- Bihar
- West Bengal
- Andhra Pradesh
- Madhya Pradesh
- Tamil Nadu
- Rajasthan
- Karnataka

xxx-xxx-xxxx
www.supportIPT.org
VI. Action Plans

A. Targeting and Positioning

IPT’s initial target market is people with recent amputations due to trauma in Tamil Nadu, India. IPT will see success in this market through positioning itself as a social organization dedicated to providing affordable, functional, and high-quality prosthetic arms. IPT will be aggressive in spreading awareness about the prosthetic device and will work closely with small test groups initially to communicate the proper use and value of the prosthetic device, as well as to alter the product according to feedback received. Creating a brand name and reputation that is associated with care, helpfulness, affordability, and ease is essential to success in this new market.

B. Sustainable Product design

Looking forward to the eventual success and widespread use of IPT’s open socket design, it is very important to create a product that utilizes materials as effectively as possible. It is also important to design this product to cause minimal impact on the environment and availability of natural resources.

IPT’s prosthetic device functions in numerous ways and for a variety of users. This multi-functionality allows the device to be used in many different situations and by many different people. Having just one device for a number of different situations instead of having many different devices to fit each user and each situation exactly saves resources and time on the development and production of additional device types. A high-quality product design is essential for creating a sustainable product. The IPT prosthetic arm uses high-quality materials, so the device is durable and long-lasting.

Ideally, IPT will use materials that are locally produced in India. Materials made locally support the community with jobs as well as saves resources on moving materials a long distance from the origin to the place of assembly. In addition to using local materials, IPT should also strive to use materials that are organic or can easily be replenished, such as hemp. When materials cannot be of this type or it is inefficient to do so, recycled and recyclable materials should be used whenever possible. Main components of the prosthetic device that can be made of recycled material include the hard and soft plastic pieces and aluminum used for the terminal device. These materials are also very durable and can be reused in future prosthetic devices.
C. Sustainable Value Chain

IPT will create value for amputees through a high quality and functional prosthetic device. This device will be mainly distributed through hospitals, as it is also valuable to hospitals in their overarching goal of improving people’s well-being. Hospitals should pay IPT for a stock of prosthetic arms that they will turn around and sell to recent or past amputees. The hospitals may make a slight profit on the sales, but ideally, they would not make the cost of the arm prohibitive in an amputees decision to use a prosthetic device.

The sustainable value chain will change slightly as IPT grows and the open socket design becomes more successful in India. The first phase will produce a value chain as follows. IPT will make 5-10 prosthetic arms in the U.S. and bring them to a social organization in Tamil Nadu. IPT will collaborate on the ground with the Tamil Nadu social organization to manufacture a trial batch of arms using the 5-10 prosthetic arms brought with as models and for training. The social organization will initially make around 50 arms for IPT. IPT will compensate the social organization for supplies and the social organization will provide labor (for sewing and assembly) free of charge for this trial period. Learning new manufacturing skills and learning about prosthetic arm technology may be valuable for some people at the social organizations. As IPT and the social organization learn which local suppliers to work with and how to best assemble the arm in India, IPT may begin to employ specific people at the social organization for full time assembly.
During the trial period, IPT will visit hospitals in Tamil Nadu and work on gaining trust and respect with doctors and administrators in the hospital. IPT will find hospital or a few hospitals to work with initially. IPT will sell prosthetic devices to the hospital along with information and marketing materials. IPT will also provide training to specific staff members on fitting amputees free of charge. IPT should continuously keep in touch with these hospitals throughout the trial period on a monthly basis, if not more. The hospitals will sell prosthetic arms to amputees that visit the hospital and will provide basic training to the amputees at the point of sale. IPT will sell the product to the hospitals to break even. Ideally, the hospitals will do the same, and IPT will communicate their purpose and this goal of affordability.

D. Design of the Value Proposition

Bringing amputees functional prosthetic devices through a decentralized system that gives amputees easy access to receive care and support

The IPT arm is valuable because it helps amputees do activities they previously could not. It also helps amputees do activities better and/or faster than they previously could. Additionally, the prosthetic arm helps amputees can feel more comfortable in social situations through the cosmetic elements and increased functionality they have wearing the arm. Because the IPT prosthetic arm creates so much value for amputees, it also creates value for hospitals, because hospitals serve amputees and hospitals strive to improve the quality of life for all people.
The sooner amputee patients begin using a prosthetic arm, the sooner they can be on their way to physical and mental recovery. Amputee patients can begin using the Open Socket even before leaving the hospital bed post-operation. It is often difficult to verbally explain to amputee patients the benefits they will experience by utilizing a prosthetic arm, which can discourage new patients. With the Open Socket, there is no need to explain. Patients can quickly be fit with the device, and within minutes they can see the benefits for themselves.

E. Communication of the Value Proposition

At the outset, IPT’s primary means to communicate the value of their design is to have dedicated sales people. These people will spend most of their time with IPT on communicating the value of the product to hospitals and on making sales to hospitals. It will take time and perseverance to form relationships with doctors and administrators at hospitals throughout Tamil Nadu. Once the relationships are made, someone from IPT needs to put effort into maintaining these relationships.

Another important method of communication and marketing involves brochures, advertisements, and videos. Brochures should be made to succinctly explain IPT’s mission, product, and how to access the product. These brochures should be distributed to hospitals to spread the word to professionals. They should also be placed in areas that see high traffic, like with certain vendors. Below is a sample brochure that IPT can use for its marketing communication.

IPT would also communicate its value through IPT hotline which would provide information on various issues faced by people with amputations. Below is the process flow of IPT’s hotline from the user perspective.
Welcome to IPT’s information portal

For English press 1, hindi 2, regional language 3

Have you used this portal before?

YES

Please enter your phone number.

NO

Say your name and age clearly

For below elbow amputation press 1, for above elbow amputation press 2

Please enter your telephone number

You have been added to the database successfully.

Choose from the following options
1. Prosthetic device
2. Hospital
3. Workshops
4. Repair and maintenance guide
5. To connect to other amputees
6. Other

1. Prosthetic device data
2. Hospital information
3. Workshop information (places they build on the
4. Repair and maintenance guide
5. To connect to other amputees
6. IPT representative (Other Q’s)
When a person calls the IPT hotline he/she would be directed to choose a language of his choice for easy communication to take place between the IPT portal and the customer. Once he chooses the language he would be asked if he is a returning customer or not. If he is a returning customer his information would be retrieved using the unique telephone number using which he registered himself in the portal at an earlier time. If he is a first time caller he would be prompted to add his name, age, type of amputation and a telephone number that will act as his unique identification number.

As more people in the city center become aware of prosthetic arm options, it will be easier to spread the information to rural villages. One way of doing this is through TV and radio advertisements. Looking forward to a 5-year plan, IPT could develop an ad that will catch people's attention with the affordable, functional, and pleasing design of a prosthetic arm. The advertisement should also briefly contain information on how to acquire this device. IPT will partner with local partners in order to ensure that regional languages are used correctly and that the advertisements are culturally appropriate. The goal of these advertisements will be to reach out to people with amputations who may be in direct need of a prosthetic device but also to increase general awareness of IPT and amputations. By creating a more public image for IPT, amputees are more likely to be encouraged to receive help by friends and family. Additionally, profiling stories of amputees through the advertisement will serve to provide the general public with a greater appreciation for the struggles of amputees and the main causes of amputations. By making some of the main risk factors for amputations clear, it would be possible to reduce the total number of amputations per year.

Lastly, IPT can create videos for their website and to be distributed in hospitals. These videos can range from basics about IPT and their mission to specific videos showing how to best use the prosthetic arm. Training videos may be most useful in a hospital to train new doctors and to be used as supplements for amputees. Videos on the website can be helpful to spread
awareness about IPT to those with a connection to the Internet. While people living in subsistence marketplaces typically do not have access to the Internet, this could change in the future as internet access has become more widespread and available in developing countries in recent years.

F. Implementation Plan

It is extremely important for IPT’s success to foster partnerships with local NGO’s and hospitals for finding amputees who need our product and to help IPT distribute arms to them. Being a small organization based in the U.S., IPT cannot always be in India to oversee the entire process; so working with reputable organizations will be helpful in spreading awareness about IPT and its product. Hospitals are also a key partner for IPT, being the first customer and point of distribution. Hospitals will buy the prosthetic devices from IPT and will therefore need to see the value in the product. The product would be subsidized by the NGO’s IPT would partner with and these subsidized devices would then be sold to partner hospitals at a low cost. Both for-profit and not-for-profit hospitals should be IPT partners, in order to better accomplish IPT’s goal of improving lives for low-income amputees.

