IPRO 332:

Longitudinal Oscillator for Cardiac Arrest Victims

Our Team

From left to right:

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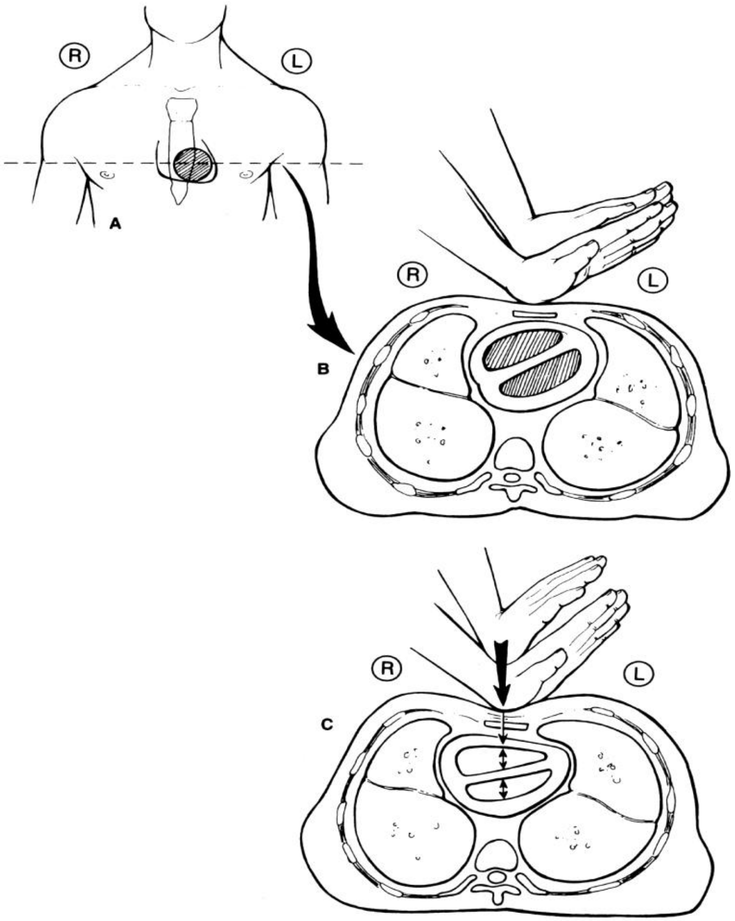
Cardiac Arrest and Prevalence

- Not necessarily associated to pre-existing heart disease
- Unpredictable
- Kills approximately 350,000 people a year
- 2 out of 3 deaths happen outside of the hospital

Survival Odds

- Usually reversible if defibrillation occurs within the first few minutes after collapse
- Surviving a cardiac arrest drops 10 percent every delayed minute of defibrillation — even if CPR is started immediately
- Irreversible brain damage can sustain if the heart is not restarted within the first four to six minutes

Complications With CPR



- Rib and sternal fractures
- Coronary embolus
- Lung contusion, and oral and dental injuries
- Liver and spleen damage
- Trachea and vena cava damage

