ASSISTIVE DEVICES: BACKGROUND PRESENTATION

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Biomedical Systems and Technologies Track

- Projects that apply engineering skills to provide solutions to biological problems
- Applications include a wide range of topics that are split into families
Project Families

- Artificial Organs
- Bioengineering Fundamentals
- Assistive Devices
  - Sponsored by National Science Foundation (NSF)
  - Developmental disabilities
  - Physical disabilities
    - Nazareth College Physical Therapy Clinic
Nazareth College Physical Therapy Clinic

- An educational and clinical setting that serves clients who have exhausted insurance allowances or have no coverage at all
- Faculty support and advise physical therapy students
- Students perform the therapy and gain hands on experience
- Dr. Mowder-Tiney and Dr. Gombatto
Why RIT, Why Now?

- Engineering college in close proximity to the clinic
- History of working with Nazareth produce new therapy equipment
- Medical equipment is an excellent opportunity for multi-disciplinary design
  - Multiple, complex mechanical, electrical, and chemical components that increasingly require integration with hardware and software systems
  - Able to design equipment that is not available commercially
- Nazareth College Physical Therapy Clinic has limited resources to acquire new Equipment
- All stakeholders will benefit
Topics of Presentation

- Background research on existing projects in the assistive devices family as well as other applicable projects.
- General assessment of the Nazareth clinic and the aforementioned projects.
Past Senior Design Projects

- 08001 – Balance Training Bicycle
  - Stationary bicycle with pivoting frame
Past Senior Design Projects

- 08003 – Portable Obstacle Course
  - Many combinations of obstacles to measure mobility.
  - Provide comparative results
Past Senior Design Projects

- 08006 – Motion Tracking System
  - Gyroscopic sensing on legs
Past Senior Design Projects

- 09027 – Upper Extremity Motion Capture System
  - Measures motion and electromyographic signals of the arm
Balance Training Bicycle

- **Problem**
  - Need equipment to aid in balance training on bicycle

- **Benchmark**
  - Senior Design Project 2007-2008

- **Past Team**
  - Mentor
    - Dr. Debartolo
  - Jennifer Zelasko (IE), Jonathan Bawas (EE), Jeffrey Tempest (ME), James Nardo (ME), Carl Mangelsdorf (ME)
Balance Training Bicycle

- **Concept**
  - Use spring canister and winch to allow for adjustable range of motion
  - Sensor located on seat
  - Lights indicate angle

- **Prototype**
  - Currently at Nazareth
  - No longer in working order
Motion Tracking Sensors

- Critical aspect of all Nazareth projects
  - PT’s need concrete method of measuring motion
  - Sensor prioritization: project-to-project basis
  - Prior Sensors used:
    - Inclinometers
    - Gyroscopes
    - Potentiometers
    - Accelerometers
    - Encoders
Motion Tracking

- Mobile, wireless motion tracking device
- 4 Gyroscopes utilized
  - Measure patient’s angles of the hip, knee, and ankle joints
- Past Team
  - Mentor
    - George Slack
  - Josemaria Mora (EE), Wade Daughtery (EE), Brian Leigh (EE), Jennifer Mallory (ME), Eric Danielson (CE)
Motion Capture System

- Track motion of arm and accompanying muscles
- Concept Selection Matrix:
  - Rotary Potentiometers
    - Velocity measurements of limb movements
    - Measure elbow-shoulder, arm-body angles
  - Electromyography
    - Measure activity of 4 muscle groups

- Past Team
  - Mentor
    - Dr. Edward Brown
  - Melissa Gilbert (ME), Alan Smith (EE), JJ Guerrette (ME), Adey Gebregiorgis (EE), Pooja Nanda (EE), Dan Chapman (CE)
Existing Projects of Interest

- Technological possibilities:
  - iBot
  - MIT Second Skin:
    - Low-End Tracking Technology
    - Cost > $1000 Total
    - Projectors/Photosensors
    - Microcontroller- Bluetooth
Human Interfaces

- **A human interface** is the means by which a person interacts with a device.
  - Physical – handles, switches, knobs, straps, etc…
  - Digital – on screen instructions or buttons to click etc.

- **Human Factors** is about understanding what the human body is capable of and designing products/systems that match those capabilities.
  - Physical - Varied body types/sizes, Varied levels of physical ability
  - Mental - Varied levels of mental ability, easily and intuitively understood

Image from Designing for People by Henry Dreyfuss
Human Interfaces

In past projects:

Handlebars and seat on balance bike

Sensor attachments/electronics pouch in motion tracking system

GUI for motion tracking software

Arm brace and sensor attachments in upper extremity motion capture system
General Assessment

- Use background research and observations to develop a better understanding of how a project for the Nazareth clinic could be planned and executed
General Assessment Goals

- Develop some common themes between the projects
- Based on observations at the clinic, develop an understanding of the application environment
Common Themes

- **Accuracy and reliability**
  - 08006 did not meet accuracy requirements
    - Max angle, +/- 5%
  - 09027 team did not develop a calibration process

- **Ease of use**
  - 08001 is difficult for staff and clients
    - Pedal mechanism
    - Visual display
  - 08003 is straightforward and easy to use
Common Themes

- Incomplete aspects of project
  - 08001 did not include a feedback control on the winch system
    - Device was operational but lack of feedback control lead to failure
  - 08003 did not deliver automated tracking
    - Manual tracking was still available
  - 09027 did not complete the arm model
    - Device still operational
Clinic Capabilities and Needs

**Capabilities**

- **Durability**
  - Maintenance ability very limited or non-existent
  - Repair ability non-existent
- **Ease of use**
  - Limited or no ability to learn complex procedures for use

**Needs**

- **Versatility**
  - Range of ambulatory ability
  - Wide range of body sizes
- **Easy Access**
  - Patients with limited mobility or dexterity
  - Therapists provide physical support
- **Small storage size**
Conclusions

- Plan projects that will be successful even with failures along the way
- Keep projects as simple as is required and as easy to use as possible
- Design devices that fit the end user
  - Client – all sizes
  - Therapist – ranging technical skills
- Products that fit the application environment
  - Size
  - Durability
Discussion