Steps to partner with a hospital:

1. Identify hospital to work with
2. Approach hospital with business plan & proposition
3. Work with hospital to determine their demand for upper extremity prosthesis per month
4. Train the staff and nurses on fitting and operation of the prosthetic device
5. Supply the devices to the hospital on per month basis
6. Collect feedback from the staff and amputees on training material and devices respectively
8. Keep up relationships with trial hospitals, visit regularly to see progress and problems.
12. Continue to identify new hospitals and build relationships with other hospitals to broaden IPT’s reach

Steps to partner with an NGO for subsidizing the product and help with distribution:

1. Identify NGO to work with or NGO identifies IPT
2. Establish talks with the NGO to discuss the business plan & proposition
3. After understanding how the NGO wants to contribute to this cause, work with them to get the devices subsidized for a particular hospital or hospitals in a particular area.
4. Agree upon which hospitals will the NGO help IPT with.
5. Manufacture the arms to be supplied to these hospitals and bill the NGO with the amount to be subsidized.
6. Bill the hospital with the remaining amount.
7. Keep up relationships with the NGO by updating them with activities relating to the particular hospital they have helped.
8. Continue to identify new NGO’s and build long term relationships with them as later we would use their existing network to distribute arms in India.

Steps to partner with an organization that would manufacture the product locally:
1. Identify an non-profit organization to work with manufacturing of the arms like Sulabh.
2. Approach the organization with business plan & proposition
3. Work with the organization to determine appropriate suppliers, materials, and manufacturing process
4. Manufacture trial batch of arms (up to 15) with NGO and local workforce
5. Distribute trial batch of arms to local amputees in the hospitals identified earlier and receive feedback from these amputees after few weeks of use. Alter the design of the device with the organization based on user feedback.
6. Produce a larger batch of prosthetic arms as per demand of the area
7. Sell first batch of arms to the hospitals identified in the area
8. Get feedback about the product quality from the users and give it to the manufacturer.

The entire implementation plan is divided into three main phases spanning over five years.
Phase 1: First 18 months

During this time we aim to establish partnerships with local hospitals and NGOs and create awareness for our product. We would start with a small production of 250 units which is the estimated number based of the regional proportion of recent amputees during those 18 months who are living in subsistence. The investment required for this phase is estimated to be $50,000.

Manufacturing Plan

During this phase, we would start with a small production of 250 units which is the estimated number based of the regional proportion of recent amputees during those 18 months who are living in subsistence. The first batch of arms will be produced by a partner organization locally in Tamil Nadu. IPT will work with the another NGO to incorporate user feedback to alter the design where possible.

Launch Schedule

IPT would partner with some NGO’s to subsidize the cost of the arms to the hospitals who would in turn distribute these arms to the recent amputees. These arms would be distributed in small amounts to a few hospitals in the Tamil Nadu area (likely Apollo REACH or another hospital with an emphasis in social outreach for those living in poverty). The hospital can charge a slight markup to the subsidized cost of the device to the amputee.

Product Forecast

IPT’s adjustable socket design is a successful design as there is not delay in care and amputees can see and try on the device while still being in the hospital. So, IPT’s product should be successful in India where low cost prosthesis are in huge demand. Especially as we are producing a small lot in the first phase we estimate a stock out at the end of this phase. The user feedback would be given to IPT regarding the product design and any changes that are needed would be incorporated in the production in the following phase.

Phase 2

Phase 2 would be the next 18 months.

We aim to produce 500 units during this phase and that is roughly double the amount we would produce in the first phase. The highlight for this phase would be the implementation of the IPT hotline in addition to the production of the arms. IPT hotline would be an information portal accessible over the telephone to all our customers i.e. the amputees, hospitals and the NGO’s IPT is connected to. We aim to produce 500 units during this phase and that is roughly double the amount we would produce in the first phase.

In addition to the revenue we obtain by selling the arms from the first phase, the estimate additional investment for this phase would be $50,000.

Following this early pilot study, further expansion will continue through enrolling additional hospitals in the program and continuing production in partnership with local social organizations. It may be necessary to expand the manufacturing partners to an additional
social organization or employ local women to produce the device with a small profit being provided for each piece completed. In addition to continuing the partnerships created, it will be useful to find advocates from areas such as medical universities or social groups.

Once large-scale production is in place, additional elements may be added to IPT’s reach. IPT should develop a toll-free number that will be distributed to amputees with IPT products. This toll-free number can be easily used by amputees, as cell phone use is extremely common even in subsistence marketplaces. Amputees may use this number to identify places close by for repair and maintenance of their product. This number may also serve as a way to connect amputees around India.

Phase 3
Phase 3 would be the next 24 months or two years. We aim to produce roughly around 1500 units during this phase which is around three times the amount we would produced in the second phase of production. Along with producing more arms in this phase we also put our efforts into building a connected network and making off site product delivery possible by leveraging our partnership networks. We aim to produce roughly around 1500 units during this phase which is around three times the amount we would produced in the second phase of production. The break even point would reach in the first half of Phase 3.
In addition to the revenue we obtain by selling the arms from the second phase, the estimate additional investment for this phase would be $200,000.

Quality Control
IPT will maintain quality control through production and expansion in India by identifying and training managers within the NGO’s and keeping up close relationships with those managers. By talking with the managers regularly, keeping an open and transparent relationship with all employees, and making visits to the NGO’s and production facilities often, IPT can ensure quality products and processes.

G. Financial Forecast
It is the goal of IPT to be completely self-sustainable in five years. This will be accomplished by charging the distributors, hospitals and NGOs, at a higher price than the cost of production. This will allow for a small profit generation while not affecting the ability of those who cannot pay for the product to receive a prosthetic device and lowering the operating costs of the hospitals and NGOs by reducing the need for on site manufacturing and trained staff. Additionally, costs will be kept low by doing the majority of production locally in India.
### Phase 1 | Phase 2 | Phase 3
--- | --- | ---
Demand in India | 3796 | 3862 | 5274
Demand within subsistence population | 1518 | 1544 | 2109
Units produced by IPT | 250 | 500 | 2000

| Demand in India | 3796 | 3862 | 5274
--- | --- | --- | ---
Demand within subsistence population | 1518 | 1544 | 2109
Units produced by IPT | 250 | 500 | 2000

| Manufacturing cost including labor | 31250 | 62500 | 250000
Setting up the toll free number | 8000 | 8000 | 8000
Overhead expenses | 9375 | 12500 | 25000
Wages (IPT Team in India- sales force) | 15000 | 15000 | 15000
Revenue from Sales | 37500 | 75000 | 300000
Profit | -18125 | -23000 | 2000
Sales expected-Expenses | 55625 | 60500 | 223000
Investment | 60000 | 65000 | 225000

### Raw material costs

The total cost for the raw material is estimated to be $104 per unit. Below is the table that shows the estimated cost associated with different components that go into making each unit.

| Terminal Device | $25
--- | ---
Harness | $3
Elbow | $23
Wrist | $15
Forearm | $12
Upper arm socket | $20
Cabling | $6
Total | $104

### Labor costs

Labor costs have been estimated to be Rs. 525 per unit in India within the prosthesis manufacturing industry. This is based on the information provided to us during our field trip. Assuming we would not be manufacturing our product in bulk, we have conservatively estimated our labor cost per unit as Rs. 800 or $16. In addition, $5 is estimated to be rework cost added as a cost in each unit.
Pricing
Total cost of the materials, overhead costs and labor costs are together estimated to be $125 per unit. The prosthetic arm would be sold at a $25 profit margin in order to keep IPT financially sustainable. Hence, the selling price for the arm is estimated to be around $150. The profit made by the sales of the arms would go into continually improve the arm as well as slowly increase distribution to more and more hospital and NGO’s. This profit revenue also gives IPT an opportunity to work on another product to improve the lives of people living in subsistence. Revenue from sales in India would also help IPT to support its staff and infrastructure in the US.

H. Ecological (Planet) Impact Forecast
As of 2010, the World Bank estimates the population of India to be 1,170,938,000. India is one of the world’s fastest developing countries, and this number will continue to grow.

Arm production picture
IPT’s prosthetic arm will use materials that are recycled and reusable. Natural, durable products will be used as much as possible for the fabric pieces of the device.

I. Societal (People) Impact Forecast
IPT will greatly improve the daily lives of many people throughout India by providing a low cost, functional device that will increase functionality and employability. This increased employability will indirectly have a positive effect on the people other than the amputee including family members, employers, and consumers.
VII. Implementation, Controls, and Evaluation

A. Measures of Performance – Meeting Triple Bottom Lines

The product and business plan outlined will help IPT to achieve the triple bottom line by having a positive impact on society, maintaining ecologically responsible production, while still maintaining a profit which allows for continued success of IPT. The societal impact of IPT will be measured by the number of people who are able to use an IPT device that would have not been able to receive a prosthetic device in another way. Additionally, the quality of the impact on the amputee will be measured by having a low number of complaints and repairs. By providing amputees with prosthetic devices that will allow them to return to work, IPT will also be helping their families and the larger community. The length of time following the amputation before the amputee is able to receive a prosthetic device is very important to ensuring that amputees are more likely to use the device and will miss less opportunities for learning. The length of time between injury and receipt of prosthetic device will be measured and recorded with the goal of reducing this time as much as possible. The effects of the prosthetic device on employability will be examined by comparing the earnings of amputations before and after the prosthetic device.

