68K Blade Process Handling

Courtesy of TECT Power

Team 09

Michael Brantley[2], Ryan Ferm[2], Jason Newton[1], Nadia Siddiqui[2]

[1]*Department of Mechanical Engineering, Florida State University, Tallahassee, FL*
[2]*Department of Industrial Engineering, Florida State University, Tallahassee, FL*

Overview

- Introduction to TECT
- Problem Overview
- Design Concepts
- Design Analysis
- New Process
- Summary
- Acknowledgements

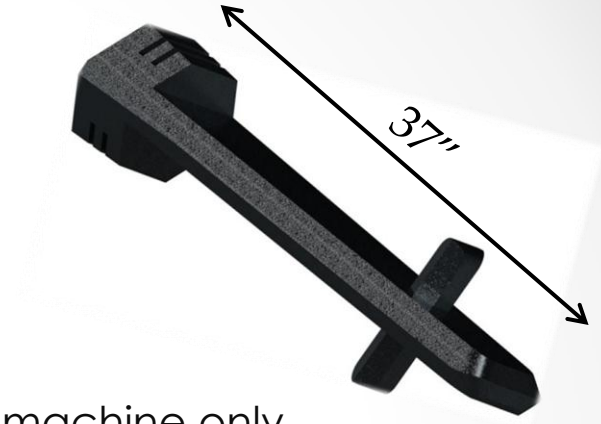
Introduction to TECT Power

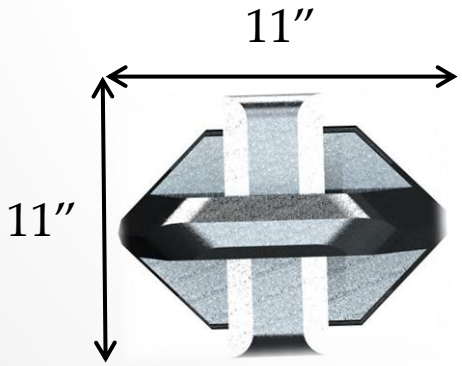
- Company Overview
  - Located in Thomasville, GA
  - TECT – Turbine Engine Component Technologies
  - Contracted to manufacture components
    - Customers: GE, Pratt and Whitney, etc.

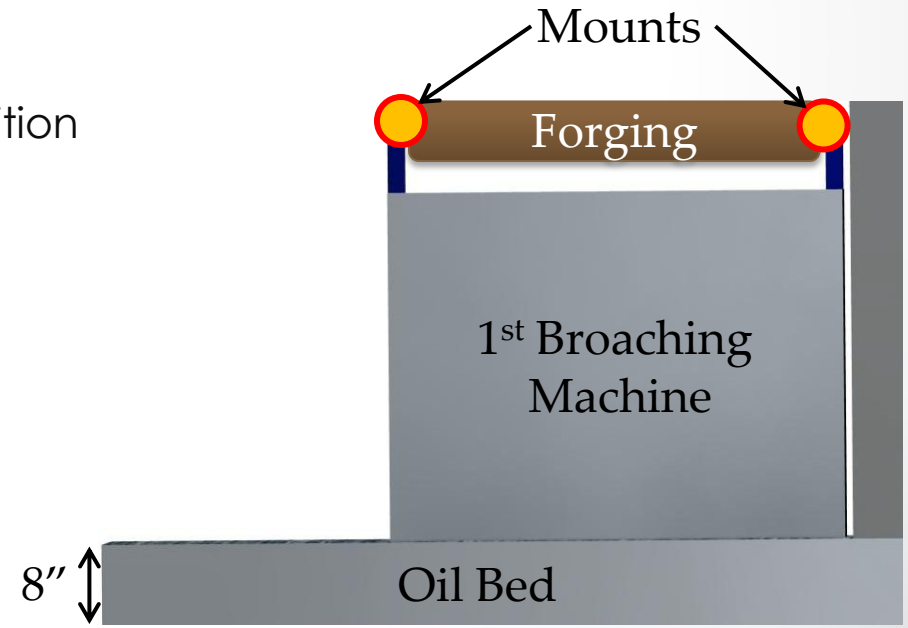
- Sponsor: Ashok Patel
  - Industrial Engineer
  - Environmental Health & Safety Manager

Introduction to TECT Power

- Our Focus
  - 68K Forging Process
    - 45lb per when received
    - Approximately 3 feet long
    - Can approximate as 11x11x 37 inch box
    - Concerned with process for first broaching machine only
  - 1st Broaching Machine
    - Placed on 8 inch oil bed
    - Holds blade in horizontal position

