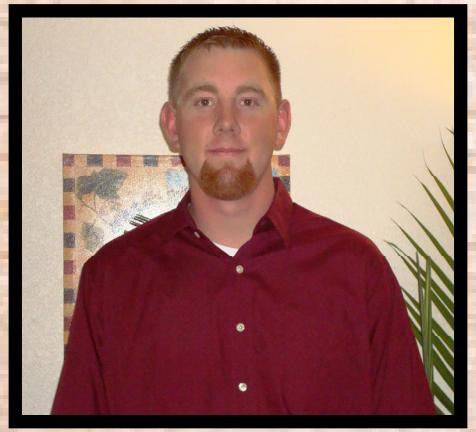
LOG HANDRAIL ASSEMBLY DEVICE

OUR TEAM

- **LeAnne Cossairt**

- **JP Holcomb**



- **Joaquin Nungaray**

- **Jennifer Tourtillott**

OUR ADVISOR: **Dr. Mike Ward**

PROBLEM STATEMENT

Segal Woodshop fabricates “residential market” type handrails from two pre-manufactured rails and a set of balusters. The assembly process is very labor intensive and time consuming. The function of the device will be to improve the assembly process of the log handrails by decreasing time and manual labor.

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QUANTITATIVE REQUIREMENTS

- **Single operator assembly**
  - One operator for assembly process
- **Quick assembly time**
  - Average assembly time of 5 minutes or less for one unit
- **Device must be adjustable for rails**
  - **6**’-12’ length rails in 1’ increments
- **Device must be adjustable for balusters**
  - Heights of 23”-**32”**
- **Successful assembly of balusters into rails**
  - OLD DEFINITION: Balusters on each unit must protrude at least **¾”** into predrilled **1”** deep holes. (6” on center and 1 ½” diameter holes)
  - **NEW DEFINTION: Each assembled rail must measure no taller than the height of the baluster being assembled plus 6” ± 1/8”. If this height is met, the rail will be successfully assembled**

QUALITATIVE REQUIREMENTS

- **Must be mobile within workshop**
  - 2 persons must be able to move device
- **Device must not be too big for workshop**
  - dimensions of device should not exceed 15’x8’x8’
- **Device must restrict handrail components**
  - Balusters and rails must be secured while under compressive loading
- **Must be fully controllable by operator**
  - Operator must be able to stop and reverse cylinder actuation at any time
- **Components must be easily serviceable**
  - Components that have the need for routine maintenance or replacement must be accessible

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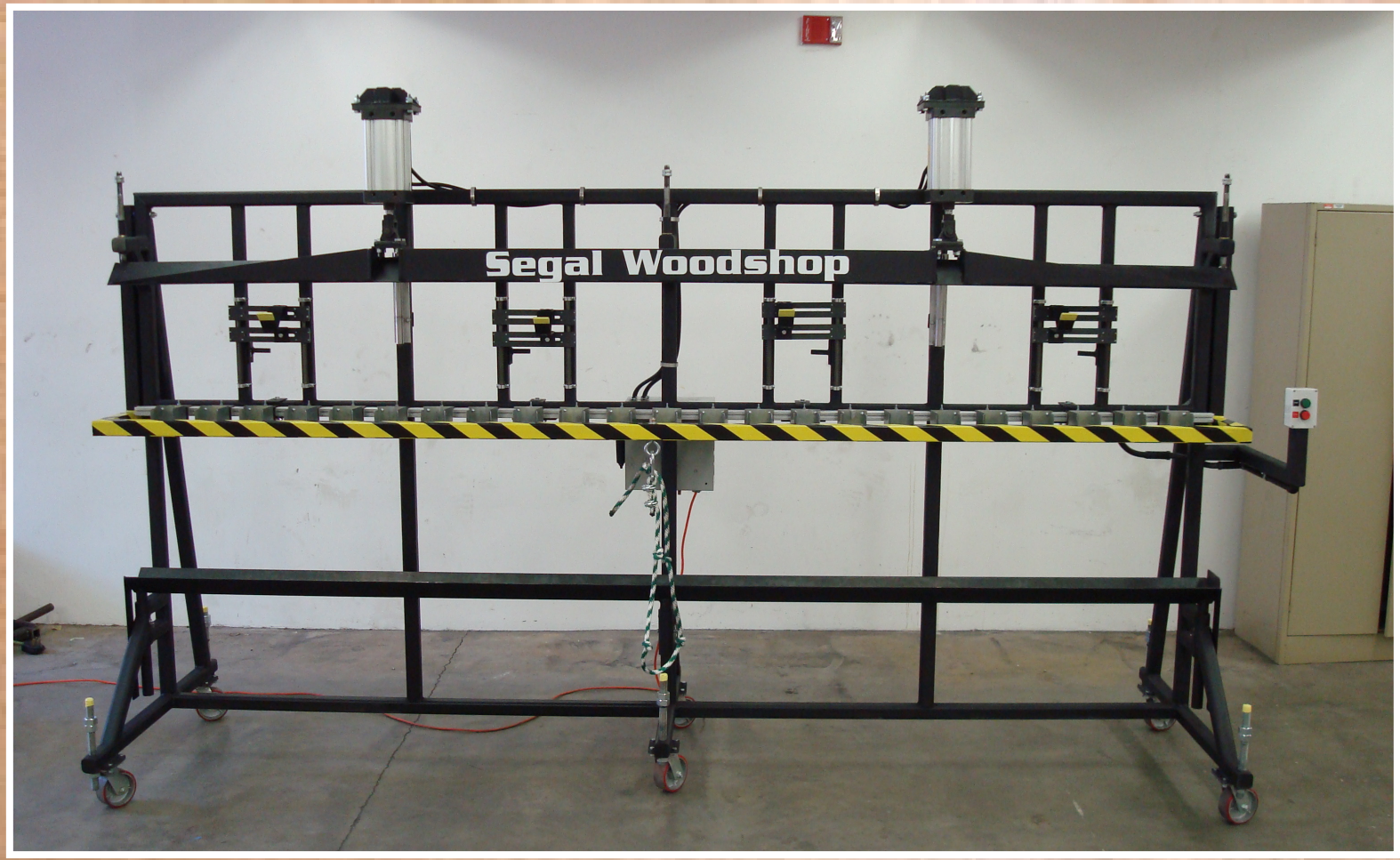
DESIGN SOLUTION

