EC.721 Wheelchair Design in Developing Countries
Spring 2009

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2009 PROPOSED PROJECTS
1. World-wide network to connect donors local workshops

Objectives:
• Connect funds from international donors to local workshops
• Compete with large-scale donation organizations

Project details:
• Assess donation capability, user need, and develop business model
• Minimal NGO required – Maximize fund transfer
• Inputs/outputs managed by donors and workshops through internet
• Workshops held accountable for confirming delivery of wheelchair

Example: APDK

Foreign donor
Log on to network
Choose country
Donate to client
Delivery confirmation to donor

Client
Provided: $50
Required: $150
Bio:
David is a polio survivor from Busia, Kenya. He requires a tricycle…

Wheelchair network website

February 3, 2009
2009 PROPOSED PROJECTS
2. Low-cost tricycle attachment

Objective: Design a new tricycle attachment that costs ~$50

Project details

- Low cost (~$50)
- Stowable on wheelchair
- Optimize usage of bicycle parts
- Connects to both 3 and 4 wheelers made in partner workshops
- Gear ratio appropriate for local conditions (may use 2-speed trike from last year’s class)

Photos courtesy of MIT M-Lab.

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Objective: Identify ways disabled people can buy their own mobility aid and use it to generate an income.

Ex) APDK retractable mobile phone tray

Photos courtesy of MIT M-Lab.

Project details
- Identify small business opportunities
- Develop business models for each wheelchair-based business
- Locate resources to allow people to buy own chairs
  - Micro loans
  - Pay-over-time plan from manufacturers
- Optimize usage of available materials and processes
- Work with mechanical engineers to prototype add-ons to wheelchairs to facilitate business

February 3, 2009
Objective: Design a human-powered/power-assisted tricycle

Project details

- Low cost (~$300-$500)
- Human-powered or power-assisted or combo (like a moped)
- Need to control engine and pedals at the same time
- Uses locally-available components and parts
- Can transport the user at ~10mph for 10 miles
- Uses a locally-appropriate fuel
2008 PROPOSED PROJECTS
5. Adjustable gear ratio for Kien Tuong tricycles

Objective: Enable the Kien Tuong tricycle to change gear ratios on the fly

Project details

- Current tricycle only has one gear, but great steering/geartrain combo
- Kien Tuong would like a system to shift gears on the fly
- Can change gear ratio by moving pivot position
- Cannot add significant cost
- Made from local components

February 3, 2009
Objective: Facilitate container shipments of tricycles

Project details

- Design a frame that can fold down flat for shipping
- Also make foldable for transport on busses
- Make frame light weight – not more than current trikes
- Optimize material usage for high strength, low weight
- Make adaptable for different trike designs (Kien Tuoung, APDK)

Photos courtesy of MIT M-Lab.
2009 PROPOSED PROJECTS
7. Marketing and funding guide

Objective: Increase awareness of locally-made mobility aid products and help workshops write grants, gain funding

Project details
• Study other successfully marketed appropriate technology (ex. Treadle pump)
• Identify potential forms of media in Africa vs. USA
• Advertise to foreign donors
• Create materials for brochures, posters, TV, and radio
• Create websites that can be maintained by workshops (consider internet speed)
• Assemble a grant-writing guide to be used by local workshops

http://make.a.website.on.googlepages.com

Courtesy of Shirley Fung. Used with permission.
Objective: Design an appropriate electric wheelchair/scooter

Project details

- Use locally available motors and batteries
- Develop control system and user interface
- Small enough to use indoors, through doorways
- Possibly use solar power
- Low-cost (~$300-500)

Wheelchair made by Thaiwheel

Photos courtesy of MIT M-Lab.

February 3, 2009
9. Sports wheelchairs and tricycles

**Objective:** Design new mobility aids purely for recreation

**Project details**

- Wheelchairs for tennis or basketball
- Wheelchairs should conform to international competition standards
- Tricycles made for sport or commuting or possibly off-road
- All products made low-cost out of local materials
- Ideally produce jigs and production manuals for products

Have an Idea?