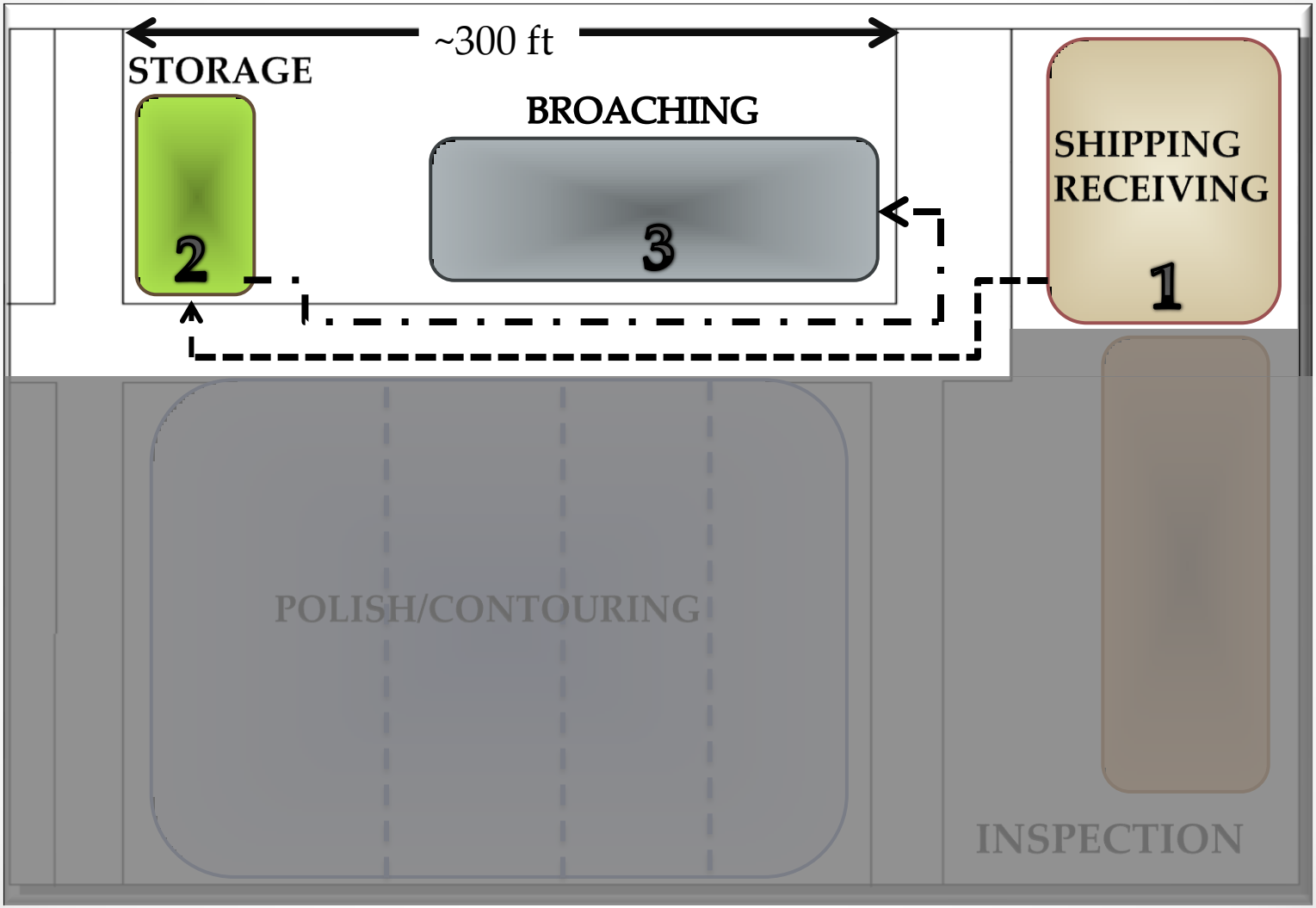






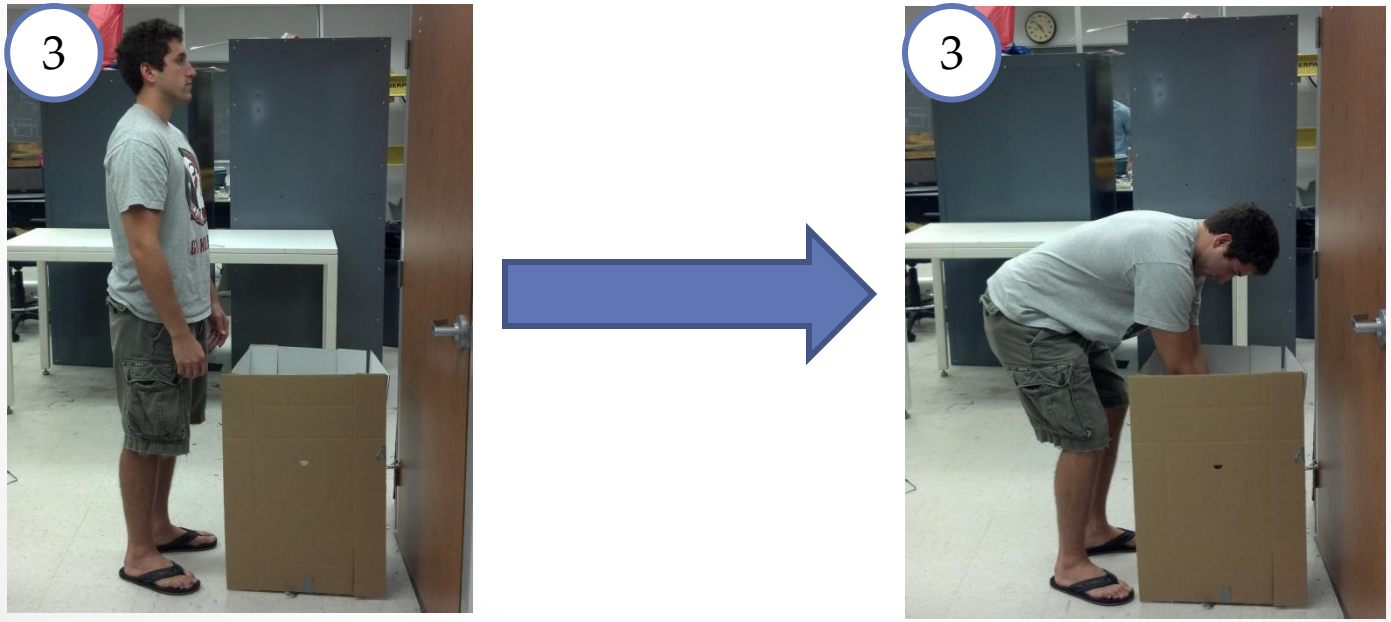
Introduction to TECT Power

- Plant Layout



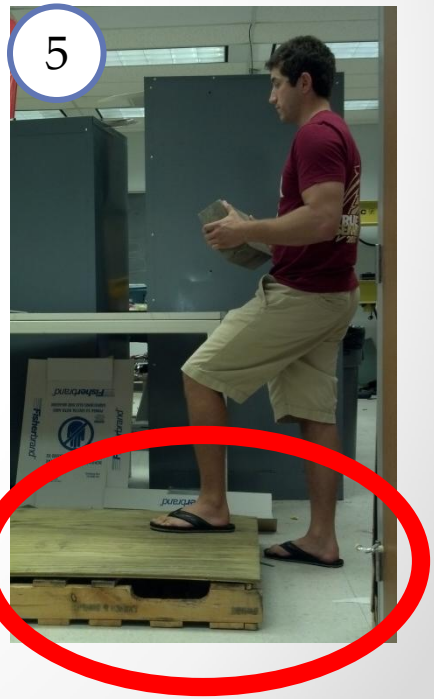
Current Process

1. Forgings received in unorganized container
   - Tangling occurs
2. Forgings placed in cluttered storage area
   - Stored at ground level
3. Forgings manually removed by lifting
   - Approximately 30 inch container wall
   - Must be untangled



Current Process

4. Forgings manually loaded onto cart for transport
    - Certain carts require bending for forging placement
5. Forgings must be manually lifted from cart and placed onto milling machine