Ecological responsibility will be maintained throughout the production process by using locally produced materials and producing the prosthetic devices locally through partnerships with social organizations. Parts will be reused from disposed or returned prosthetic devices. Beneficiaries will be encouraged to return their device to an IPT partner if they decide to not use it or to arrange for their family to return it after their death. The weight of the device and the means by which it is transported will be an important thing to consider and record for estimating the ecological impact. Ideally, the devices would be produced as closely as possible to the organizations they are distributed to. Through a reduced need for processing at point of fitting, IPT’s design will require distributing organizations to produce less carbon emissions and use less energy.

Throughout the process IPT will be able maintain profitability by selling this device to prosthetic providers such as hospitals and NGOs with an interest in providing prosthetic devices to those living in subsistence. These organizations will have an incentive to buy from IPT as opposed to another prosthetics company because IPT’s design does not need to be custom made, reducing cost and effort for the organization. Additionally, the off-the-shelf design of IPT’s prosthetic arm allows hospitals and NGO’s with an interest in providing prosthetic devices that lack the facilities to produce custom-made devices. Costs will be kept low by partnerships with local
social organizations for manufacturing and using locally produced materials. The cost of materials and labor in India is much lower when compared to the United States counterpart.

**B. Monitoring and Evaluating Performance on Multiple Dimensions**

The success of IPT’s venture in India will be measured using several metrics. The spread of the device is one very important aspect and will examine how many people are using the device and where they are located. This can be evaluated by determining which organizations are actively distributing the prosthetic devices and what their reach is. Additionally, once the toll-free number is made active, the location of each call can be recorded and used to map where the majority of device distribution is.

In addition to the number of amputees that are directly provided a prosthetic device, the general awareness of the mission of IPT is important to the future success of the organization. Having a strong knowledge base is important for gaining trust in the community and it was apparent through field research that community influence is an important factor in determining what kind of product to use. Community support can be evaluated by contacting local social organizations and attempting to gauge their familiarity with the name and mission of IPT.

The financials of IPT must be self-sustainable in order for the organization to continue their mission. This can be monitored by keeping records of money input and output. In addition to the costs of producing and distributing the device, employee salary and the costs of further prosthetics research must be taken into account.

Feedback on the device will highly valued throughout the distribution of the device in order to evaluate how to improve the design in the future. Organizations which supply the device to the consumer will be encouraged to gather feedback and when the toll-free number is implemented later in the development plan, it can also be used to gain feedback.

**Following is the draft of the sample survey that IPT would use to get customer feedback:**

1. How many hours in a day do you use the device?
2. Are you able to work more number of hours now? Y/N
3. Is the device working well?
4. Does it need frequent repair?
5. How much have you spent on it during the time you have been using it?
6. What improvement do you think the device can have?
7. How has the device changed your lifestyle?
Intellectual Property

After informal consultation with several lawyers, and independent research, IPT has chosen not to pursue intellectual property on its unique technology. Obtaining IP internationally would not help further IPT’s mission. The cost of obtaining international IP would be very costly, and the ownership of that IP would not prevent the technology from being copied. However, ultimately, if our technology is copied, it only helps further our mission of providing amputees around the world with affordable prosthetic solutions.

NEW STORY

Feel Normal
Be Independent
Support Family
Appendix
Vishwa
12/29/2011

Vishwa is a very recent amputee, with his left arm amputated above the elbow. In April of 2010, Vishwa had renal failure and experienced severe swelling in his extremities. During his hospital treatment for swelling, Vishwa developed an infection near the IV access site. The hospital either did not detect the infection or gave him improper treatment as the loss of sensation and blackened skin spread along his arm. To prevent the infection from spreading further, Vishwa’s arm was amputated in April 2011 above his elbow, leaving him with full shoulder ROM and a healthy residual limb. He doesn’t notice phantom pain but has sharp, shooting pains when anything comes in contact with the tip of his limb. Since the amputation, Vishwa has leg pain that prevents him from walking for long periods of time.

Vishwa is devastated by his amputation. He has lost the abilities needed for his profession running a fruit stand, a job in which he used to earn 600-2000 rupees/day to provide for his family of 5. Now his mother provides for the entire family by working as a housemaid. Though
Vishwa reopened his fruit stand a few days prior, he is relying on help from his friends as he’s unable to lift boxes of fruit. Vishwa avoids uncomfortable social interactions with all but select family members and friends. He feels depressed by his situation and by other’s sadness in response to his loss. All this has caused Vishwa, a devoted temple-goer for the last 15 years, to lose his faith in god. Above all else, Vishwa is frustrated by his inability to do the work he once did at his fruit stand to provide for his family.

Vishwa was shown a prosthetic arm with a cosmetic flat hand and fixed elbow joint. He saw no value in it, only inconvenience. Though the hospital offered him the cosmetic arm and a certificate of disability, he refused both, desiring only to work at his fruit stand. His ideal prosthetic arm is just as or more capable than his good hand when it comes to lifting, and has an articulated elbow joint. When shown the Open Socket, he was pleased with the hook and understood how it was operated. If the prosthetic arm had an articulated elbow joint and a hook that allowed him to lift boxes, he would be willing to borrow money and pay between 30-35,000 rupees.

S. Gautum
12/29/2011

Speaking with Gautum was like a breath of fresh air; he was enthusiastic about the present, hopeful for the future, and confident that he could get there on his own. Gautum was confident
of god's presence because of how happy he was with his life and how he was able to do so many things by himself. Gautum lost his arm at the age of 18 when he fell into a well, causing his left arm to be amputated above his elbow. He hasn't let his loss of limb slow him down much, as he continues to do the carpentry work his father taught him from the age of 8 and supervises 6 others in this profession. He was very proud of his work making chairs, cupboards, and doors and told us that he makes about 3000 rupees per week. With this steady income Gautum is able to own his own house in Chennai, which he built in 1980. He lives there with three family members and has more relatives living next door. Two of his children are married and living on their own, and his younger daughter, who was able to complete college, is employed in a technical role with Nokia.

We were able to visit Gautum’s home, though we were barely able to fit inside without knocking anything over. Inside a roughly 10' x 12' space, Gautum had a kitchen, living space, sleeping space, puja cabinet (which he built himself), and washing space. The TV and surround sound system Gautum proudly showed us were in stark contrast with the rest of his possessions. The family's health consciousness was demonstrated by a sizable container of toothbrushes hanging on the wall. Inside his home, Gautum showed us how he is able to hold a board between his feet and saw with his one hand, the method with which he accomplishes most of his work. After some difficulty in seeing the usefulness of a prosthetic device, Gautum demonstrated how he could use a prosthetic arm as a tool to install the uppermost part of a doorframe. He asked us if the hook would be strong enough to hold a nail so that he could hammer with his other hand. This task is difficult for Gautum as his feet are unable to be his second hand in this situation.
While some other amputees were like an open book, Ram was a puzzle and it was difficult to read his emotions during our interview. His eyebrows were always furrowed and his mouth straight beneath his neatly trimmed mustache. He told us that he was 36 years old but his grey hair and the translator told otherwise, with his actual age estimated to be 45 years. Ram’s legs were dusty as he had just come from his job working as a mason’s assistant, a job he has held for the last year along with his wife. At work, Ram earns 300 rupees a day mixing cement, carrying boards, and lifting heavy bags, carrying one at a time balanced on his head. Prior to moving to Chennai and starting work in masonry, Ram worked as a laborer on a sugarcane farm, making around 40 rupees per day. It was in this line of work that Ram lost his arm, as he had an accident with a sugarcane machine at the age of 15 that caused his arm to be amputated below the elbow. After his accident, Ram was in a government hospital for 60 days but was not shown any prosthetic options. He was able to continue his farming work without interruption following the amputation and only moved to Chennai because his income as a laborer was not enough to support his wife and two young children.

When we spoke with Ram about prosthetics, he said he had seen cosmetic limbs that weren’t functional and that he wasn’t interested, as he had learned how to do everything he needed to with one hand. He knew a few people with leg amputations, most of whom had prosthetic legs. Ram even knew a few people with arm amputations but told us that none of them were using a
prosthetic device. He said that if an arm was functional, he would like to try it, as he imagined lifting two bags of cement instead of one with the use of another hand, which would allow him to earn more. Though Ram felt that he could be trained to be a mason if he had two hands, which would allow him to earn more money, he had no ambitions to do so and said that he was satisfied with his current earnings. Ram told us that he would not be able to pay for a prosthesis as currently everything was balanced and adding another financial burden would mean going without food or otherwise. For Ram, stability was paramount and any change would be a threat to survival, even if it meant improving his family’s condition in the long run.

