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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

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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

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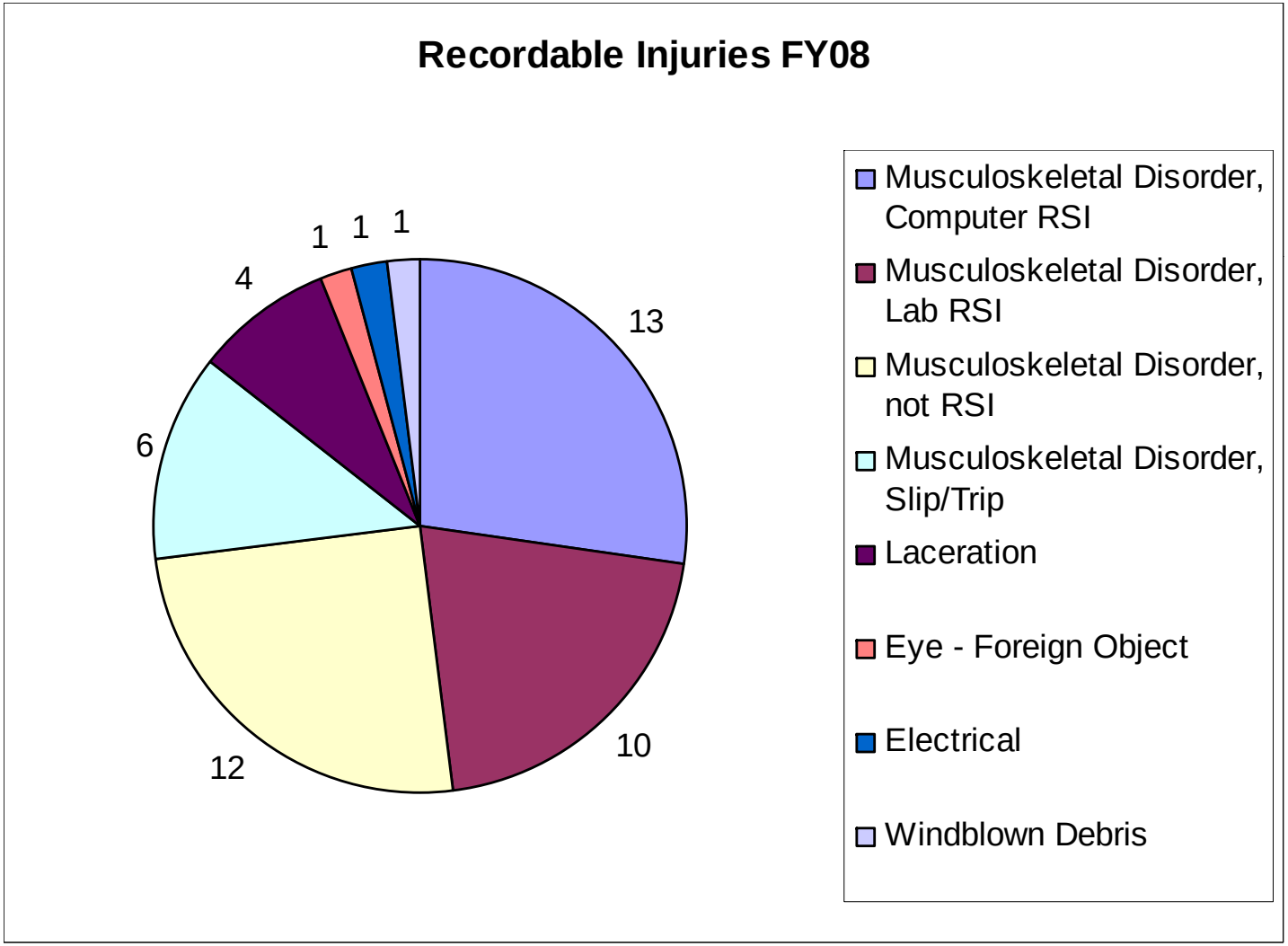
48 Recordable Injuries FY08



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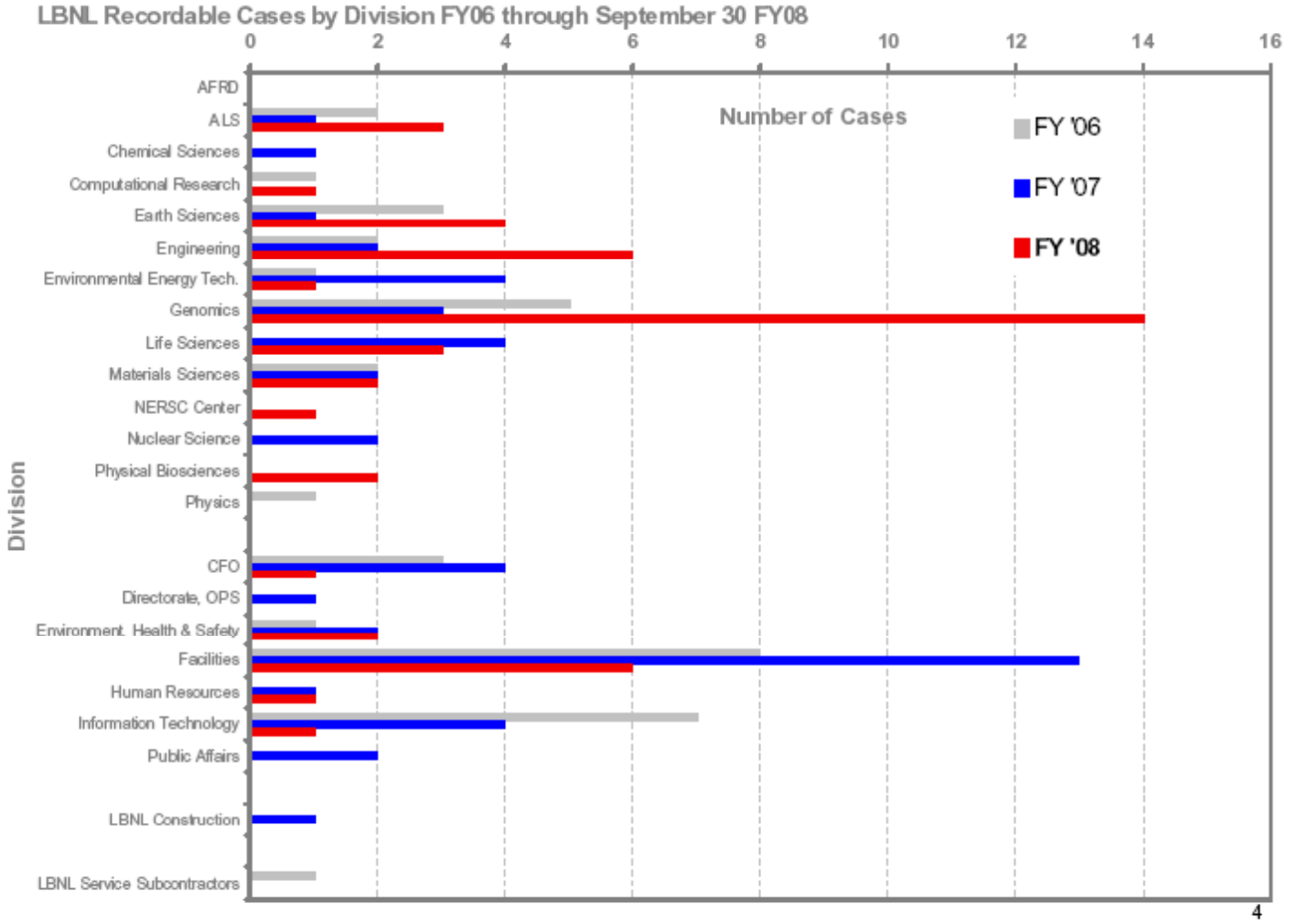
The Problem - JGI Injuries