    - Forging is held while stepping onto elevated oil bed
6. The forging is then lifted out and returned to cart



Problem Overview

- Current Process Problems
  - Too much manual lifting
  - High risk of injury
  - Physically demanding
    - Operator exclusive
- Constraints
  - $2000 Budget
  - No industrial crane placed at machine
  - Allow for operator maneuverability in work space

Assessment and Methods

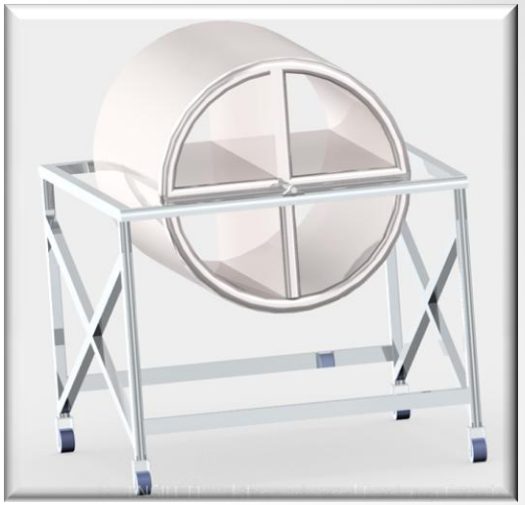
- New Design Must:
  - Reduce injury risk for employees
  - Eliminate Lifting from the process
  - Not require intense physical capability to perform
  - Hold a minimum of 4 forgings