Longitudinal Oscillator: Porcine Model

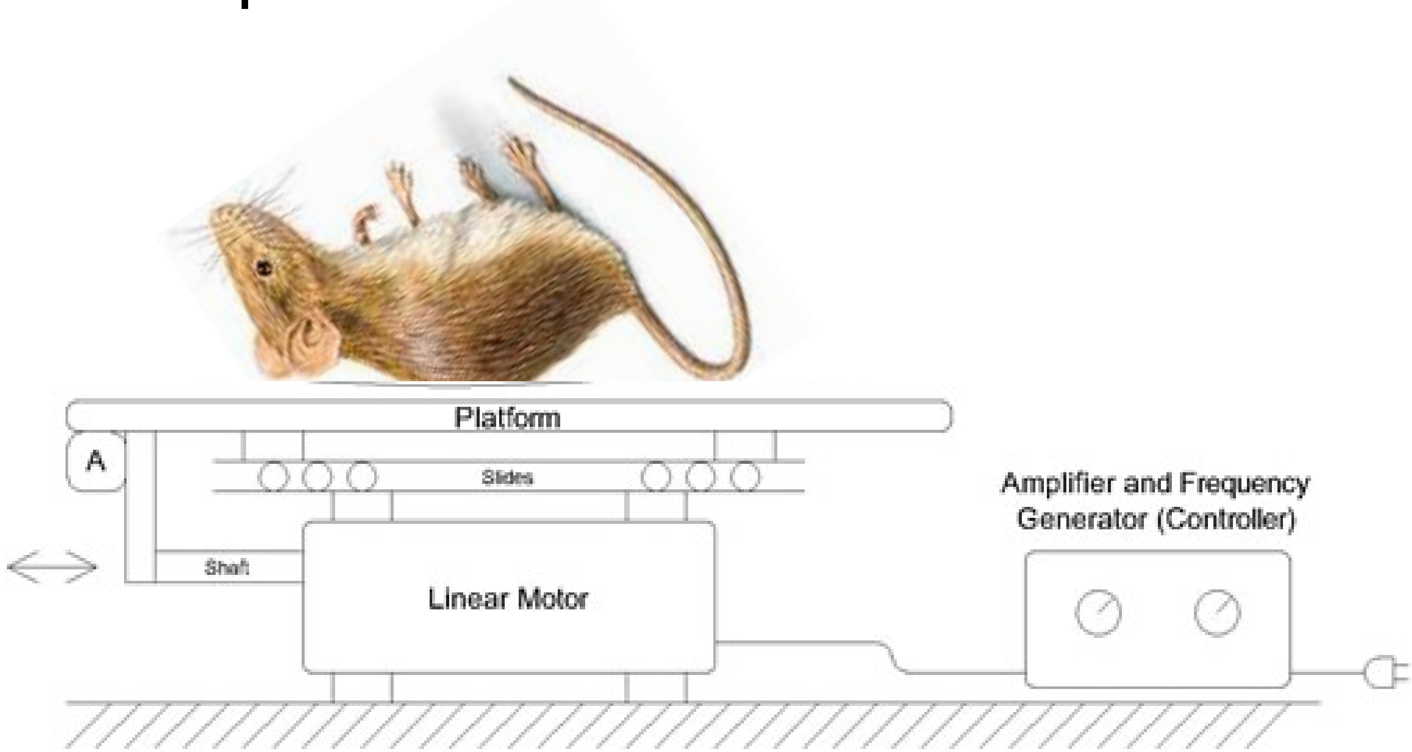
- Potassium used to stop the heart of pigs
- Periodic acceleration along the spinal axis applied (pGz-CPR)
- Blood flow, and ventilation proved sufficient
- Neurologic outcomes remained normal at 48 hours
- Eliminates the risk of rib fractures

Divisions of Neonatology, Department of Research, Mount Sinai Medical Center, and Miami Heart Research Institute

Translational Research: Murine Design

Longitudinal Oscillator: Murine Model

- Goal: create a shaker bed for mice specimens to continue pGz-CPR research



Subteam Project Goals

- Operational Parameters
  - Oscillate with Amplitudes of 3-5 cm at Frequencies of 10-20 Hz for up to 20 minutes
  - Permit Amplitude and Frequency adjustments during operation
  - Fit all Components into compact, laboratory-friendly layout

Two basic designs can meet all three parameters: **completely mechanical** and **electro-mechanical**

Design A: Completely Mechanical

- Zero-Max Speed Reducer
  - Pros:
    - Cost effective
    - Compact design
    - Simple mechanical motion
  - Cons:
    - Requires lubrication
    - Low precision
    - Custom made parts