When Ram imagined how life could improve with a prosthetic arm, he thought of how he could be more productive in his current line of work. Going for a promotion was out of the question, and Ram seemed to not consider changing his line of work, even though he had learned how to write with his 5th standard education. Ram and his family live in a precarious balance of resources and needs and he does not think of things being any other w

Prabhu

12/31/12
Prabhu is a 48 year old man with a right below elbow amputation. His life has been full of surprises and disappointments, including a 15 year stint in Saudi Arabia when he was promised construction work but ended up herding sheep instead. Four years ago, Prabhu returned Chennai from Saudi Arabia while on vacation and had an accident with a reaping machine while helping in the fields. Though his injury was minor, infection set in due to poor treatment in the series of hospitals he visited. When Prabhu finally reached a bigger hospital, his hand had to be amputated. Prabhu was shown a cosmetic arm but he did not have the time or money to follow up and get one. A major factor in Prabhu's decision was his family. Though his wife encouraged him to get a prosthesis, she was forced to move to Kuwait for work in order to pay off a sizable family debt from medical bills and their daughter’s dowry. Prabhu’s parents, a nearby influence, discouraged him from getting a prosthesis for unknown reasons. When we spoke with him, Prabhu was wearing a shawl over his shoulder that hid the evidence of his amputation.

When shown a drawing of the Open Socket, Prabhu responded positively and seemed to understand how it worked. At first he said the hook was acceptable as it was functional, but when he was shown the Alimco hand, Prabhu strongly felt that the hand was what he would want. Prabhu could see the prosthesis being useful for washing clothes at home. Prabhu now supervises staff in a hotel, earning 4500 rupees per month. Prabhu's son has left the family to live with a youth group in another city, blaming his father for the 'trouble he has caused', presumably referring to his amputation. Despite this, Prabhu has property set aside that he is saving for his son, property he could be selling to pay off debt and bring his wife home to Chennai sooner.
When speaking with Steve, we had an overwhelming sense that Steve was at peace and was content with where he was at in life. This is significant given that Steve has lost a hand and was forced out of his former line of work. Steve, now 44 years old, was originally a building contractor and supervisor. About 20 years ago, he had an accident with a government lorry (large vehicle) while riding his motorcycle and lost his right arm above the elbow. He lost function in his left hand at the time of the accident but that function was restored after a year of physical therapy at a hospital. In the process, his left hand was trained to do what his dominant right hand used to do, including writing. His medical expenses were covered by an out of court settlement with the government to compensate him for his losses, as Steve was diagnosed as 80% handicapped. Though Steve returned to work after his accident, he didn’t stay long, as he was losing money. Steve told us that his laborers cheated him, knowing he was not able to actively supervise them like before. Additionally, Steve had lingering fears of travelling by motorcycle and couldn’t commute between worksites as easily as in the past.

Around this time, Steve married his cousin in a family arrangement to help provide for him. Even now Steve’s wife provides for their family of four through her work as a tailor in an export company, while Steve manages the home by cooking and keeping things clean. Steve seemed to take great pride in his ability to do these things well, as he told us a funny story about his wife’s failed attempt to take over the kitchen on the weekend and he repeated the value of cleanliness in his life.

Though Steve was calm and content when we talked with him, he spoke of sadness before he joined a church. Steve’s conversion to Christianity seemed to be a positive turning point in his life, as he found purpose serving at his church and took on the name of Stephen, which represented cleanliness to him. Steve’s responsibilities at church included setting up for services, cooking for gatherings (which his pastor called him about during our interview), and encouraging others with counseling and prayer. When asked about change and his plans for the future, Steve emphasized that he would do whatever was “God’s will” for him and thus he did not seek out major change for himself. At the end of our interview, Steve gave us the only gift we received in our interviews, a bookmark with a verse from Psalm 55 written on it in Tamil.

When we asked Steve about prostheses, he said he had seen rigid cosmetic arms but was not interested in wearing one himself. He initially refused because of how the straps fell across a prior injury, but his strongest reason was tied to his family. Steve feared that wearing a prosthesis would be a rejection of his family and all the support they have provided him thus far. For Steve, ending his dependence was synonymous with breaking trust and hurting the family he has so heavily relied upon. Steve thought that wearing a prosthesis would remind him of what he is missing and of his handicap, something he claims to not think of otherwise. When we asked what he could do with two hands, Steve thought of returning to work as a construction supervisor, though this contradicted what he told us earlier. Steve dreams of
taking his wife and two children on motorcycle rides, something he misses very much now. Steve said he would be willing to try a prosthesis if it allowed him to provide for his family in this way.

While visiting Kadambur, we spoke with Kumar, a 50 year old man with a left below-elbow amputation who wore a shawl that barely covered his residual limb. The communication barrier was much more evident with this weathered man from a very rural village and what he shared was limited. Kumar worked as a stone breaker and lost his hand in 1996 during an accidental TNT explosion at work. He was treated without complications at the hospital in Jakput, where he stayed for 45 days. He was supported and given medicine from ASIFA for about 4 months before returning to work as a stone breaker, with his wife helping him break smaller stones. Their earnings were 125 rupees a week, depending on their production volume. He continued in this work until a year ago, when he quit because of feeling weak and experiencing chest pain. Now Kumar works in a government program where he is given 100 days of work and 1000 rupees a month. This income supports him, his wife, three daughters (including a one who is sick), and son (who dropped out of school despite his father's protests). If he was able, he
would like to open a small shop, but the limiting factor for him was money, not his lack of an arm.

Kumar was invited to travel to get a prosthetic arm but had not pursued that option, having never seen a prosthetic arm. He had not heard of government camps for the handicapped coming to his area and has never met another amputee. He saw a prosthetic arm being a good support for his work and home activities but the only specific improvement he mentioned was the assistance it would provide in carrying vessels. He was interested in trying an arm as long as it was functional, but said he would be unable to pay. When shown the hook and the Alimco hand, he said he would be willing to use both but preferred the hand.

Azad Singh

01/06/11

We had our first house visit with Azad Singh, a 34 year old man with a left below-elbow amputation. He was joined by his family for the interview, including his mother, aunt, 3 children, wife, and cousins. His family played an active role in the interview, chipping in their ideas and joking around with Azad. One of the first things we noticed about Azad was his hair, which was
dyed red, likely in imitation of a movie star. Azad was outspoken in his distaste for prosthetic arms, telling us that he didn't find them useful and that he had thrown out the one arm he tried. Azad lost his hand at the age of 12 when he was playing on a threshing machine at his home. Initially Azad was taken to a local doctor, who arranged a car for him to get to the hospital in K. He was only hospitalized for 3 days but made return trips every 15 days to have his bandages changed. He spoke vaguely of being awarded 12,000 rupees by a committee, potentially as assistance for his injury. Two to three years after his amputation, Azad visited his uncle in Jaipur and was fitted with a prosthetic arm that had an Alimco hand. His visit to Jaipur included going in for a fitting one day and then returning 3 days later to pick up an arm. Azad felt that the legs made by Jaipur are of better quality and more successful than the arms. Azad recalled that use of the arm came naturally and that he did not need any training. He disliked the weight of the arm especially, thought the arm didn’t look good, and did not think the arm was very useful. At home, his mother was strongly opposed to him wearing the prosthetic, describing the hand’s appearance as an ‘animal-like claw’ and saying that it made her feel uncomfortable to see her son wearing it. After about four days of use, Azad threw the arm away (potentially while he was drunk, according to a local onlooker who seemed to dislike Azad).

Since his teenage years, Azad has learned to get by without his hand, adapting his motorcycle controls so they could be operated with his right hand. Overall, Azad does very little physical labor, as his role involves driving his tractor around his fields to supervise laborers growing wheat, sugar cane, and lentils. Azad’s family owns a relatively large portion of land (40 acres) and their wealth is further evidenced by ownership of a tractor and a large living space with an enclosed courtyard. Azad can afford to depend on his large family to care for him and has the financial stability to work in a limited capacity. When questioned about what he wasn’t able to do anymore, Azad hesitated to say anything at all. His mother suggested that Azad is unable to tie his pants strings, has difficulty milking the buffalo, and can’t harvest hay in the field, a job that requires one hand to hold bundles of hay and the other to operate a cutting tool. Azad showed us how he could hold a bucket and lift a chair but admitted that he couldn’t lift a couch (low bench made of wood and rope).

Azad was willing to try on the Open Socket and Ehsan spent nearly 5 minutes readjusting the straps to fit Azad, as the last user was much smaller. When the arm was nearly set, Azad was questioned on what he thought about ‘how the arm looked’. His response was to quickly take off the arm, nearly hitting his aunt with it in the process. While we are unsure of what triggered that dramatic response, Azad was still adamant about not wearing an arm himself and not needing one. In a few minutes Azad was persuaded to try on the arm again, this time managing to put it on himself with some assistance from Ehsan, and quickly picking up how to operate the hook with minimal directions. While wearing the prosthesis, Azad took a brief ride on his motorcycle (but did not make use of the prosthetic) and lifted the couch to carry it a few meters. Azad appeared unimpressed but observed that the arm felt lighter, a change partially attributed to his physical change from a teenager to a grown man between experiences.