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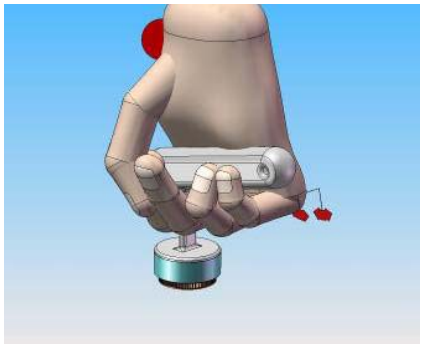
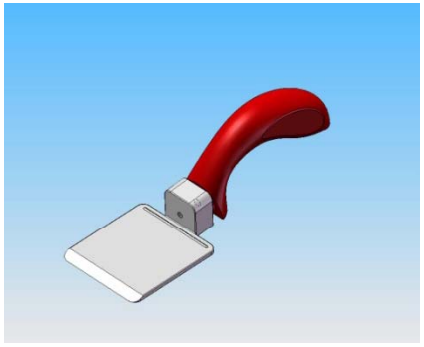
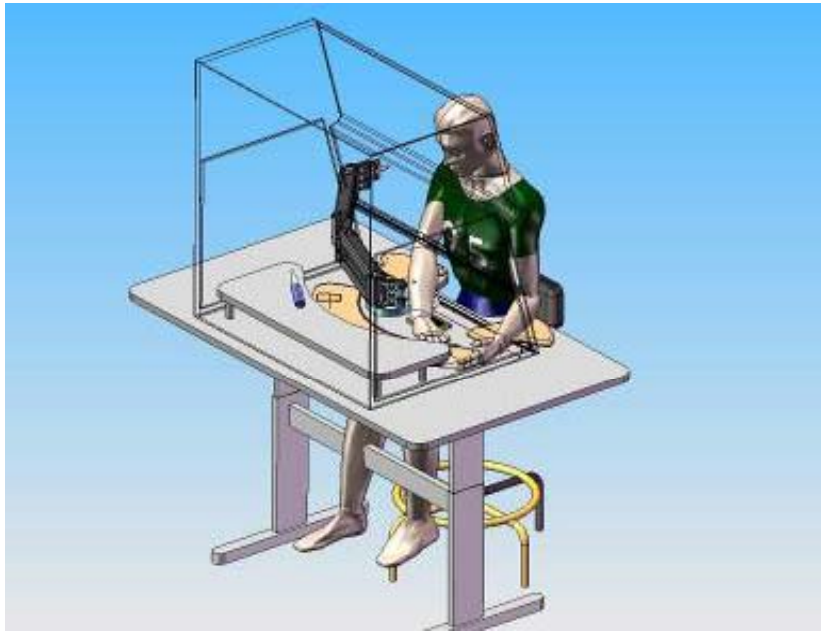
What is Engineering?

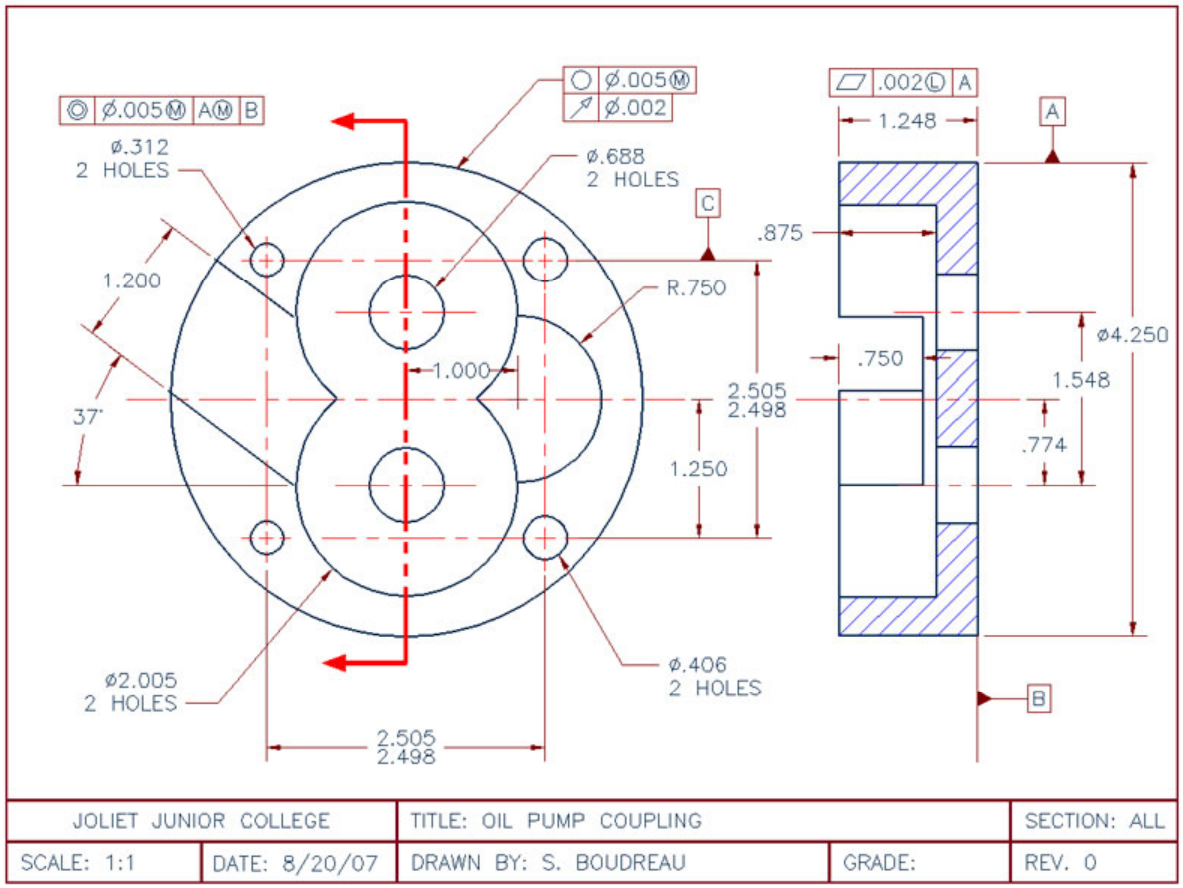
- Engineers design and build systems
- Engineers have technical skills, experience, and resources not available to the average person.