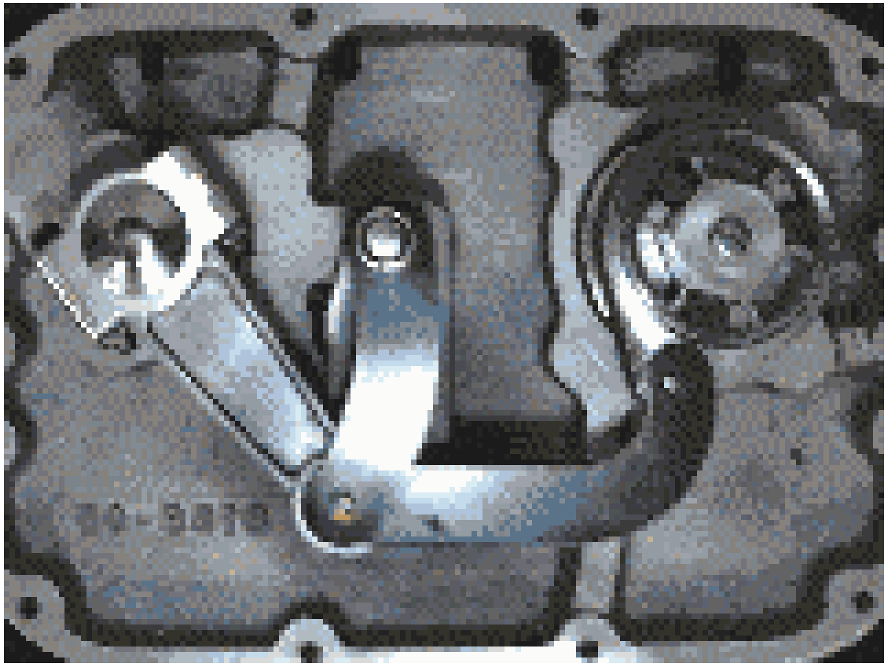


Image courtesy of Zero-Max, Inc.[5]

Design B: Electro-Mechanical

Image courtesy of Equipment Solutions, Inc.[6]

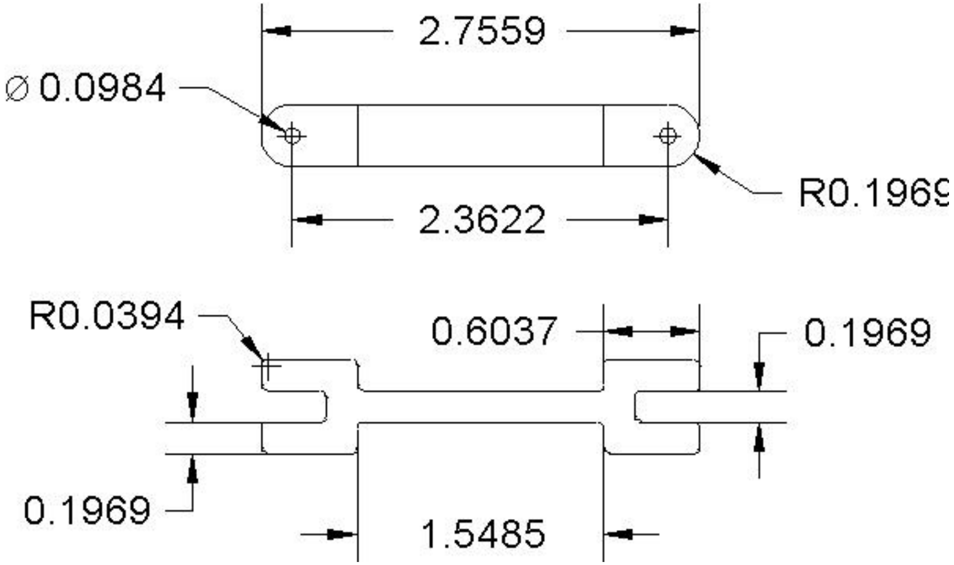
- Voice Coil System
  - Pros:
    - Electronic interface
    - Automatic feedback
    - Precision
    - Little maintenance
  - Cons:
    - Expensive
    - Interface must be programmed
    - Overheating (requires modification for use)

Decision

- Design A
  - Significantly less expensive
  - No heat difficulties
  - Simple intuitive interface
  - Can be manufactured by IIT’s Machine Shop

Progress

- Required capabilities and dimensions of components calculated
- Electric motor and power supply purchased
- CAD Drawings of Zero-max components completed, machine shop is making them