Azad is diagnosed to be 75% handicapped and has received 500 rupees/month for his disability since he filled out the government paperwork 2 years ago. Azad knew of one other amputee in
nearby in Palwal who had lost both his arms in the war. The government usually provides generously for war veteran and gave this man a petrol pump for his livelihood.
Mukti

Mukti Foundation was found by Ms. Meena Dadha in the year 1986 to help physically handicapped people. It provided free artificial upper and lower limbs and calipers without any bias, to all the amputees and polio victims seeking their help. Mukti has its headquarters in Meenambakkam in Chennai and a branch in Kottakuppam near Pondicherry. Mukti has a printing press and screen printing shop on site to provide employment for mentally and physically handicapped people.

We visited the Chennai branch to see its operations and talk to technicians who have been working there since many years. We met Captain Bala and his team who collectively run Mukti currently. Mukti has around ten technicians at present and has provided more than 74,494 lower limb and 473 upper limbs to beneficiaries. It has also provided more than 25,348 braces to polio victims. Captain Bala likes to call amputees as beneficiaries and all his staff follow the same culture. Most of the beneficiary population comes from India, Srilanka and Bangladesh. The prosthesis made at Mukti are made of HDPE pipes and the measurement of the stump is done by casting PoP. The amputee comes into the workshop one day and gives the measurement. He gets the prosthesis either the same day or the next day and is fitted with the prosthesis and trained as well at the facility.
Mukti had got its technicians trained from Jaipur Foot organization way back when Mukti started. Since then they have been using the same technology of custom fit artificial limb manufacturing using HDPE pipes. There are a lot of people who donate limbs to the beneficiaries. Mukti survives on these donations and aid from other organizations. Mukti avoids government grants due to the time involved to procure them. Captain Bala mentioned international funding from donors in Switzerland, US, UK plays an important part in keeping Mukti functional. He also added that as they provide prosthesis and calipers for free they put in effort to find out whether an individual is ready for using the prosthesis or not. If the beneficiary is mentally prepared to use the prosthesis then they go ahead and provide him/her with one. Mukti also partners with Rotary International, Lions Club and MALT, England to organize camps to reach to a larger population.

Most common repairs and replacements are of joints, calipers, and the feet, which wear quickly given the unwillingness of many rural beneficiaries to wear shoes for protection. Mukti organizes an annual gathering of beneficiaries called the Mega Mukti Mela where beneficiaries and their families are invited.

Bhagwan Mahaveer Viklang Sahayata Samiti (BMVSS)

Source: www.jaipurfoot.org
Lots of great factual info in here: http://vimeo.com/35434966 (password: isupportipt)

Bhagwan Mahaveer Viklang Sahayata Samiti (BMVSS), Jaipur was set up in 1975. It is a formally registered society in India. It is a non-governmental, non-religious, non-sectarian, non-regional, non-political society, for helping the physically challenged, particularly the financially
weak among them. BMVSS is the largest organization, for the handicapped in the world in terms of fitment of artificial limbs and calipers etc., to the handicapped. BMVSS, being a social organization engaged in humanitarian work, provides all the artificial limbs, calipers, crutches, ambulatory aids like wheelchairs, hand paddled tricycles and other aids and appliances totally free of charge to the physically challenged.

Since its inception BMVSS has helped more than 1.2 million handicapped people to be mobile again. BMVSS has 21 branches for caliper and limb making.

The main objective of the BMVSS is the physical, economic and social rehabilitation of physically challenged, particularly the resource-less, enabling them to regain their mobility, self respect and human dignity so that they become self-reliant, normal and productive members of the community.

Pursuant to the above, the BMVSS provides or engages in –

1. Artificial limbs and other rehabilitation aids and appliances to amputees.
2. Calipers, modified footwear and other rehabilitation aids and appliances to polio afflicted and other disabled persons.
3. Hearing aids to persons who are hearing impaired.
4. Special shoes and other aids to persons suffering from leprosy.
5. Various types of financial and other support of self-employment and social rehabilitation of the physically challenged.
6. Scientific and technical research in developing and improving aids and appliances for the physically challenged.
7. Dissemination of knowledge and expertise relating to the manufacture of aids and appliances, care of the disabled by providing training to technicians, doctors etc., by organizing training courses, technical workshop, seminars and publication of technical and social books / reports etc.
8. Collaboration with various organizations both National and Inter-national dealing with the handicapped.
10. Some programs for the up-liftment and self employment of distressed women, whether physically challenged or not.

Jaipur foot organization has revolutionized the prosthesis delivery and fitment process. The time between when a person enters he Jaipur foot facility till he gets a prosthesis and is trained is at a maximum 36-48 hours; mostly it is 24 hours or less. Beneficiaries arrive in daily waves, they are housed and fed, as their foot is readied, and are only sent home walking.

BMVSS partners with Rotary international to organize camps not only in India but also worldwide mostly in developing nations. They call this delivery approach as the “CAMP APPROACH” where calipers and artificial limbs are provided free of cost at the camp site. The average cost of a limb is estimated to be $45 and BMVSS accepts donations to run its operations. Almost 99% people BMVSS serves are below the poverty line. Jaipur foot technology is very well suited for Indian population as it may be worn with shoes or without shoes depending on the desire and the need of the patients. The Jaipur foot is very close to a human foot and is an all-functional and all-terrain foot.
Bike Shop

With traditional upper-extremity prosthetic arms, the custom made socket generally has a suitable life span. However, the cable components which allow the user to actuate the terminal device are prone to failure. The metal wire cable and metal connection parts are placed under repetitive cycles of stress and inevitably are worn down due to natural wear and tear.

When failure occurs, 3 options are possible. The user returns to the clinic and obtains a repair, two, the user seeks local help from a handy man who replaces the cable with a bike cable or other alternative, or three, the user does not seek help or is unable to seek help in repairing the device and may discontinue use of the prosthesis as a result.

Visiting a village bike shop allowed us to observe the wide collection of tools, and capabilities for bike and motorcycle repair. Currently, an idea we would like to explore is the potential have having local bike shops serve as the first point of contact for repair of prosthetic components for the IPT arm. The local doctor and bike shop can work together to repair and maintain the prosthetic arm, especially for users who live far distances from a prosthetic clinic. A handbook can be given to such patients when they first obtain the prosthesis, so that they in exchange provide the handbook to their local doctor. The handbook can educate the doctor on the device, encourage to refer new users, and learn how to adjust and repair the device.
Sulabh International


Sulabh International is the largest non-profit organization in India with over 50,000 volunteers. Sulabh has 22 branches spreading throughout India. Sulabh International was founded in 1970 by Bindeshwar Pathak to carry out the work of liberation of scavengers from the sub-human practice of manual excreta cleaning in India and other related jobs. This is when the seeds of the Sulabh Sanitation Movement were sown. Over the years, Sulabh International, under the inspiring leadership of its Founder, Dr. Bindeshwar Pathak, has branched into several inter-related activities meant not only to rehabilitate, socially and economically, those weaned away from scavenging, but also to restore their self-esteem and self-respect. Towards this, its flagship initiative Sulabh International Center for Action Sociology (SICAS) was established in 1993 and its main objectives are as below:

1. To develop a systematic understanding of social, economic and psychological problems of scavengers, and  
2. To evolve and implement a range of innovative, sustainable and replicable intervention activities which would bring scavengers into the national mainstream.

Sulabh has many innovations in the field of sanitation. These include a scavenging-free two-pit pourflush toilet (Sulabh Shauchalaya); safe and hygienic on-site human waste disposal technology; a new concept of maintenance and construction of pay-&-use public toilets, popularly known as Sulabh Complexes with bath, laundry and urinal facilities being used by
about ten million people every day and generates bio-gas and biofertilizer produced from excreta-based plants, low maintenance waste water treatment plants of medium capacity for institutions and industries. Other work includes setting up English-medium public school in New Delhi and also a network of centres all over the country to train boys and girls from poor families, specially scavengers, so that they can compete in open job market.

Sulabh has more than 6,000 public toilets in 25 states and 3 union territories of India. Sulabh public toilets are used by 15 million users everyday at a nominal payment of INR 1/- to 2/- for a single use, which roughly translates into a revenue of INR 550 million per annum. Sulabh has also built more than 1.2 million toilets for households at a nominal payment. Sulabh also provides mobile toilet van facility at a nominal payment, which is sought by large fares and at occasions of public gatherings.

There are many arms of this institution:
- Sulabh Public School
- Vocational Training Center
- Social Upgradation Programme
- Slum Children’s Welfare Programme
- Slum housewives Literacy Programme
- Sulabh School Sanitation Club

Our trip to Sulabh included visiting the Sulabh International Toilet Museum, Sulabh Public School and Vocational Training Center.

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Alimco

Artificial Limbs Manufacturing Corporation of India (ALIMCO) is a non-profit making organization, working under the aegis of Government of India, under the ministry of Social Justice & Empowerment (http://www.socialjustice.nic.in).