- Methods:
  1. Redesign shipping container to prevent tangling
  2. Reorganize storage area to allow for easy access
  3. Design a method for transporting blades
  4. Design a method for loading and removing blades from broaching machine

Design Concepts - Carts

L-Cart

Barrel



LOADING

COMBINATION

STORAGE

Design Concepts - Variable Height Cart

- Hydraulic Lift Cart
  - Variable height mechanism
  - Make or Buy
    - Cheaper to purchase
    - Shorter manufacturing time
    - Warranty
  - 2000lb Capacity
  - Height Range: 30 inches to 48 inches
- Cart Top Design
  - Mounts to top of lift Cart
  - Holds four forgings
- Trays
  - Allow for protection of forging
  - Easy to slide forgings from cart
  - Raised section to hold blade for mounting
  - Slot for pivot

Courtesy of McMaster-Carr

Decision Matrix

Parameters Analyzed

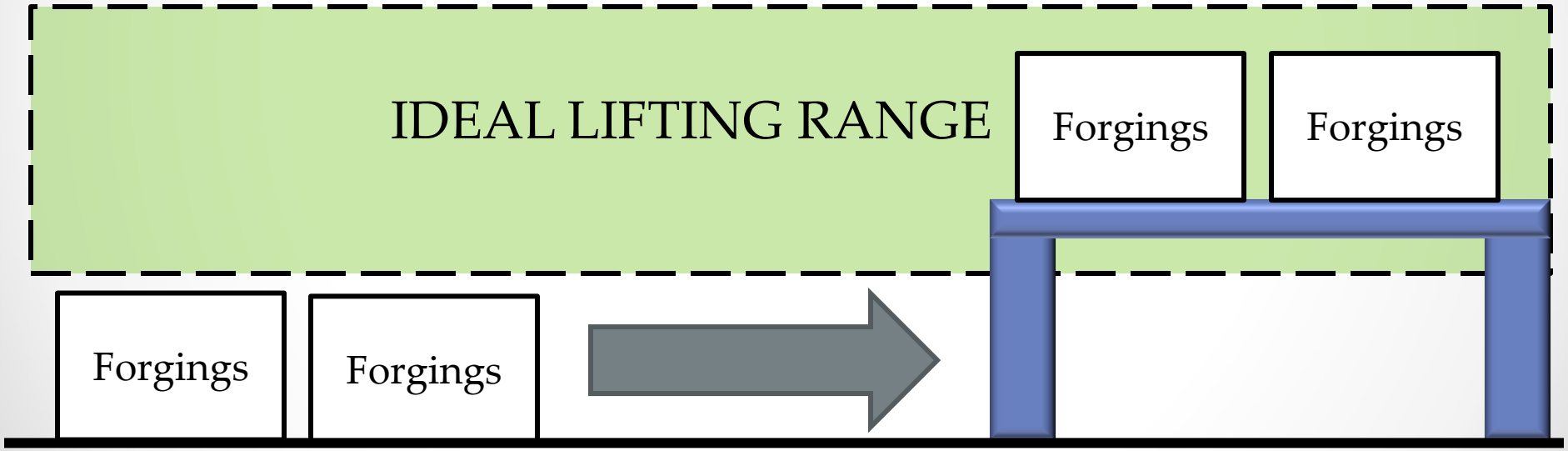
	Size (ft^2)	Cost (USD)	Force Req. (lbf)	Loading Time (min)	Forgings Held
Concepts					
Variable Height	8	~1700	25	~2	4
L-Cart	12.5	~1900	15	~1	1
Barrel Cart	8	~1200	45	~3	4

Decision Matrix

	Maneuverability	Cost	Safety	Productivity	Total (Max 50)
Weight	0.25	0.15	0.35	0.1	1
Concepts	-	-	-	-	-
Variable Height	7	4	9	7	35
L-Cart	4	3	8	8	25
Barrel Cart	7	7	3	5	30

