Sequencing the World of Possibilities for Energy & Environment

COEH 2009 Summer Institute

An Engineering Approach to Laboratory Ergonomics

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My background

- Lawrence Berkeley National Laboratory – 29 years
- Instrumentation engineer – systems design
 - Small computer controlled instrumentation
- Research laboratories
 - Air pollution monitors – laboratory and field studies
 - Nuclear radiation detectors – cryogenic and vacuum science
- Production engineering - Bioscience laboratories
 - Custom instrument invention and design
 - Production DNA sequencing
- Work closely with users to implement technology

Goals

- The ergonomics problem at LBNL/JGI
- Define “engineering” at LBNL and the biotech lab environment
- Describe engineering in the context of an ergonomics program
- Review examples of engineering projects
 - Range of projects from simple to complex

48 Recordable Injuries FY08

Recordable Injuries FY08

- Musculoskeletal Disorder, Computer RSI
- Musculoskeletal Disorder, Lab RSI
- Musculoskeletal Disorder, not RSI
- Musculoskeletal Disorder, Slip/Trip
- Laceration
- Eye - Foreign Object
- Electrical
- Windblown Debris

The Problem - JGI Injuries

What is Engineering?

- Engineers design and build systems
- Engineers have technical skills, experience, and resources not available to the average person.

Computer Aided Design

SolidWorks or AutoCAD

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eDrawing

eDrawing

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CNC Machining

Software

- Commercial software interfaces
- Custom software – vb.net, perl, web forms, Oracle
- Machine control – Labview, assembly code, C

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Lab video

Laboratory Video

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454 Sequencing Sample Prep Laboratory

Custom Workbench

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Custom Workbench

Some Working Principles

- Engineering solutions, by themselves, will seldom solve an ergonomic risk exposure
 - Engineering systems can be defeated
 - Engineering solutions may substitute one risk exposure for another.
- Engineering solutions will only be successful as part of a overall culture of safety
 - Supported by upper management
 - Buy-in by operators or users of the technology
- Engineering solutions are expensive
 - Cost/benefit within the big picture
 - Often come with additional productivity benefits

Some Working Principles

- Use risk assessment to prioritize tasks
 - Cost, time, effectiveness, difficulty
- Ergonomics is part of the design and procurement process
- Ergonomics is part of process change control when introducing new technology
- Training on how to use technology
 - Biomechanics and body awareness
 - Best practices
- Engineering solutions are most effective when considered at the beginning of a project before injuries occur.

Scope of Work

- Laboratory work involves a diversity of tasks
 - Obvious problems - Tasks directly linked to injury
 - Extended pipetting
 - Hours of microscopy work
 - Not so obvious problems
 - Cumulative work load on body from a diversity of tasks
- Look at entire work environment
 - Many solutions large and small
 - Prioritize!

The Team

- Engineers
 - Mechanical engineering - Computer aided design/hardware
 - Software engineering - Computer programming for instrument control
 - Industrial engineering – workflow planning, ergonomics
 - Understand basic principles of ergonomics and human factors
 - Excellent people skills and organizational skills
 - Design for the most cost effective solutions
- Professional ergonomist – occupational therapist
- End users
- Management

Plating Tool

- The Plating Process
 - Demo of manual plating
- Risk assessment – Strain index handout
- Applied Ergonomics Conference 2007 Ergo Cup
 - Development (handout)
- Automated version
 - Process/training benefits along with ergo benefits
 - Video
 - <http://www.jgi.doe.gov/whoweare/plating/index.htm>

Automation platforms

- Hamilton Robot/454 Sequencing Enrichment Process
- Robot system driven by ergonomic concerns
- Ergonomic design suggestions
 - Industrial engineer, ergonomist

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454 Enrichment Process Automation

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Enrichment Robot Deck Layout

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Enrichment sample holder

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Door Handle

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Awkward Tip Waste Container

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Improved Tip Waste Solution

Hand Tools

- Hand tools are very challenging
- Requires buy in by users
 - Weight
 - Tactile feel
 - Fit to hand
 - Too many opinions
- Easy to defeat – don't use it
 - Best practices

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Thermal Cyclers

Unloading Thermocyclers

Do not use claw-grip. Unload with suction cup tool, while keeping your wrist in a neutral position (adjust the tool if necessary). Or use two hands to unload plates.

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Small Tools

Centrifuge – Gripping Buckets

- Maximum of 4 plates per bucket to avoid pinching.
- Only spin maximum of 16 plates at a time.
- Use a stool to reach the centrifuge IF necessary.

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Hand Tools

Prototyping

- Prototyping – costs/time
- Solid Concepts
 - www.solidconcepts.com
- Variety of plastic materials
- Plastic printers
- Casting

Unsealing Plates: What to Avoid

Do not unseal plates by hand.

Awkward hand postures cause strain,
and may eventually lead to injury.

Plate Peeler

- Development history
 - Risk assessment
 - Strain Index
 - Pliers
 - Holding fixtures
 - Prototype

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Plate Peeler Prototype

Plate Peeler

- Development history
 - Risk assessment
 - Strain Index
 - Pliers
 - Holding fixtures
 - Prototype pictures
 - First working prototype
 - Button modification
 - Additional work to fully automate

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Custom Engineered Plate Peeler

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Video

How to use the Automated Unsealer Button

Before

Use a “smiley face” grip, and use the flat part of the second joint of the fingers to press the button lightly

Use a fist to press the button lightly

Use the palm of your hand to press the button lightly, do not use finger tips or thumb

After

Loading Automated Unsealer

Before

Do not use a “claw grip” to load the plate into “It’s Appealing”

After

1. Pick up plate with both hands in a neutral posture.

2. Support the plate with your index finger.

3. Using your index finger as a support, slide the plate on the stage.

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End

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DNA Sequencing Laboratory

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DNA Sequencing Laboratory

Loading the Centrifuge

Before

Avoid reaching or using awkward hand postures. Load no more than 4 sealed plates or 5 unsealed plates per bucket to avoid pinching the bucket.

Load buckets closest to you, use neutral posture. Rotate carousel to bring slots closer to the front.

After

Loading/Unloading Platemates

Before

After

Adjust the height of the platemates and load only 11 plates at a time.

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Plate Loading

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