It was incorporated in 1972 to take up manufacture and supply of artificial limb components and rehabilitation aids for the benefit of the physically handicapped and started production in 1976.
Product Range: The Corporation produces 355 different types of quality aids and appliances required by orthopaedically, visually & hearing handicapped persons. ALIMCO has been in the forefront in providing innovative and appropriate solutions to the problems facing the disabled. The product range includes Orthotic and Prosthetic appliances for Upper & Lower Extremities, Spinal Braces, Cervical Collars, Traction Kits, Rehabilitation Aids like Wheel Chairs, Crutches and Tri Wheelers etc. The Corporation also provides special tools and equipments required for fitment of Orthotic & Prosthetic assemblies by the Limb Fitting Centres. For visually handicapped, the corporation produces Braille Slate, Folding Cane and Braille Shorthand Machine.

For Orthopedically Handicapped
Rehabilitation Aids
- Lower limb orthotic (Calipers)
- Lower limb prosthetic (Artificial legs)
- Upper limb prosthetic (Artificial hands)
- Spinal orthotic (Braces for neck & back)
- Prosthetic supplies (stockinettes, socks and surgical boots)

Mobility aids
- Wheel Chairs (Manual & Motorized)
- Tricycles (Manual & Battery Operated)
- Axilla & Elbow crutches
- Walking Stick

For Visually Handicapped
- Braille short hand machine
- Braille slate
- Walking cane & stick

For Hearing Impaired
- Pocket type Hearing Aid
- Digital type Behind the Ear (BTE) Hearing Aid.

Source: http://www.artlimbs.com/profile.htm

From our experience during the trip we found that the ALIMCO hand is the only kind of mechanical hand used by most workshops in the low-end spectrum. The impression we got was that there is a need for another kind in the market as this ALIMCO hand has been there for a very long time and no improvements have been made to the look or the functionality of the hand. This hand is very good as such and that is the reason it has been there around for such a long time. ALIMCO hand kits are a little difficult to procure and the reason might be because of their huge demand.

http://www.artlimbs.com/pl_upper_extremity_prosthetics.htm
This link shows various components and kits manufactured by ALIMCO and the prices they are available for. Hooks are also manufactured by ALIMCO but as we saw most workshops use the kit with the cosmetic glove.

**Rural Technology Business Incubator (RTBI)**

[http://www.rtbi.in/](http://www.rtbi.in/)
Mission: Design, pilot and create successful businesses in the rural space, leveraging information and communication technologies.
INCUBATE->IDEATE->INNOVATE
It is funded by both World Bank and the Govt. of India.
Uniphore, a speech based mobility solutions company, was incubated at RTBI and is now a successful business. [http://www.uniphore.com/](http://www.uniphore.com/)

**Rotary Club & LN4**
1.2 million members in 34,000 clubs around the world. Rotary’s main objective is service — in the community, in the workplace, and around the globe. Rotary International works with many leading organizations and educational institutions in carrying out its worldwide humanitarian efforts. It partners with the United Nations, governments, NGOs, universities, etc. to take on big projects such as eradication of polio. Rotary International works with many prostheses manufacturers to organize camps across India to provide prostheses free of charge to people who participate in their camps. Rotary spreads awareness about the camp well in advance of the camp date leading to huge turnouts of amputees in these camps. Both Jaipur and Mukti work with Rotary to reach out to larger number of beneficiaries.
LN-4 Links

http://ln-4.org/
http://maps.google.com/maps/ms?ie=UTF&msa=0&msid=109713143891058216348.000473b90531690ee806e
http://www.aolnews.com/2011/03/16/giving-amputees-the-world-over-a-helping-hand/
C. India Trip Highlights

Dec 27, 2011 - Jan 9, 2012

"India is like a bumble-bee. Aerodynamically, the bumble-bee isn't supposed to fly, but it does not know that, so it flies happily."

TRAVEL SUMMARY

<table>
<thead>
<tr>
<th>Day</th>
<th>Date</th>
<th>Activity</th>
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<tbody>
<tr>
<td>1</td>
<td>Dec 27</td>
<td>Leave Chicago</td>
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<tr>
<td>2</td>
<td>Dec 28</td>
<td>Get to hotel Radha Reagent @ 11pm in Chennai</td>
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<td>3</td>
<td>Dec 29</td>
<td>Two interviews &amp; home visit of the carpenter. Visit call center.</td>
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<td>4</td>
<td>Dec 30</td>
<td>Mukti visit and Industrial Design office, +Mall</td>
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<td>5</td>
<td>Dec 31</td>
<td>Temple, street shopping, two interviews and private clinic,</td>
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<td>+New Years</td>
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<td>6</td>
<td>Jan 1</td>
<td>Village, homes, community center, interviews, drop interviewee at church</td>
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<td>7</td>
<td>Jan 2</td>
<td>Marketplace literacy village, bike shop, interview, farm</td>
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<td>Jan 3</td>
<td>Shore temple w/Srini</td>
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<td>9</td>
<td>Jan 4</td>
<td>Fly to Delhi, Sulabh visit, Dilli Hut Shopping, visit Charu’s aunt</td>
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<td>10</td>
<td>Jan 5</td>
<td>Drive to Agra &amp; Taj Mahal</td>
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<td>11</td>
<td>Jan 6</td>
<td>Palwal village visiti, two interviews w/1 at home</td>
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<tr>
<td>12</td>
<td>Jan 7</td>
<td>Visit HCL &amp; Jaipur office</td>
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<td>13</td>
<td>Jan 8</td>
<td>Visit tourist sites, McDonalds + Mall</td>
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<td>14</td>
<td>Jan 9</td>
<td>Leave Delhi @ 1am, land in Chicago same day @ 4:30am</td>
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QUICK FACTS

- 14 days total trip
- 3 days traveling
- 11 days on the ground in India
- 6 day in Chennai
- 4 days in Delhi
- 1 day in Agra
- 7 amputee interviews
- 3 AE & 4 BE
- 3 clinic visits
- 3 villages
3 cities
5 office visits
3 malls & 2 markets

TRAVEL DETAILS & NOTES

Day 1           Dec 27         Leave Chica
Day 2           Dec 28         Get to hotel Radha Reagent @ 11 pm in Chennai
Day 3           Dec 29         Two interviews & home visit of the carpenter. Visit call center.

Interview: Vishwa - age 32 - AE left
Very recent amputation, April 4, 2010. Amputation seemed to be due to infection in the arm (IV access site) following a hospital stay for renal problems
Illiterate, formerly working as a fruit-seller but has had problems re-starting the business following the amputation. Has recently re-started selling with the help of his friend.
Very depressed about the loss of his arm, has lost his faith and avoids all but the essential social contact. [When others see him they get sad and it makes him sad.]
Has seen plastic, purely cosmetic arm but is not interested.
Would be willing to borrow up to Rs. 35,000 to pay for prosthetic device, as long as it has function.
Not interested in cosmetics but wants an arm that works and helps him in his business. Most challenging task is lifting boxes of fruit, holds him back from working on his own...
Seemed interested in our device, has never seen cable system before.

Interview/house visit: Gautum - age 58 - AE left
Much different attitude than the first interviewee, likely due to how early his amputation occurred (age 18 when he fell into a well) in life.
Currently working as a carpenter, supervising 6 workers and earning Rs. 3000/week.
Utilizes feet for much of carpentry work, demonstrated projects during house visit
Home was 1 small room with cement on all sides, 4 people living there.
Initially answered that he didn’t need a prosthetic device and that he was able to work effectively without one but later reconsidered when uses of a prosthetic device were discussed.
Would like the capability to reach to high places such as when fitting a door.
Had only seen a cosmetic hand before and didn’t want one.
Overall a very positive person who was quite happy and proud of his life and what he had accomplished. Stated that he was very grateful for his life.

Call center Allsec Technologies Ltd. (Call center)
Interesting and kind of sad to see how many people had technical degrees but were still working in a call center.
Employment in a call center is more prestigious in India than for a similar worker in the US
Competition-driven workplace with odd working hours (for US & European call time) and a workforce that must find residence in major cities.

Day 4    Dec 30    Mukti visit and Industrial Design office, + Mall

Greeted by Captain and given an overview of Mukti’s purpose before going on tour

In 1986 Mukti was founded by a woman inspired by Jaipur’s work who started a clinic in her garage and received training from Jaipur. They have manufactured a total of 250,000 artificial limbs and calipers till date. Current technicians are trained by Jaipur and have worked at Mukti for many years, no new technicians trained.

Limbs are nearly identical to those used at Jaipur and the manufacturing process is the same, complete with the casting molds and ovens used to make the feet.

Technology is behind that of Jaipur’s current technology. It has not been updated.

