IEOR 170 Class Notes (2/25)
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today’s topics include straws and tablets

Assignment
● please continue using m-cafe
● the Torrance Test creativity test: with chalk - 10 minutes
● keep working on your project - next deadline March 18th
● homework: design a low cost musical device

Project Recap/Feedback
Father of Kindergarten Friedrich Froebel
● education theory (can use this as research for your reports)
● Started 1817 Switzerland
● Gifts & Occupations for kids to conceptualize 2D & 3D
● Led to a school of thinking
   ○ Design from 1st principles
   ○ Bauhaus School

Exercise: what you can do with a straw
  Torrance Creativity Test
  http://provensal.com/lbb/tag/torrance-tests-of-creative-thinking/

What is Sound? #physics
● a change in pressure in the air
  ○ pressure - Force/Area = Newtons/m^2 = 1 Pascal = 1 Pa
● ambient pressure in the atmosphere: 10^5 Pa
  ○ Ptotal (t) = pcost(ft) + AP
● low frequency sound absorbed
● high frequency sound penetrate
● \( \lambda = \frac{v}{f} = 340 \text{ m/s} \)
● smoke detector has high freq which is harder to hear
● bel: defined at the Bell labs
  ○ named after Alex Graham Bell 1928
  ○ \( B = 10 \log (p/20 \text{ micropascals}) \)
  ○ \( dB = 20 \log (p/20 \text{ micropascals}) \)
● decibels - the loudness/intensity of sound

Nest
the pros and cons
● you can wave it to turn it off
  ○ google guy who can't turn it off video
  ○ “easy” to turn off
● has a camera - is watching you #1984
● often malfunctions
● nice human voice
● location tag

Prof David Rempel [GUEST SPEAKER]
● Ergonomics
  ○ make sure people are working comfortably, present injury
  ○ ie. carpal tunnel - create tools to help this
● sound decibel
  ○ in the workspace - max 95 dB
    ▪ loudest sound on bart also 95
  ○ jet engine - 120 dB
● consulted for microsoft, apple, herman miller
  ○ apple stopped consulting them and their mice sucked
    ▪ ie. the puck (about the design not about the people)
● cable cutting - very dangerous job
  ○ apply 30-60 kg force or ~300 newtons
  ○ how to make this easier, less likely to be injured
    ▪ make it longer/bigger
    ▪ ratchet system - like a level system
    ▪ solution: battery cutter costs $1000 #dang
● pain related to computer use
- mean 4.5/10 (SD 2.16) pain scale
- >5 = medically important pain
- impeded some activity for some

- Human perception of sound
  - Differents from person to person
  - Different limits
  - Different ability to differentiate frequencies/pitch

- Tools for design
  - physiology/Sensors
    - Energy used, pressure on muscles, etc
  - biomechanical models
    - joint torque - load around torque due to being pulled down by gravity
      - torque about cervical spine
- muscle loads
- epidemiology
  - workplace intervention studies - random trials
- human factors engineering
  - anthropometry
    - designing a chair to fit the mean of the population
  - usability evaluation
    - asks: what do you prefer in a tool design
      - used by the industry a lot (ie. apple)
- Design through empirical experiments
  - using tools above
  - examples below
  - test different models/prototypes & their effects
- Balancing between
  - Cost & Effectiveness
  - Fatigue & Productivity
  - Specifications & Independent Variables
    - what your contracter fixes for you
    - what you can play around with
- Problem 1: Dental Hygiene
  - when the dentist scrape off the plaque on your teeth
    - for the health of patients
  - tools: sharp knife at the end
    - pull on it against a tooth
    - pinch it like a pencil and rotate their forearm to scrape it or use fingers or hand
  - problem: dental hygienist has high carpal tunnel risk (pinch force)
  - solution:
    - from free body diagram
    - calculate the (pinch force required to hold the tool + force to scrape) * safety factor
      - safety margin = 2-5 times the required force
    - try to minimize this. calculating this requires experiments:
      - experiments to calculate this
        - tool diameter is a factor
          - why it works: smaller diameter causes fingers to overlap, preventing further pressure
          - 10mm is ideal
        - weight is another - make it lighter (down to 15 grams)
          - decrease the pinch force
      - example: periodontal curettes
- Problem 2: Overhead drilling
  - problem:
have to drill upwards to the ceiling which mostly concrete
have to hold the hand drill up (50lb weight)
noisy, vibrating tools, dust in face, fall off ladder possibility

ideas on how to solve this problem:
- taller ladder - closer to the drilling point

solution:
- inverted drill system (example pictures)
  - big wheels, easy to move
  - vacuum mounted on the bottom for dust collection
  - industrial, very durable

result:
- less hand force
- minimized fatigue

project was successful, they took on bigger, louder drills
- universal drill jig

Problem 3: Tablets

problem:
- holding it with hand when working
  - what size is good? what are the tradeoffs?
  - more information (screen size) vs harder to hold up

experiment
- ask students what they liked best
- experiment discarded the larger size, too heavy to hold

Problem 4: Keyboard

carpal tunnel syndrome
- tendons swell
- put pressure on the nerve > lose sensation to thumb, index and middle
- pathophysiology
  - injected dye inside
- instrumentation
  - measured via 1mm saline filled catheter
    - kept it in 4 hr and had them do maneuvers with their hand
    - pressure rises when your hand is extending or flexing or pronation/engineering/computers) / supination (waiters)
    - typically at 28 degrees in daily life

examples: microsoft keyboard, mouse

Problem 5: Design of International Space Station

bay with drawers in corridor - a module
one of them is a glovebox
  - enclosed space protected from contamination
human computer modeling
  - used those model to create the glovebox design, to fit the people on the ISS
tested on a mimicked microgravity flight

**In-class Exercise** (teams 1-3 and teams 4-7)
- what’s the next technology for human computer interaction - 3D gesture
  - ie. leap motion, kinect 2
- Finding a natural language
  - some intuitive
  - some difficult to agree on
- develop gestures for each of the following commands:
  - team 1-3
    - gesture on
    - gesture off
    - select single
    - open
    - close
    - undo
  - team 4-7
    - menu access
    - cursor control
    - save
    - delete
    - copy
    - find
- they interviewed sign language translators to figure out which signs are comfortable
  - more comfortable: fists; adjacent fingers doing the same things
  - least comfortable: some fingers are up and some are down; adjacent fingers doing different things
- exercise: if you put your pinky out, it flexes when you flex your other fingers