Final Design – Storage Area

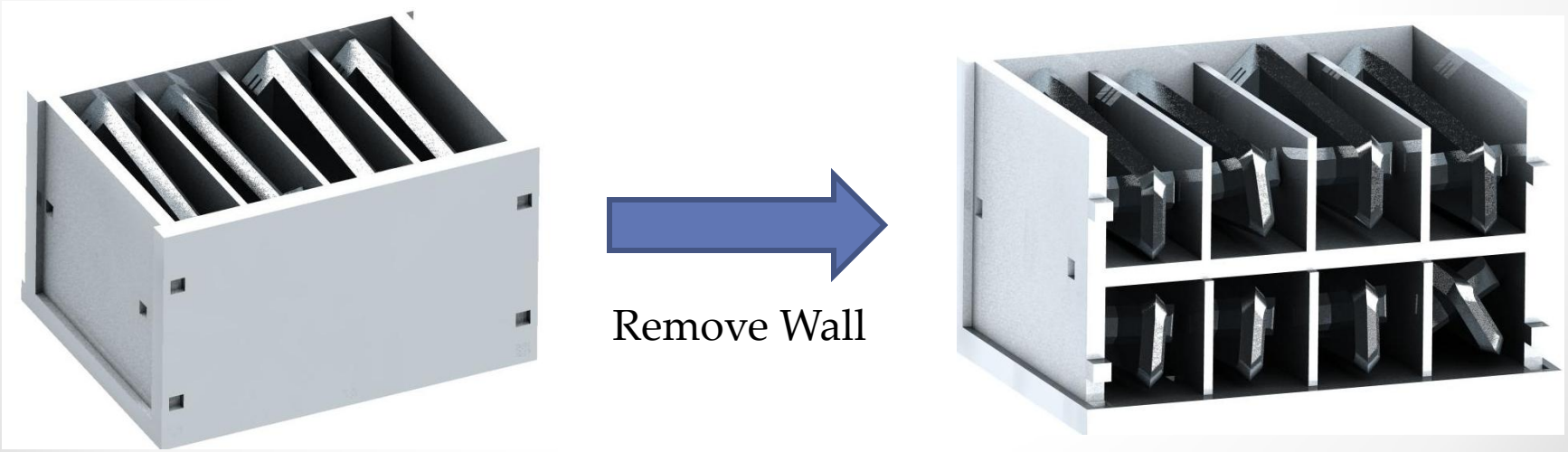
- Storage Area
  - Table to elevate containers to acceptable height
  - Two containers held per table
  - Helps to organize storage area



Side View

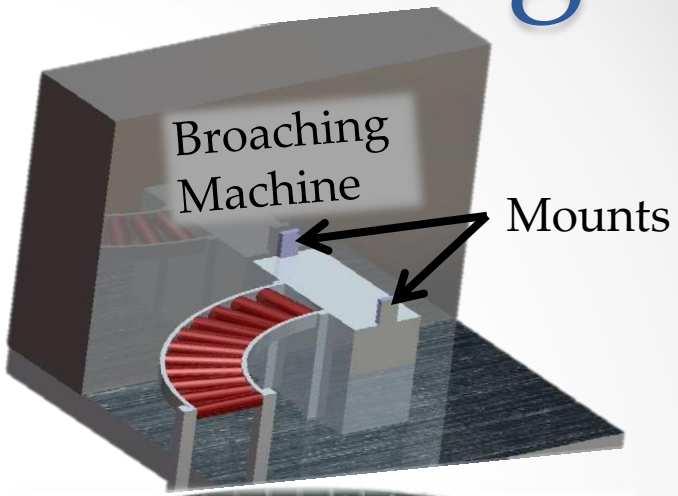
Final Design - Container

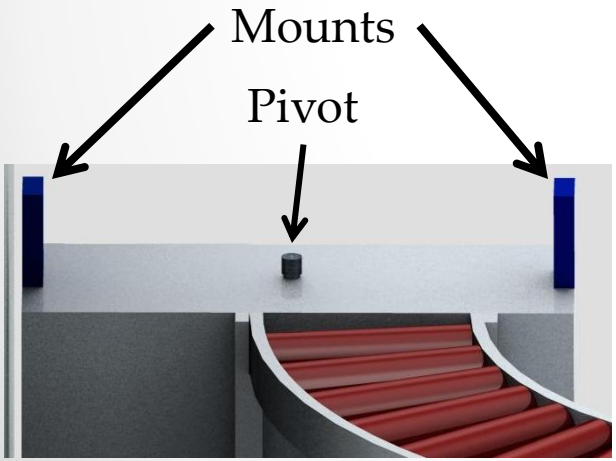
- Forging Container
  - Forgings held horizontally
  - Removable partitions allow easy removal
  - Two rows for increased storage
  - Total of 8 forgings
  - Ideally injection molded

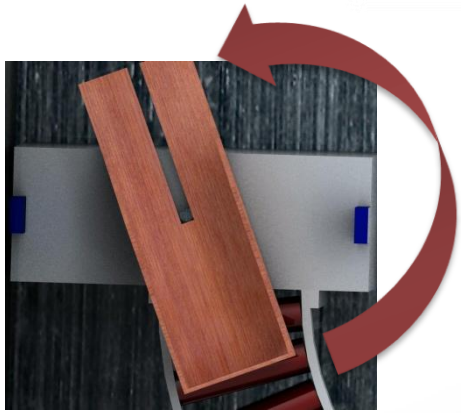


Final Design – Loading

- Curved Conveyor
  - Allows forgings to slide from cart top to mounting location
  - Bolted to oil bed
- Pivot
  - Prevents sliding over opposite side of machine
  - Tray is built to connect to pivot