Computer Aided Design



SolidWorks or AutoCAD

eDrawing

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CNC Machining

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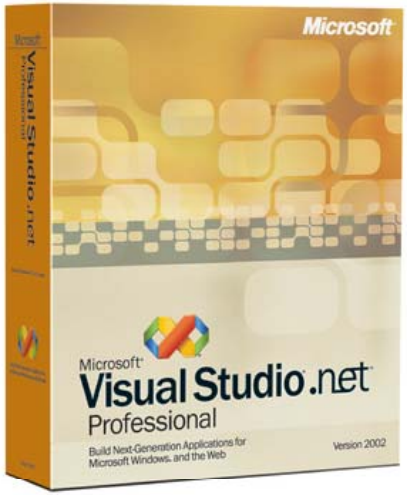
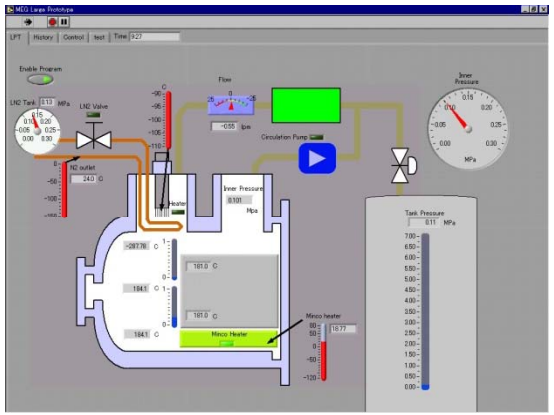
Software

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





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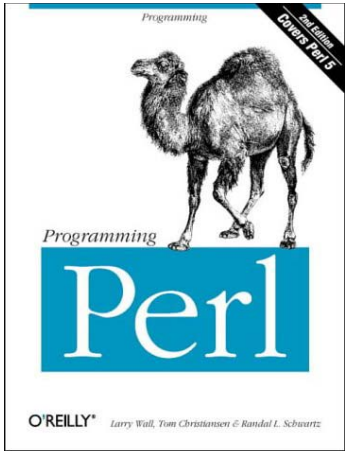

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Lab video

Laboratory Video

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454 Sequencing Sample Prep Laboratory

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Custom Workbench

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Custom Workbench

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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

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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.

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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!

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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

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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.html

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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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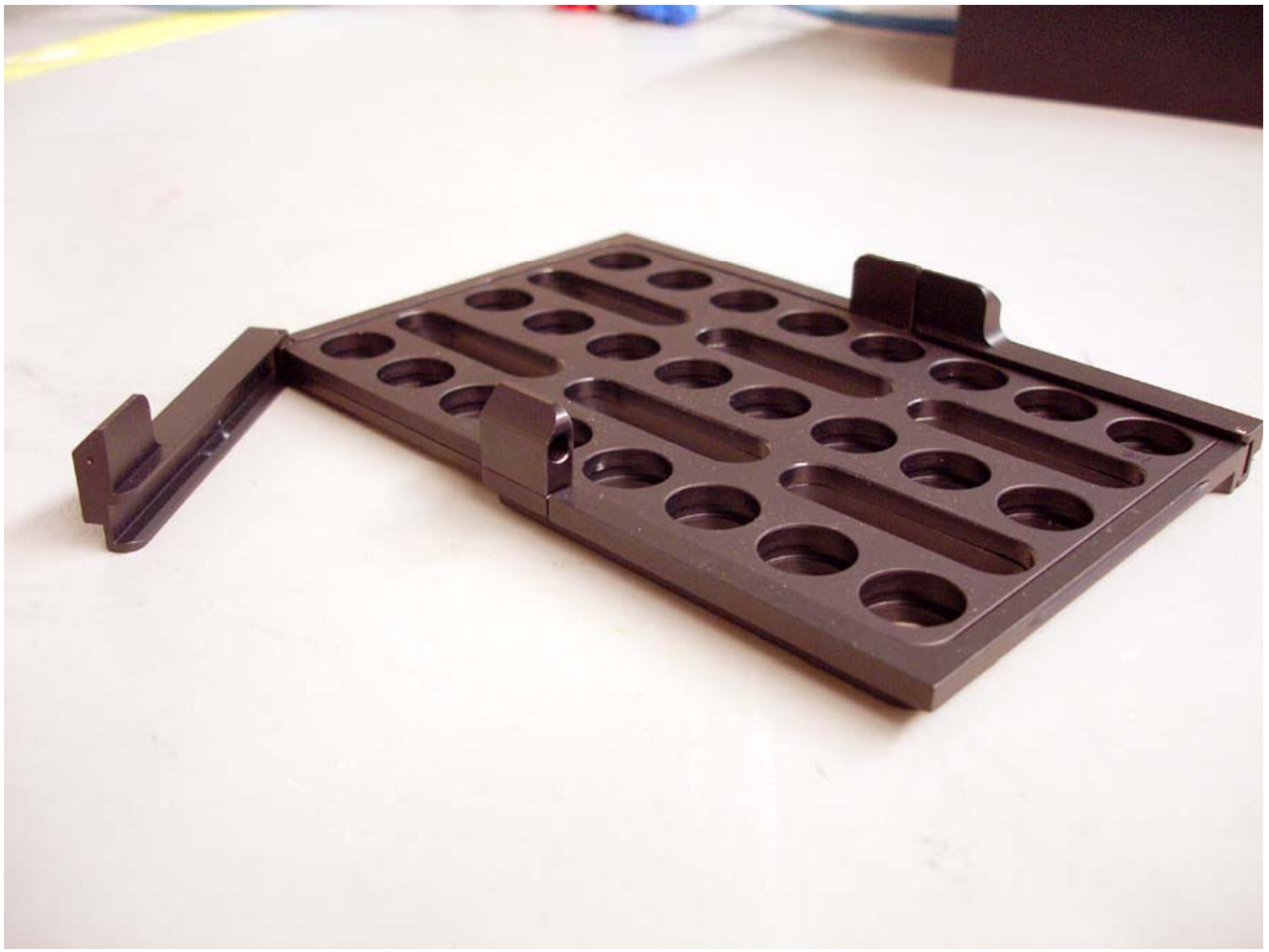
Enrichment sample holder