Limbs are made from HDPE pipes (25 inches of this pipe costs around Rs. 230) heated and molded around a cast of the residual limb. Legs have a manual lock knee joint and arms use the Hosmer E200 elbow joint. It was notable that the inside of the prostheses had a thin layer of foam in the region of contact with the residual limb for padding. UL prostheses made with Alimco kits bought for Rs. 4000. Polypropylene sheet is used to make calipers.

Most common repairs and replacements are of joints, calipers, and the feet, which wear quickly given the unwillingness of many rural beneficiaries to wear shoes for protection.

Treat 130 UL & 700 LL at camps and facilities in course of year, usually manufacturing about 100 limbs at one camp. Mukti sends out camps to areas where local Rotary clubs request & sponsor them. Mukti has sent camps abroad to Guatemala, Africa, and other areas.

The first thing amputees are asked when they come into the clinic is, “Are you mentally prepared?”

Calls amputees ‘beneficiaries’ and looks for people with the right attitude and mental preparation. Captain tells them to leave their family and crutches at the gate. Generally amputees must wait 5 months before being fitted.

Beneficiaries are victims of traumatic accidents, cancer patients, diabetics, lepers, etc. Priority is given to children (club foot), students, cancer patients and leprosy patients.

Must wait approximately 5 months after amputation until swelling of the residual limb goes down in order to be fitted for a definitive prosthesis.

Physical therapist specialist on hand to train beneficiaries after fitting

Sponsored by Rotary club, Lions clubs, and donor families (sometime related to beneficiaries) - a family was there to see the fitting of 3 limbs they sponsored for their child’s birthday. Mukti avoid government grants due to the time involved to procure them. Capt’n mentioned international funding from donors in Switzerland, US, UK.

On the first floor of the building there was a workshop where Jaipur feet are made using moulds of different sizes employing the Jaipur foot technology. There are 3 workers here (1 worker had a below knee amputation and 2 had above knee amputation) who manufacture around 12-14 sets of feet everyday.

Mukti has a printing press and screen printing shop on site to provide employment for mentally and physically handicapped people. Have distributed CDs to donors with bios on
unemployed beneficiaries to connect them with employment. Organize an annual gathering of beneficiaries: Mega Mukti Mela

“Mukti’s primary objective is to provide artificial limbs and Calipers to the orthopedically challenged persons and also to provide vocational training and facilitate self sustainable and gainful employment. Mukti’s vision is to see that all orthopedically challenged persons have artificial limbs and Calipers to walk with dignity and be self sufficient. The vision is to ensure that all amputees have freedom from crutches, freedom from pain and freedom from misery.”

Production Process (takes one complete day):
Patient arrives in the morning and sits in central open room, waiting to be seen.
Patient’s residual limb is measured and a cast is made using plaster of paris
The HDPE pipe is heated to 180ºC in an oven so that it forms around the mold
The pipe is cooled and the mold is broken
Jaipur Foot is fit onto the leg (independent manufacturing process-first floor workshop referred earlier)
Vulcanized rubber is formed around wooden shape and wrapped with skin-colored leather
Materials are heated in different sized dyes

Donations (Mukti)
• Donate Rs. 2000 for an artificial limb
• Donate Rs.1400 for a Caliper
• Donate Rs.3500 for an artificial hand

Industrial Design studio - Centroid Creative Hubb
Innovative design in the India context making finger toothbrushes, tractors giving the impression of strength, and a baby glider
Potential partner for creatively designing occupation-specific tools & solutions for adult amputees.

Day 5 Dec 31 Temple, street shopping, two interviews and private clinic,
+ New Years

New Years was really fun, there was a lot of delicious food and dancing. Kolaveri was played approximately 100 times and everyone, including Madhu, tore up the dance floor. It was a very, very sweaty situation.

Interview 1: Name: Ram, male, below elbow, 36 years, left arm amputation
He works and lives in Chennai with his family of 1 boy, 1 girl, and his wife
He is an assistant to a mason. He earns 300 Rs/day. Basic activities include carrying and mixing raw material.
He lost his arm operating a sugar cane machine when he was 15.
He studied up to the 5th standard and knows how to write.
He does not find anything difficult to do at home; he practiced often by himself.
He currently goes to a private hospital when he needs medical attention because the government hospital is far (4-5 km).

The hospital did not show him any prosthetic options when he had his amputation. He says he has seen plastic artificial limbs but ones that are not functional. If the arm is operable and functional, he would like to use it or try it but he does not care much about only having 1 hand—he can do everything he needs to.

He knows several people with amputations—people have prosthetic legs but no prosthetic arms.

He feels satisfied with his work and earnings.

Asked what if he had two arms, he said I could carry 2 bags with 2 arms and earn more.

**Interview 2: Name: Prabhu, Age: 48, male, below elbow, right amputation**

Lost his hand in a farming accident, with additional hospital mistakes. If he had been in a good hospital, his arm probably could have been saved.

He had to take out loans for his amputation and his wife is currently working in a different country to help pay off the loans and support them.

He has seen a prosthetic arm but is not thinking of getting one—no time or money.

Said a prosthetic device would be useful at home, specifically in washing cloths.

Said he doesn’t have time or money to get device. Would only want a hand, not a hook.

**Day 6**

Jan 1 Village, homes, community center, interviews, drop interviewee at church

**Interview 1: K. Venkatesh (Stephen), age 44, above elbow, male, right arm amputation**

Currently does charity work, was formerly a building contractor.

He was hit by a lorry, settled outside of court, receives payment from government.

He has seen rigid cosmetic arms, but is not interested, he also had an injury where the straps fell.

His other hand was also injured, so he went to physically therapy at a hospital to regain use of that hand.

His right arm was dominant at the time of the accident and he trained his left arm after the accident in order to perform various activities at home and in the church.

He does not want a prosthetic arm because he feels that it would offend his family members who are currently taking care of him.

He does not want to use one because he feels peaceful now.

His work includes cleaning and arranging in the church with a high emphasis on cleanliness.

His wife supports the family as a tailor working in an export company.

He is considered 80% handicapped by the government.

Very emotional in general. He seems to be in a good place now, but maybe was not always the case?

He said he would like to go back to construction work and be a supervisor if he had 2 arms, contradictory to what he said earlier. This was when he was asked what will you do if you had 2 arms.
He said he dreams of taking his family on a bike ride with his wife sitting behind him. He feels very sad that he is not able to do so now. He will be willing to try a prosthetic device if will help him ride a bike.

Day 7 Jan 2 Bus shenanigans, marketplace literacy village, bike shop, interview, farm

Interview: Kumar, 49 years, left, below elbow
Worked with stone (breaking big stones into small ones, earned Rs. 90/day), but does not now because he lost his arm from a dynamite accident during work. Now the government pays him for 100 days to do cleaning work in villages
went to a government hospital and was told of prosthetic options but he did not want one
He stopped doing stone work one year ago because he was too physically weak with chest pain, pain in arm
He would like to open a small shop but is limited by capital, not lack of hand
He saw the hand as potential support for carrying things, he would use the hook but likes the hand better. He said his confidence would increase if he uses the device.
He gets no compensation from the private company that he worked for where the accident took place, he gets Rs. 1000/month assistance from the government.

Day 8 Jan 3 Shore temple w/Srini
Day 9 Jan 4 Fly to Delhi, Sulabh visit, Dilli Hut Shopping, visit Charu’s aunt
Day 10 Jan 5 Drive to Agra & Taj Mahal

Breathtaking visit to the Taj Mahal where we got to be tourists with the rest of India. Everything about the Taj has been designed so carefully and elegantly, from the floating foundation and outward tilting towers, to the smoothly fit precious stones and proportionally-sized script around the entrance door.

Day 11 Jan 6 Palwal village visit on way from Agra to Delhi

General thoughts on villages: use pump for water, fairly wide variety in income levels (some people were in huts, others had nice homes), university education seems fairly common for young people who are motivated, dirt roads, no English spoken

Interview 1: Shivkaran, 21 yrs, twisted lower leg
Went to doctor, was given injection, and developed disease in his legs, likely due to polio
Was assessed by the government to be 90% handicapped and received funds for school as a result
Currently a college student in English, looking to get a PhD and teach English to give people confidence and the ability to join in as Indian society progresses forward. Conversed in English with us for nearly the entire interview and asked us questions about agriculture and poverty in the USA. Came with us to our second interview and had a poor opinion of Azad Singh, saying that a prosthetic arm would be accepted by someone who was educated and could appreciate the value. Whispered during interview that Azad Singh threw away his prosthetic arm when he was drunk (questionable truth to his information as he seemed to have a superiority complex).