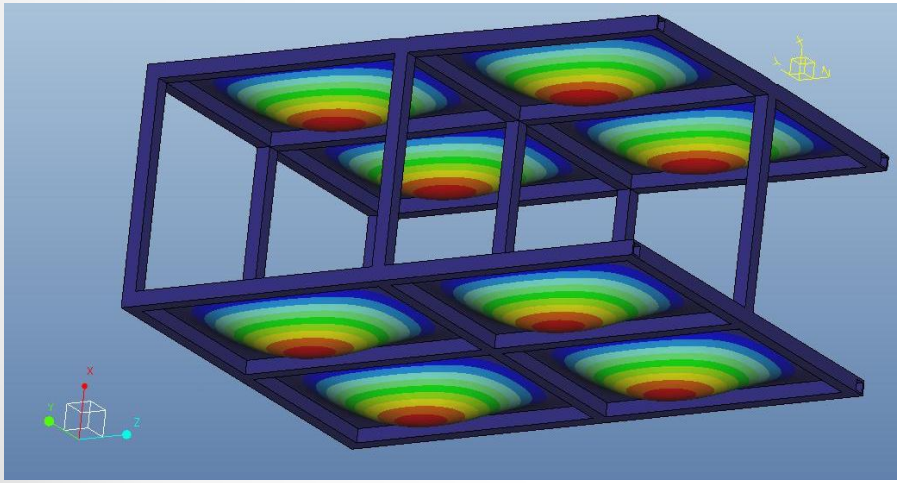




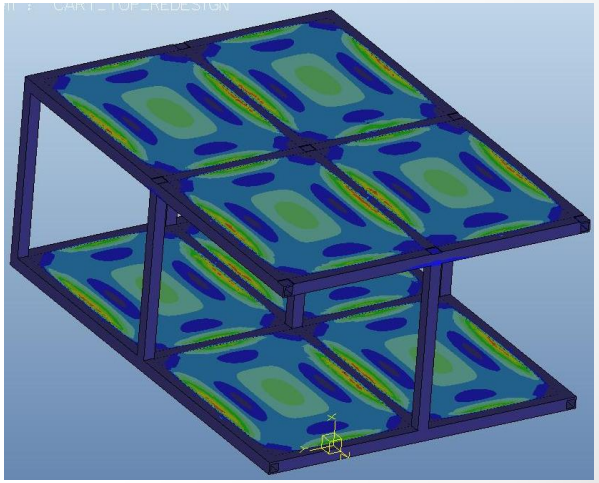
Final Design

Stress Analysis

- Pro Engineer – Mechanica
  - 150lb Distributed load over each cart level
  - Factor of safety of ~2
- Maximum Stress: 1.282 ksi
- Maximum Deflection 0.007325 inches



Displacement



Stress

RULA

- Rapid Upper Limb Assessment
  - Ranks process for safety
  - Based off of posture and limb motion