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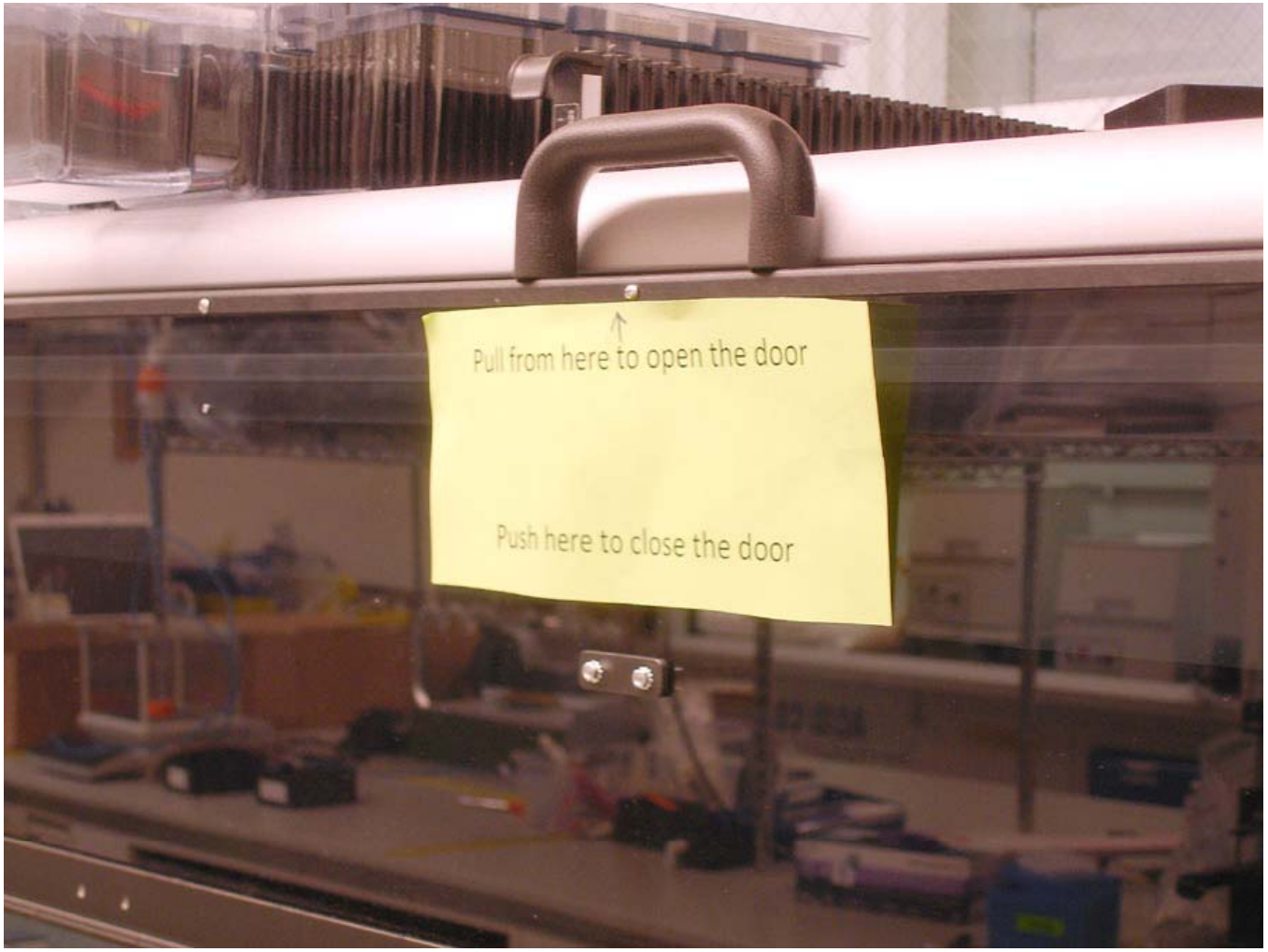
Door Handle



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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

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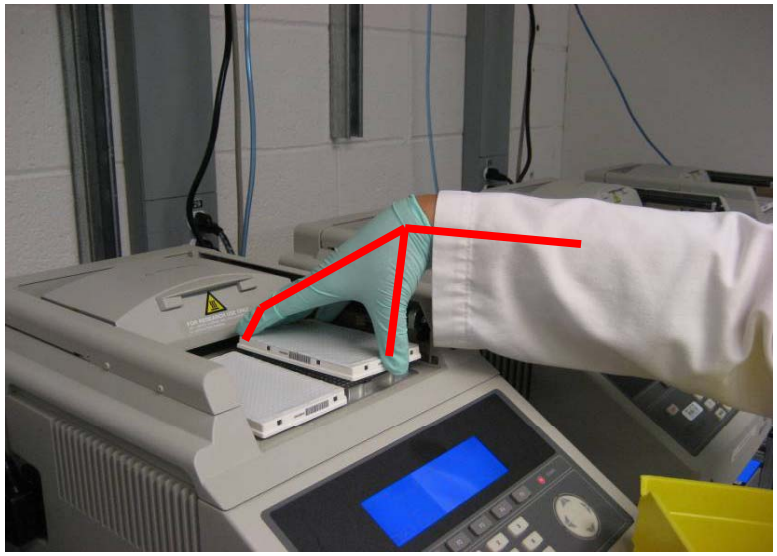
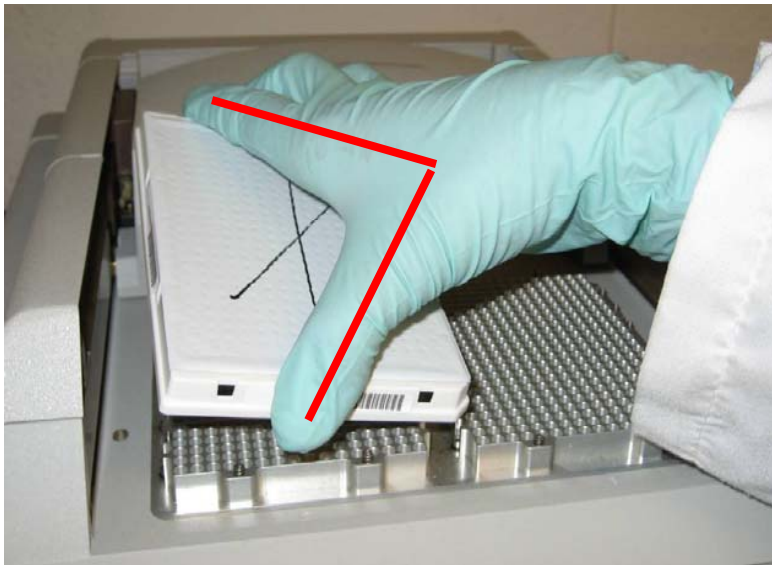
Unloading Thermocyclers