Future Plans

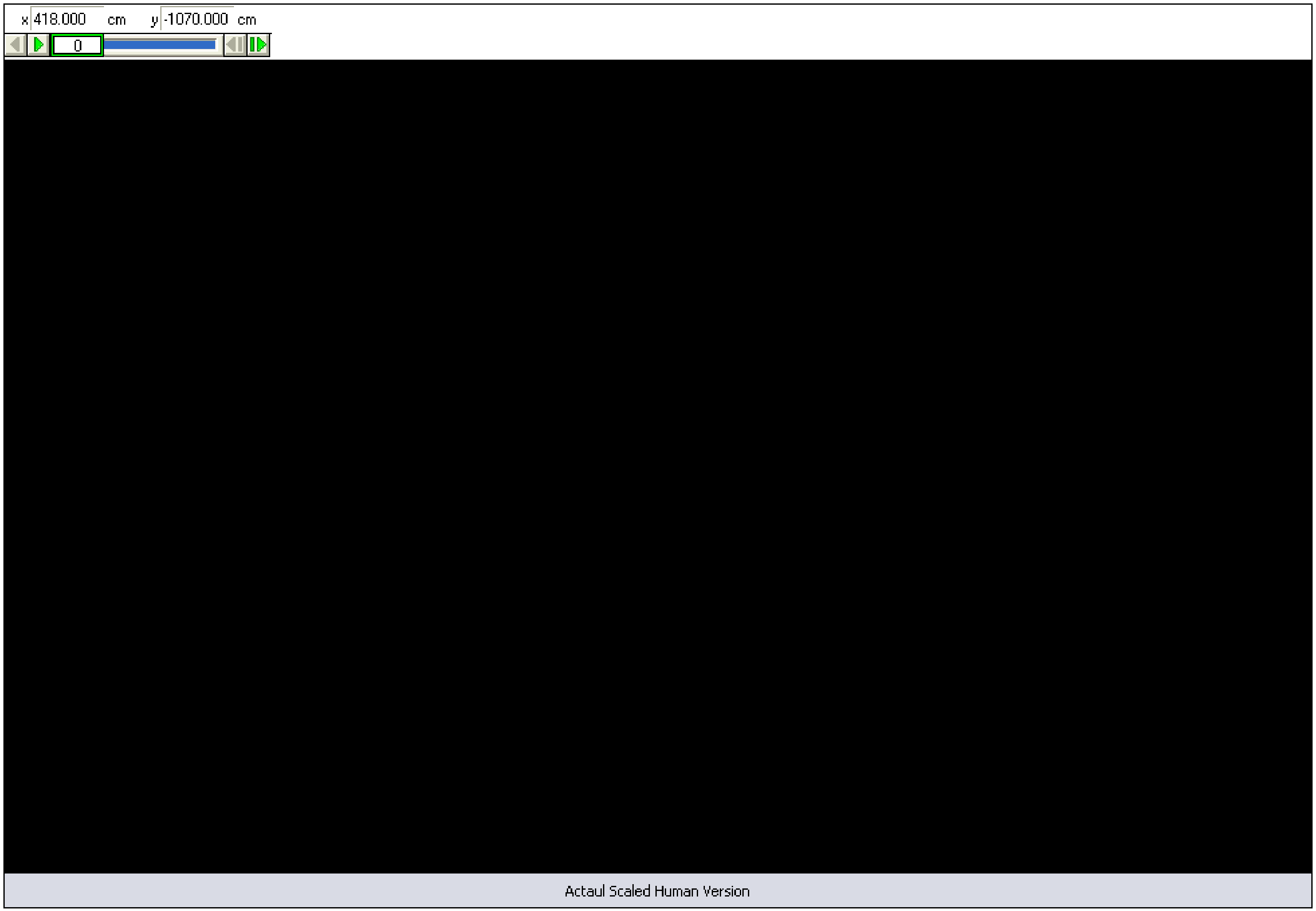
- Most components have been purchased. A suitable motor controller will be ordered, and the machine shop is creating the links for the zero-max assembly
- The components will be integrated into a prototype
- The prototype will be tested with weights or models until all bugs have been worked out and necessary modifications have been made
- The settings on the zero-max controller will be calibrated to correspond to Amplitude values
- A final working device and blueprints will be delivered to University of Chicago

Translational Research: Human Design

Subteam Project Goal:

- Goal:
  - Come up with a design for human testing
- **Possible Uses:**
  - Portable for paramedic use
  - Ambulance use for bridge to hospital care
  - Hospital use as integration with beds and monitors
  - Home and assisted living use as a bridge to defibrillation