Current Process Results

RULA Score = 7

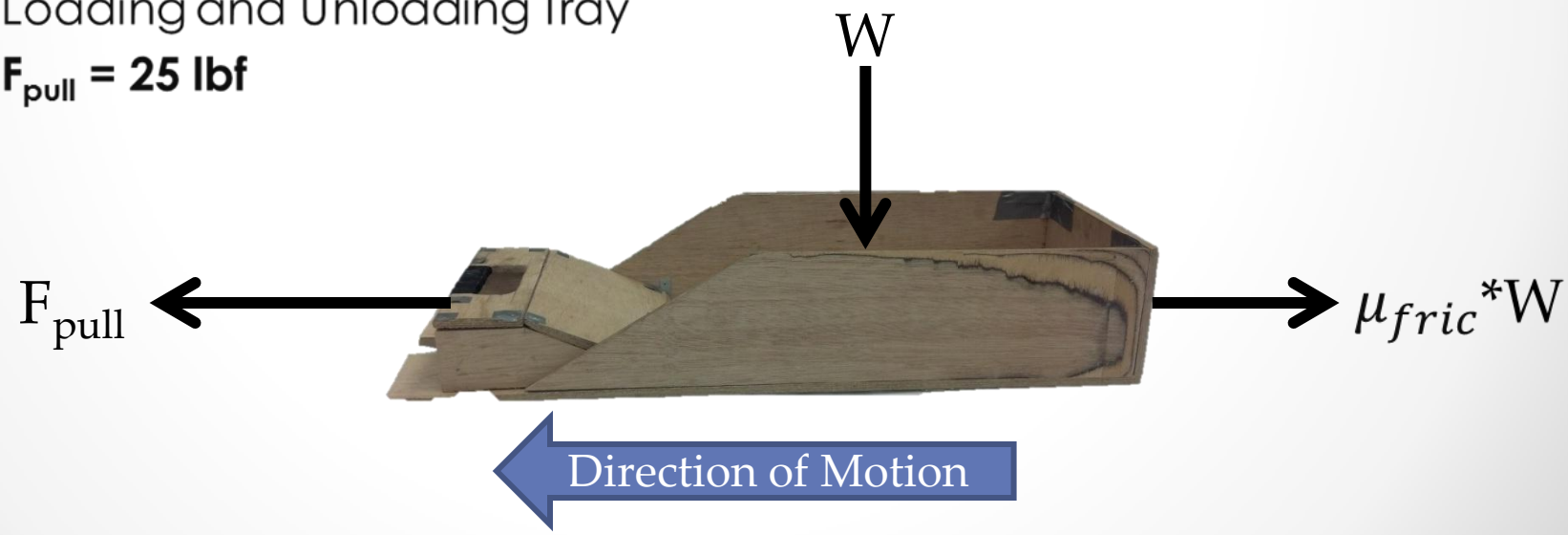
Improved Process Results

RULA Score = 3

RULA Score	Implication
1-2	Posture is acceptable if it is not repeated for long periods of time
3-4	Further investigation and changes may be required
5-6	Further investigation and changes are required soon
7	Further investigation and change immediately

Force Analysis

- Experimentally Calculated Friction Coefficient
  - Between Tray and Cart Top
  - μ_{fric} =0.50
- Force Calculation
  - Loading and Unloading Tray
  - F_{pull} = 25 lbf

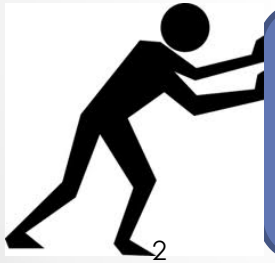


Psychophysical Analysis

- Liberty Mutual Tables
  - Push/Pull forces found from tabular data
  - Compare to experimentally calculated force

Liberty Mutual®

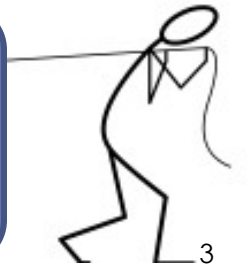
1



2

Maximum Push Force 59 lbf

Maximum Pull Force 57 lbf



3

Calculated 25 lbf

Courtesy of Liberty Mutual[1], Clker[2], & Flashpoint[3]

Project Cost

Product Description	QTY	Unit Price ($)	Total ($)
Raw Material	1	-	538.68
Hydraulic Cart	1	1437.19	1437.19
Curved Conveyor	1	160.53	160.53
Conveyor Stands	3	44.78	134.34
Subtotal			2270.74
Shipping			282
Total			**2552.74**