Completed Log Handrail Assembly Device



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DESIGN SOLUTION

Video Demonstration

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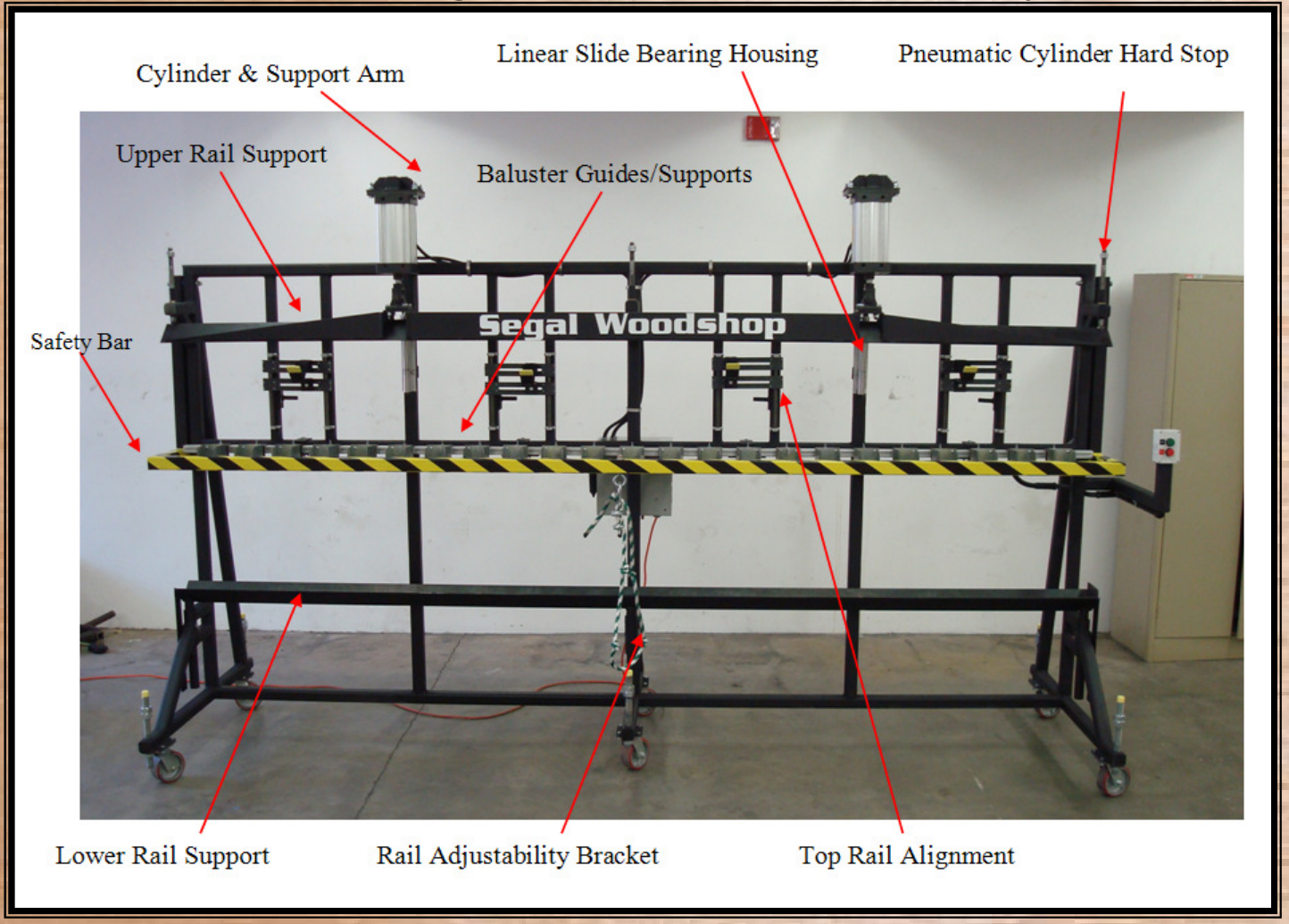
DESIGN SOLUTION