- Write it down and we will include it when projects are chosen
HOMEWORK
Due at beginning of next class

- Pick your top 5 projects
  - Projects will be ranked by popularity
  - Project teams formed next Tuesday 2/9

- Readings (posted on course website)
  - International Society of Prosthetics and Orthotics (ISPO): “Wheelchair” article
  - Whirlwind Wheelchair International: “Proposal to develop standards for wheelchair provision services” article
  - A. Winter: “Assessment of wheelchair technology in Tanzania”
NEXT CLASS
Wheelchair relay race

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Objective: Modify the popular African-made three-wheeler to collapse like a 4-wheeled wheelchair

Project details

- Design a system to fold the rear wheels in closer to the frame
- Utilize bicycle parts and other local materials
- Cannot add significant weight or manufacturing cost to the chair
- Can use in conjunction with front wheel coupling developed in last year’s class.
- Has to fit in the trunk of a car or in a bus
2009 PROPOSED PROJECTS
11. Wheelchair modifications for women

Objective: Design wheelchair accessories specifically for women’s needs

Project details

- Enable user to easily get down to the floor
- Carry children
- Carry supplies/groceries/water
- Removable to reduce weight
- Low-cost (~$20)
- Made from local components

Photos courtesy of MIT M-Lab.
Objective: Improve practices and efficiency of local workshops and identify supplemental income generating activities

APDK Kenya makes 200 wheelchairs per month, whereas most local shops make 10-20

Project details

- Create a general assessment system to optimize local wheelchair builders for their region
- Investigate the local market – clients, funders, materials, labor skill, etc.
- Determine whether to build wheelchairs locally, import from larger African manufacturers, or import from Asia
- Identify supplemental income sources from related products, such as charcoal compactor or pedal grinders

Wheelchair workshops have the capacity to produce products like pedal-powered grinders and charcoal presses

February 3, 2009
Objective: Design a short course to train wheelchair prescribers

Project details:

- Develop a curriculum to teach people how to prescribe wheelchairs for different disabilities
- Offer different levels of training (similar to PADI)
- Make prescriber also salesman for products
- Train prescribers so they can be posted far away from workshop, as to utilize central manufacturing
- Write for people with English as a second language
- Class to be taught by wheelchair technicians

February 3, 2009
2009 PROPOSED PROJECTS
14. Creating testing methods and instruments

Objective: Design protocols and instruments to test the appropriateness of wheelchairs in developing countries

Double drum tester
Photo removed due to copyright restrictions.

Project details

- All tests have to low-cost and made from local materials
- Modify double-drum test for rough-road testing
- Test max user weight for chairs
- Use tests to determine appropriateness of donated chairs
- ISO certify locally made chairs
- Test bearings for life under harsh conditions (wet, mud, sand, dust, etc)

Imported wheelchair
Photo courtesy of MIT M-Lab.

February 3, 2009
Objective: Optimize the logistics of workshop production and improve product quality

Project details

- Track manufacturing quality and customer satisfaction by using serial numbers to trace product defects back to the workers
- Implement a computerized stock room and purchasing system
- Purchase in bulk to lower unit cost of components
- Outsource fabrication of some components to specialty shops
- Apply lean manufacturing techniques

Stock material at APDK

DAGE workshop

Photos courtesy of MIT M-Lab.
Objective: Improve functionality, comfort, and efficiency of tricycles.

Project details

- Upper body motion with highest sustainable power output
- Gear ratio for different terrains
- Best configuration of hand grips
- Best rake angle for stability vs. comfort
- Appropriate, supportive seating
- Simplified production

Aligned or opposed hand cranks?

WDDC 2-Speed design

Photos courtesy of MIT M-Lab.
Objective: Find best components and materials to reduce weight, improve serviceability, extend life, and lower cost.

Project details

- How can bicycle components be used more effectively in wheelchairs?
- What components are available
- How could they be used differently
- Life and durability
- Cost savings of replacement

Available materials

Castor barrel-bike hub concept

Images courtesy of MIT M-Lab.
Objective: Decrease manufacturing time with better, more repeatable welding jigs and simplified frame designs.

Project details
- Assess current process time and manufacturing steps
- Identify bottlenecks in production
- Find unnecessary frame complexity
- Tolerance stack-up and mitigation
- Simplified frame prototype
- Jig design prototype
- Process plan for making frames

Current Whirlwind jig with separate left and right sides

Photos courtesy of MIT M-Lab.
Objective: Design jig to hold tricycle components during welding and make a production manual to teach other workshops to make tricycles.

Project details

- Understand tricycle building process
- Design to avoid tolerance stack-up mitigation
- Accommodate bending errors
- Calculate process complexity and time
- Produce a simplified frame prototype
- Produce a jig design prototype

Tricycle frame production, APDK Nairobi
Photos courtesy of MIT M-Lab.
Objective: Teach safe manufacturing practices

Project details

- Consider language, literacy, and cost of printing
- Demonstrate unsafe practices in workshop
- Describe manufacturing processes
- Explain tolerance stack-up mitigation, bending errors
- Introduce lean manufacturing principles

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Objective: Improve reliability and safety of breaks

Project details
- Examine existing bike braking systems
- Calculate stopping requirements
- Understand road surfaces
- Consider manufacturing cost/complexity and tire wear
- Prototype brake for both tricycles and wheelchairs

February 3, 2009