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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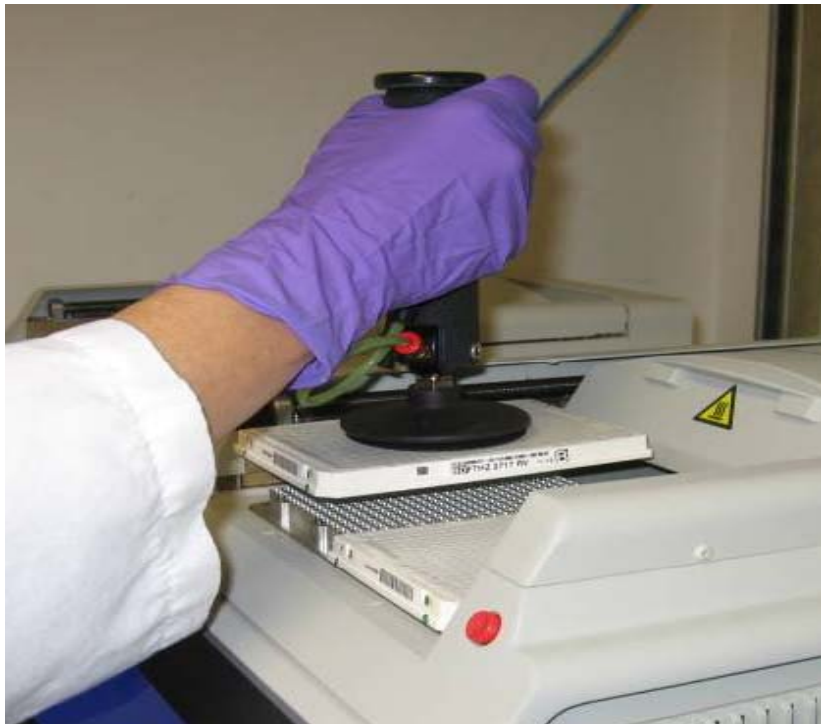
Small Tools



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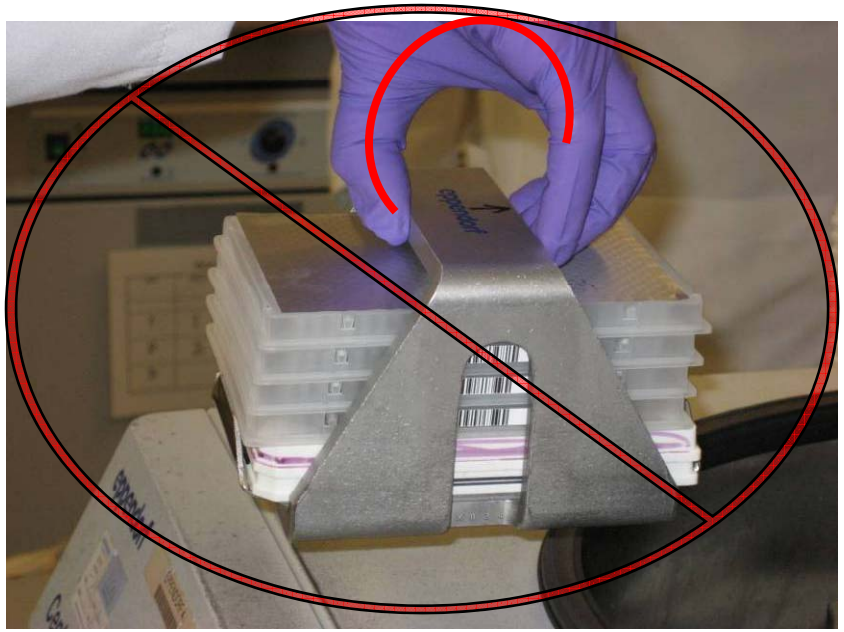
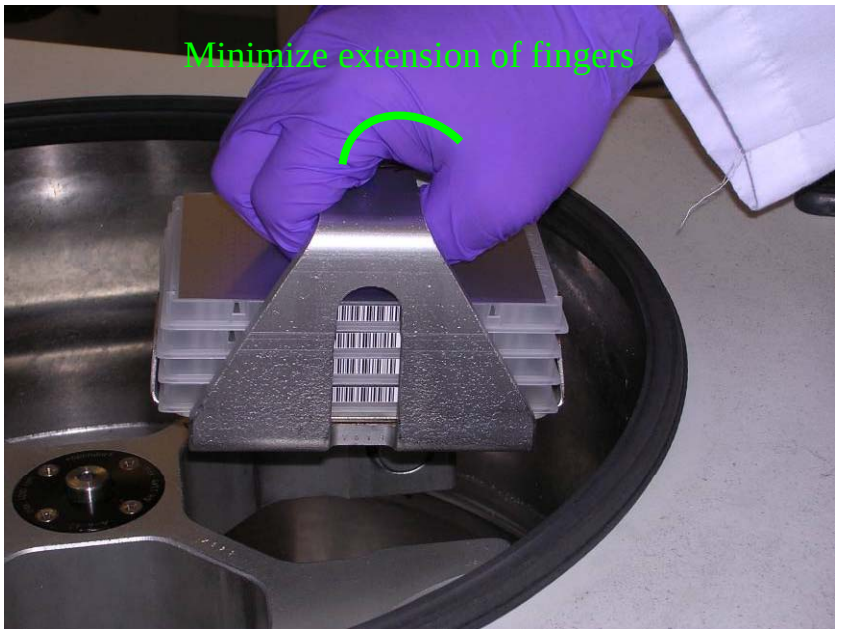
Centrifuge – Gripping Buckets