**Interview 2: Azad Singh, 34 yrs, Left BE**

Visited at his home, may not have been aware of us coming to visit him. Entire family present for the interview and engaged in the interview while quietly mocking us. Worked in agriculture from an early age on a family farm of 40 acres (relatively wealthy). Grow wheat, sugarcane, rice, & lentils on land. Currently supervises laborers in field by riding around on tractor (can drive with 1 hand). Studied up to the 12th standard, started a bachelor’s degree but dropped out. Lost hand at age of 12 while playing on threshing machine (still present at house). Family doctor arranged a car to bring him to hospital in nearby Faridabad. Stayed in hospital for 2-3 days, then went back every 15 days to have bandages changed. At 14-15 yrs went to stay with uncle in Jaipur and was fitted with prosthetic arm. Went in 1 day & returned 3 days later for arm. Thought it was easy to learn how to use arm & didn’t receive any training. Found the arm to be heavy and thought it was a “show”, thought legs were more successful at Jaipur than arms. Mother disliked arm due to ‘animal-like claw’ appearance, said that seeing her son wearing the arm made her feel uncomfortable. After trying the arm for 3-4 days he threw the arm away. Mentioned getting 12,000rps award from committee, potentially to help with med expenses. Hesitated to say what was difficult for him to accomplish, mother was more forthcoming with ideas. Difficult to milk buffalo, cut grass (requires one hand to hold bundle, one to use cutting tool), tie pants sting, can't lift large couch. 2 yrs ago: Assessed as 70% handicapped, now receives 500rps/month from govt.

**Day 12**                **Jan 7**             **Visit HCL & Jaipur office**

**HCL**

Harvard Business Review and London Business School have done case studies on HCL. Their CEO, Vineet Nayar, came up with a strategy ‘Employees First Customer Second’ as he wanted to stress on the importance of the contribution of HCL’s employees, HCL’s primary assets. The above strategy was thought of at a time when HCL was experiencing lower growth rate, lower retention rate and loss of market share to competitors.
Shiv Nadar, the founder of HCL has a personal philanthropic initiative, The Shiv Nadar Foundation.

Another initiative, Vidyagyaan, is in practice where the toppers after 5th grade from rural backgrounds are enrolled in a boarding school and provided with top quality education, food and other support to succeed in life.

**Jaipur Foot - Delhi office**

Sanjeev Kumar, Manager (P&O) Jaipur Foot, mentioned that he thinks the following three things should be considered while designing a mechanical hand (any prosthesis):
- **Weight**
- **Aesthetics**
- **Functionality; easy to adapt, easy to use**

He said pipes used in Jaipur Foot’s technology are locally available and are cheap and durable; they are available in skin color.

Advised IPT to use locally available materials like Jaipur does

Monster or northwestern design for self suspension

He mentioned that we should look into a battery powered or body powered prosthetic hand; use mobile batteries etc. Hybrid design could be a good option.

He mentioned Mobility India (Bangalore), Worth Trust (Katpadi, Tamil Nadu near Chennai) as some of the organizations working on prosthesis. Worth trust had made a prosthetic hand which was battery powered.

Jaipur Foot has 22 branches in India

Sanjeev’s comment on the Alimco kit: it looks like a kid’s hand, does not look like a real hand, too small. The hand should not absorb water, should be of soft material, should look like the other hand, easy to repair and maintain, light weight.

Said ALIMBCO was sole upper limb kit provider and is used because no other option exists in India. Believes not a good source of terminal device because there is not much innovation for upper limb.

He said rejection rate for ALIMCO above elbow prosthesis was 80%
Believes huge opportunity in upper extremity prostheses because not a lot has been done in developing countries. Upper limbs not a heavily penetrated market.

Causes of amputation: Road accidents, train accidents, industry accidents

The approach that he said should be taken for working on prosthesis should be patient-centric

What Jaipur needs the most? Money needs 130,000,000 rupees to sustain
- 25% government grants
- 75% donations

They make 20,000 lower limb prosthesis annually

He told about the Center for International Rehabilitation (http://www.cirnetwork.org/content.cfm?id=5B&newCommunity&CFID=1614343&CFTOKEN=15990230)

He mentioned about RIC: Rehabilitation Institute of Chicago as well: Prof. Andrew Hanser. Prof.Young Chi Wu, Prof. Hector Casanova

He told us about the conferences OPAI2012.com in Shillong this February and the ISPO conference in Hyderabad in 2013.
Thoughts on elbow joint: Clutch breaking mechanism, mechanism should be able to work simultaneously and independently with the terminal device. Shoulder movement: elbow locking+unlocking

He mentioned about usage of Dynacast tapes in camps conducted by Jaipur in some countries

Said design must be compatible to culture

Hooks not liked in India

Cosmetic is important

Approximately 30% of patients are women and believes there are fewer women patients because women are not exposed to outside work


Day 13                     Jan 8            Visit tourist sites, McDonalds + Mall

Day 14                     Jan 9            Leave Delhi @ 1am, land in Chicago same day @ 4:30am
D. Notes from Rotary Camp

Process:
Patients walk into the camp and register themselves. Then, their disability is screened. Their information is recorded and signatures are taken. Then, they are sent to the respective part of the camp for further advice. If corrective surgery might be needed, they are sent to a doctor and his team from a Medical College in the city. If a below elbow device is required, they are sent to the LN4 workshop.

This workshop is run by non-professionals who have been informally trained by doctors from the US 3 years ago. The arms are imported from the US at a cost of INR 2500 per arm (approximate cost). If the residual limb is long enough (4 inch minimum from the inner part of the elbow) the fitting is possible and is carried out. No tools are used for the LN4 except for a measuring tape to make sure the residual limb is long enough. After that, the fitting is done in 5 minutes with the help of straps. In the case of disability with the lower limbs, Jaipur Foot takes over and goes through the entire process of making a device suited to their disability (below knee/above knee/polio affected limb).

The LN4
The arm is made out of plastic. The grip is made so that it locks itself in place when pushed inwards using the other hand. When the grip needs to be released, the other hand needs to bend the hand part of the device forward and the grips release. 5 people came to the LN4 workshop while I was there. 3 people could not be fit since their residual was too short. The other two were fit successfully. One of them was extremely happy that he could do some basic functions with the LN4 as opposed to the cosmetic one he already owned. Another person wanted a cosmetic arm and was not very happy with the LN4. He was told by the people running the workshop that he could now actually use that hand, but he was not convinced. I could not speak in detail with any of the patients since the atmosphere was not conducive to that. They were all very eager to return to their homes as soon as possible. However, I got a sense that the LN4 is good for people who wanted some limited function over no function at all. For example, a barber had visited on an earlier day who could now hold a comb with the LN4 while he used scissors with his other hand.

The camp
People from all over the state of Karnataka were present. There were also some people from other states in southern India who had come to the camp. Many of them had come with their families and people who could not afford to stay at some place were staying inside a large tent that was put up by the rotary club. Free lunch was also being provided for patients and their families. The camp was completely funded by donations since every device was given to people free of cost. This is the 15th year of this camp being held. The sponsors of the event were State Bank of India, Jindal Aluminum Ltd., ITC Limited, CIGFIL Ltd.

In addition to this, there were a number of nursing students from Nepal and some parts of India that were helping out in a big way with the camp. They were running the various booths (screening, registration etc.) as well as actively learning how to prepare a cast, how to fit the
LN4 etc. They were in Bangalore to help out with the camp as well as get educated on prosthetic care.

Jaipur Foot
Jaipur foot was at the camp with their people from Jaipur. They had brought their equipment with them which included various drills, lathes and cutting devices, a large oven, various casting tools and of course all the materials required to manufacture the limbs. The scale that they were working on was astounding. Due to this, people had to wait for a couple of days sometimes to get their prosthetic limb, but the free lodging and food went some way in helping with the long wait times.

People I met
I introduced myself as visiting on behalf of IPT and directed people to the website. I met people from the Rotary Club, Doctors from a Medical College and technicians working at the camp. I also met some patients but my interactions with them were short. People were very supportive of the mission of IPT and specifically asked for solutions for above elbow and short residual limb prostheses. They were also very keen to get in touch and collaborate but that is a very sensitive topic that I stayed away from.
E. Contact List

Sanjeev Kumar (Delhi Jaipur P&O Manager)
Ahimsa Bhawan, Shankar Rd
New Rajendra Nagar, New Delhi-110060
Office #: 28745133
Cell #: 9868234040
Email: sanjeev@jaipurfoot.org
www.jaipurfoot.org

Dr. Mehta
Jaipur Foot, Founder
drmehta.jaipurfoot@yahoo.com

Mr. Vinod
Worth Trust
Ph: +91-8015336342

Maj. Devinder Pal Singh
(person who wanted the start amputee association, runs marathons with a prosthesis)
+91-9650960322, +91-9891369573

Captain Bala
Mukti Foundation
+91-9444226220

Tulsi (Technician)
Mukti Foundation
+91-9445293029

Prabhu-Interviewee
Phone no: +91-8939025248
Address: Arun International, #239, Jawaharlal Nehru Salai, Koyambedu, Chennai 600 107

K. Venkatesh - Interviewee
Phone no. +91-8939431037, +91-9790846601

Kupuswamy-Interviewee
Contact: K. Indumathi - +91-8754842218,
Palaezhithotum, Kambalamboondi post,
Uttirameru palam, Kanchipuram distt.
References