Design Idea- Simple Crank System



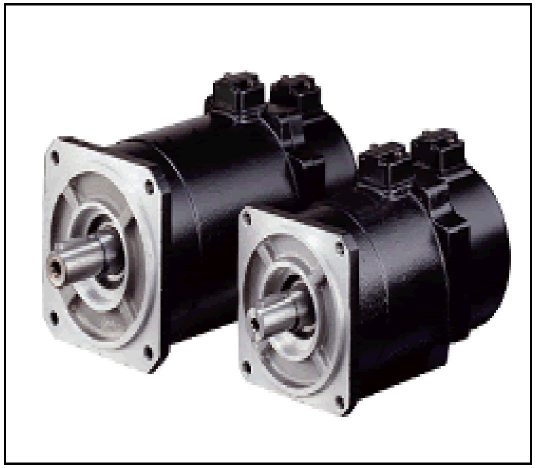
Design Guidelines

- Two Possible Implementations:
  - Portable-easy to carry
  - A “Built-In” solution for ambulances

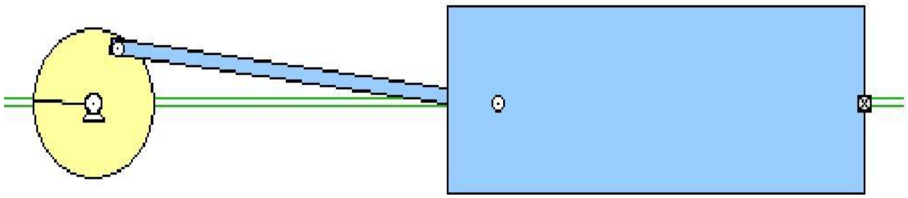
- Design must be user friendly
  - Paramedics and professionals should be able to operate the system quickly and with ease
  - Easy enough to use at home

Portable Design

- **Two separate units:**
  - Motor & foldable links
  - Stretcher and Rails
- **Each component is:**
  - portable
  - lightweight



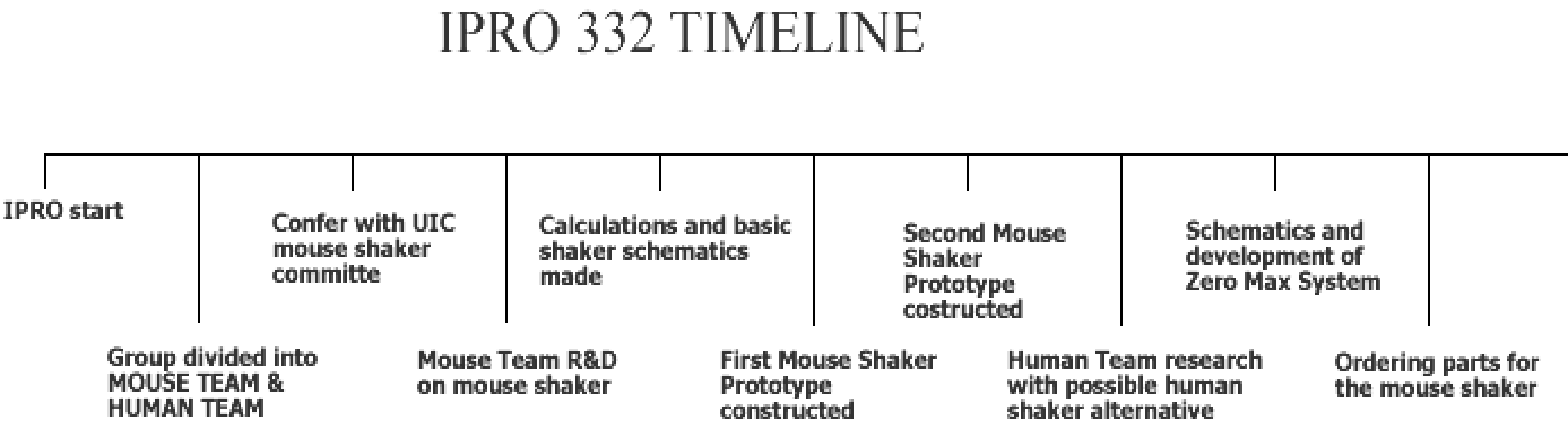
Power for the motor should be approximately 11.25 joules. (estimated from μ=.25 and weight = 450 kg)



Built-in Solution for Ambulance

- The stretcher base (holds the stretcher in it’s place) and the motor are mounted on the ambulance.
- The stretcher can be removed, just like how it works right now.

Future Plans



The test subjects as of right now are mice. Next step is to get the idea for the human version patented. Eventually, if the research shows hope, then we can work on trying to get FDA approval.

References

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