- 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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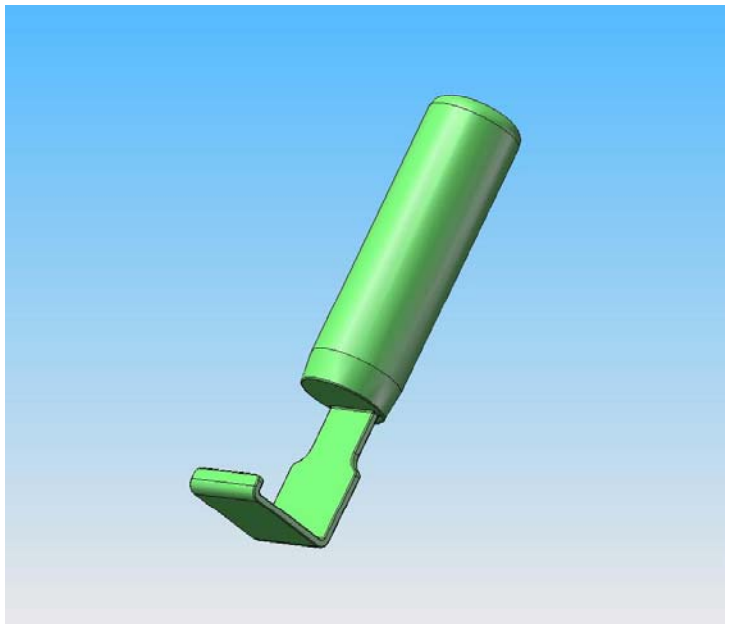
Hand Tools



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Prototyping

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

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Unsealing Plates: What to Avoid

Do not unseal plates by hand.