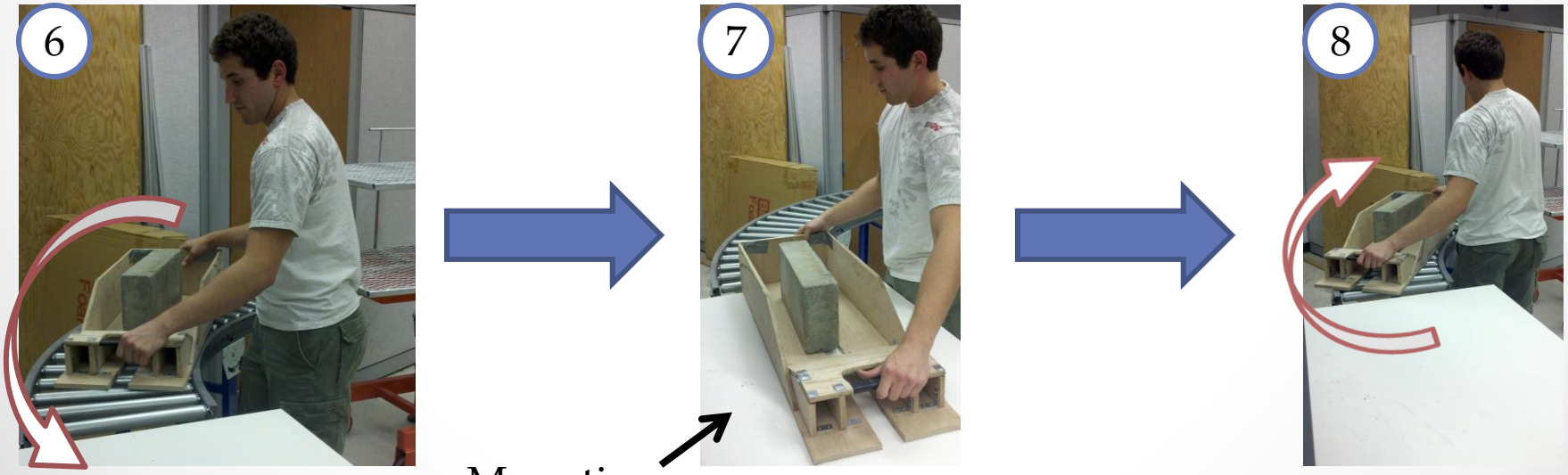
New Process

1. Cart aligned with front of container in storage area
2. Forging can be slid from container to tray
3. Repeat until cart is full
4. Travel from storage to broaching area
5. Place cart in front of conveyor

2-4

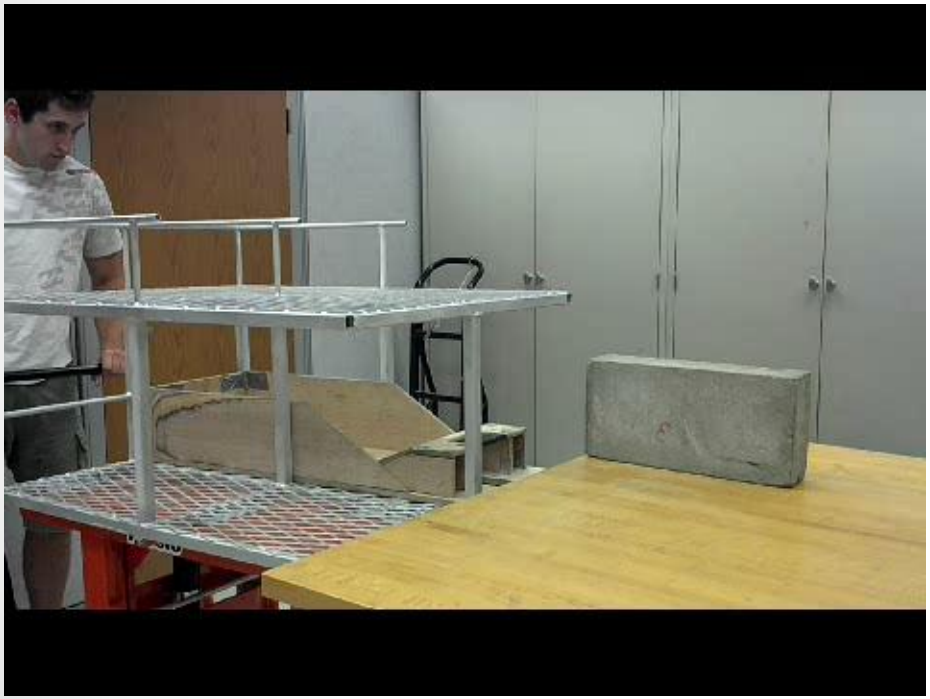
New Process Contin.

6. Slide tray along conveyor to mounting area
7. Mount blade and remove tray
8. Once milling complete, replace tray and remove forging
9. Place forging into cart and remove new forging



Prototype Demonstration

Loading Cart from Container



Loading Blade into Machine

Future Work

- Implement Design at facility
  - Utilize fundamental controls to maintain optimal process
  - Controls
    - Training
    - Maintenance
- Integrate modular sections
  - Allow for uninterrupted motion between all broaching machines
- Develop method for manipulating forgings for all broaching attachments
  - Use a single tray compatible with all machines

Summary

- Redesigned Process to Remove Lifting
  - Shipping and Receiving
    - Developed a container holding 8 forgings
    - All forgings removed horizontally
  - Storage Area
    - Reorganized area with elevated table
    - Allows forging retrieval in appropriate height range
  - Transportation
    - Designed a mechanism useable with pre-fabricated cart
    - Holds four blades
    - Allows for variable height retrieval
  - Loading and Unloading
    - Implemented a rolling conveyor to slide blades into place
    - Tray design holds forging for mounting and prevents damage to product

Acknowledgements

Special Thanks:

Ashok Patel

Dr. Chiang Shih

Dr. Srinivis Kosaraju

Dr. Matthieu Dalban-Canassy

References

Company	Location
TECT Power	http://www.tectcorp.com/scope/tect-power/
Liberty Mutual	www.libertymutual.com
McMaster-Carr	www.mcmaster.com

Questions?