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

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Plate Peeler

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

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Plate Peeler Prototype

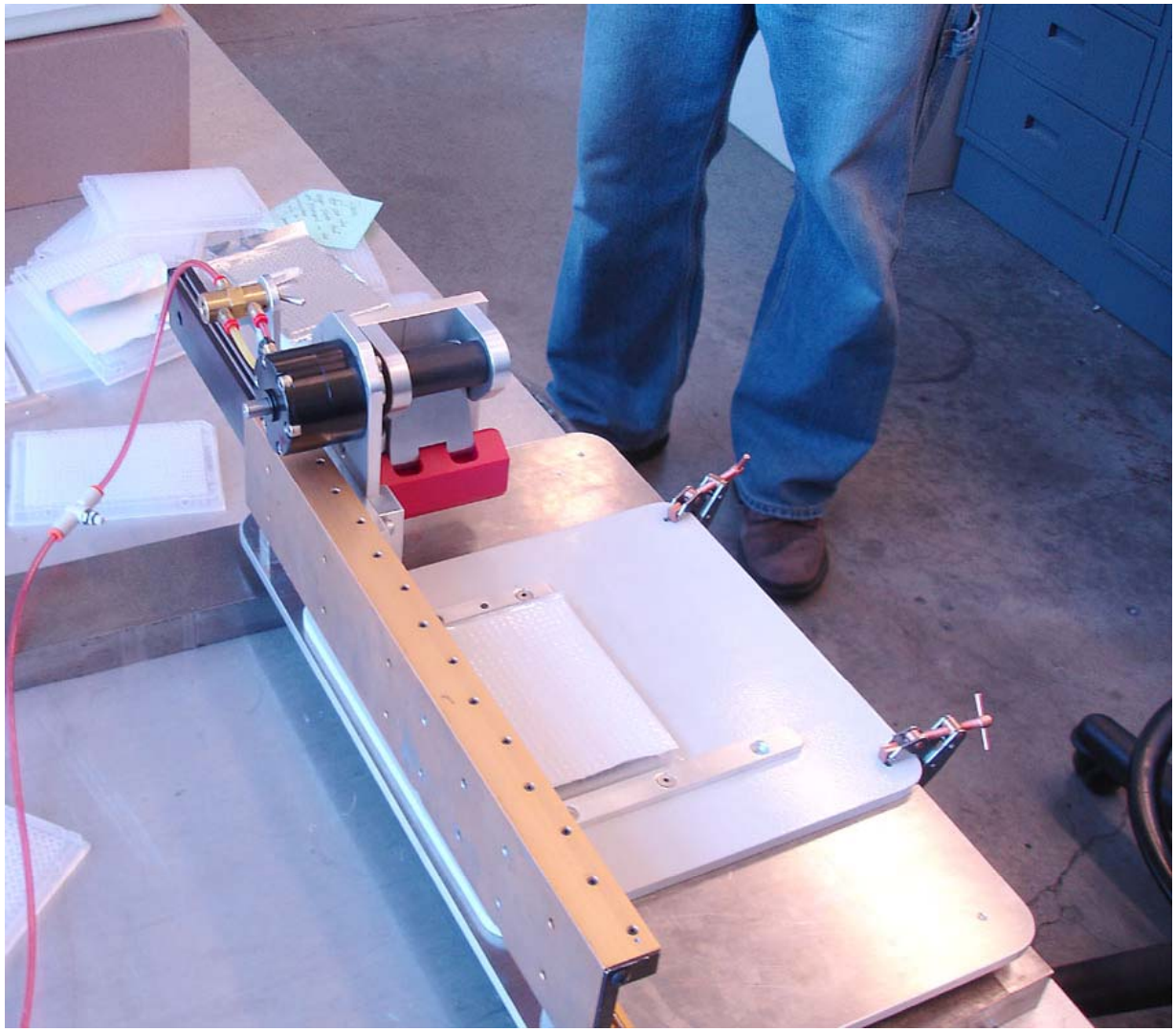

Plate Peeler

- 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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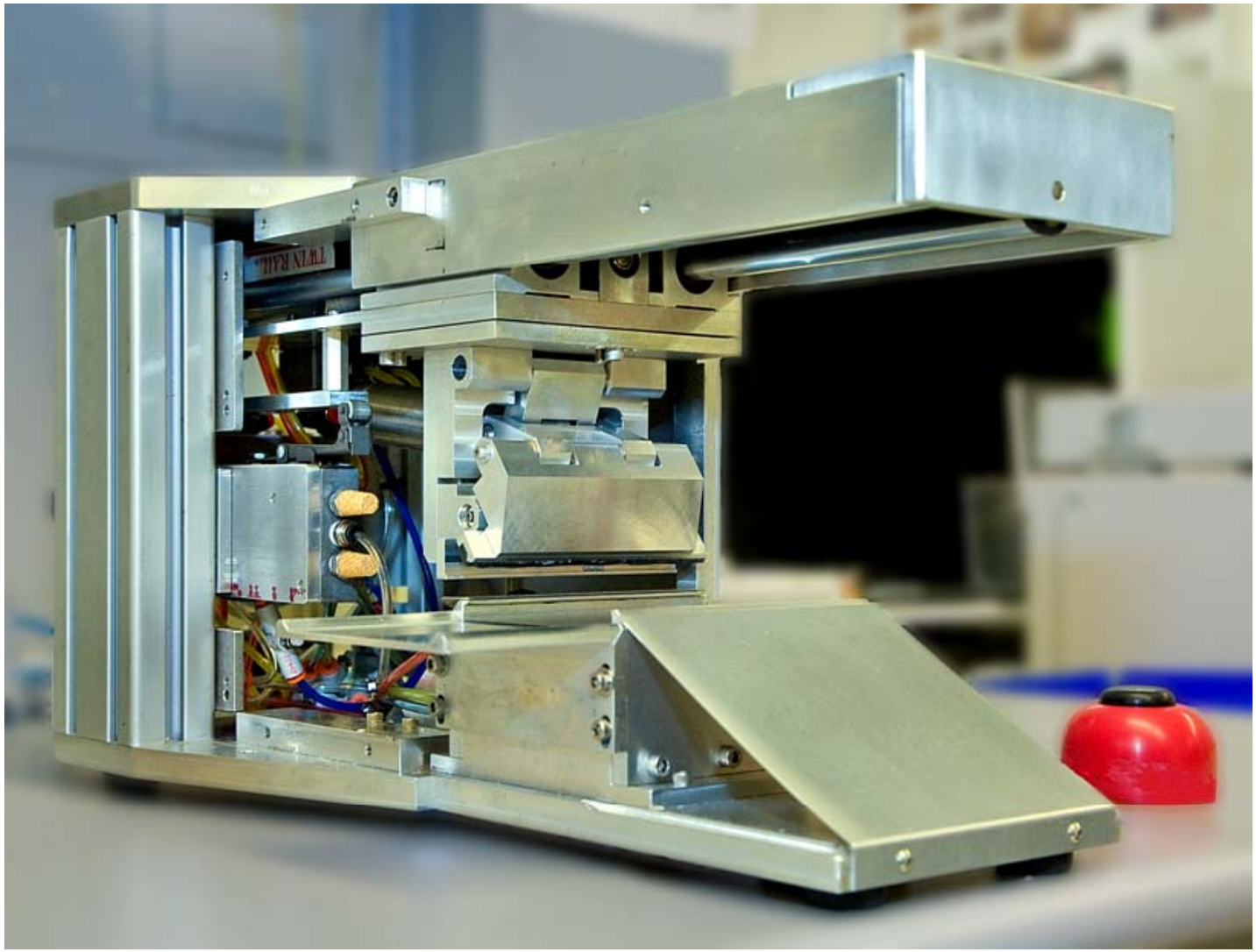
Custom Engineered Plate Peeler



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Video

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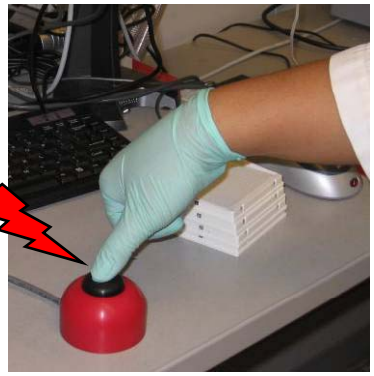
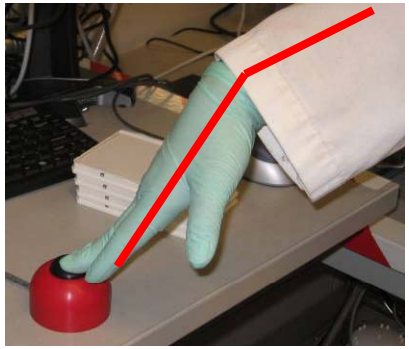
How to use the Automated Unsealer Button

Before



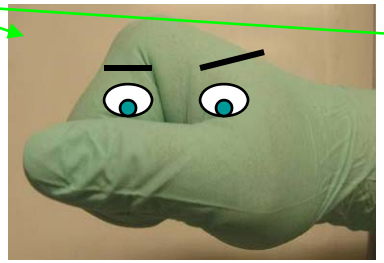


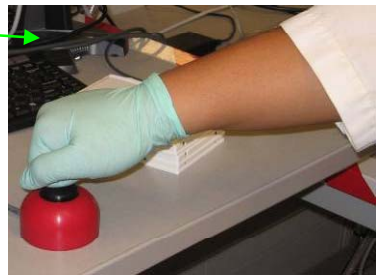
Use a “smiley face” grip, and use the flat part of the second joint of the fingers to press the button lightly

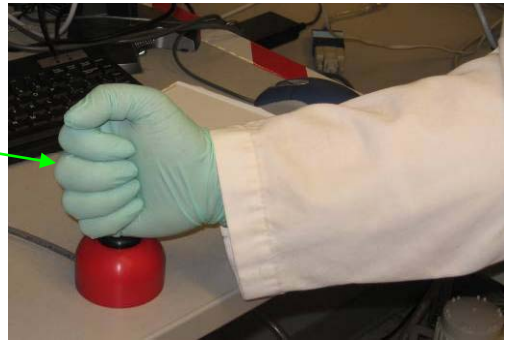
Use a fist to press the button lightly

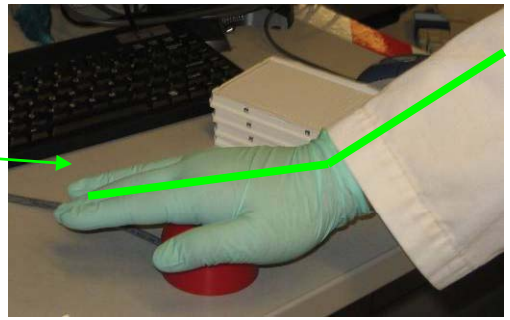
Use the palm of your hand to press the button lightly, do not use finger tips or thumb

After









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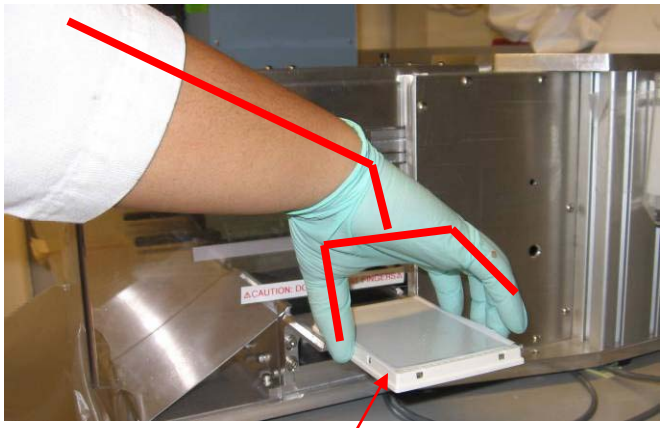
Loading Automated Unsealer

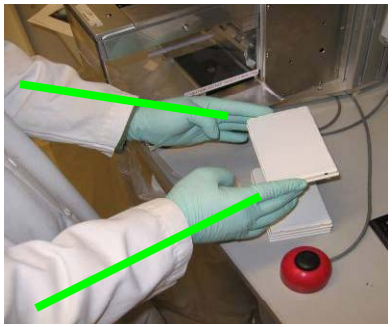
Before



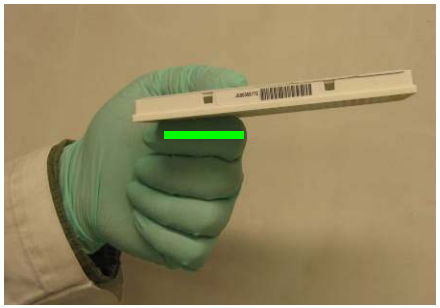
Do not use a “claw grip” to load the plate into “It’s Appealing”

After

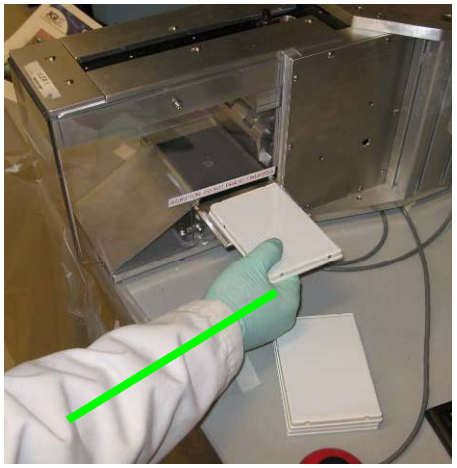
1. Pick up plate with both hands in a neutral posture.



2. Support the plate with your index finger.



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



End

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DNA Sequencing Laboratory

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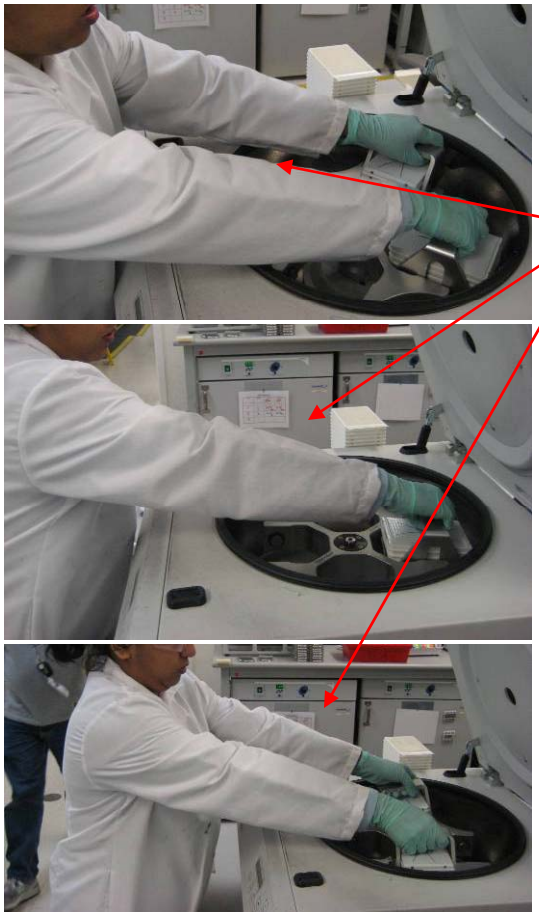
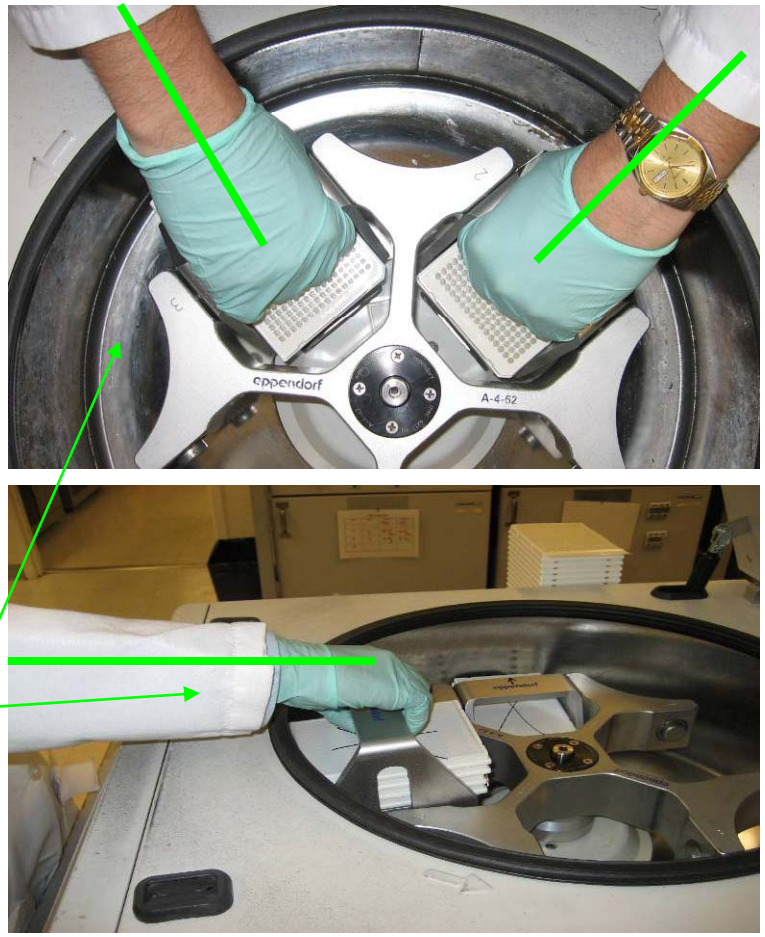
Loading the Centrifuge



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.



Before

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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