Parts of the Log Handrail Assembly Device



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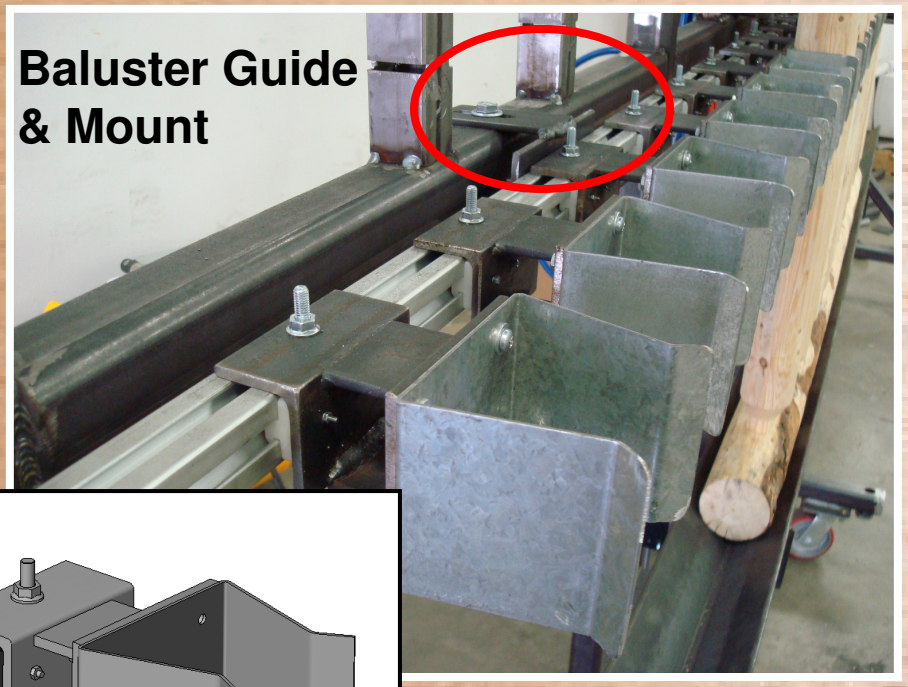
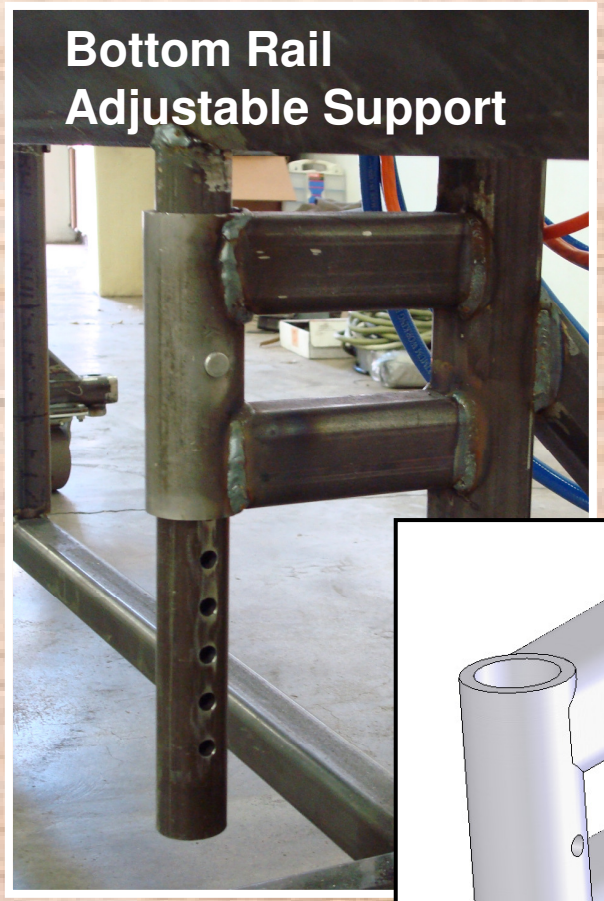
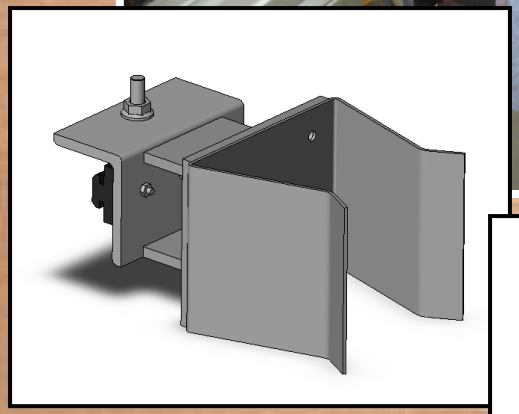
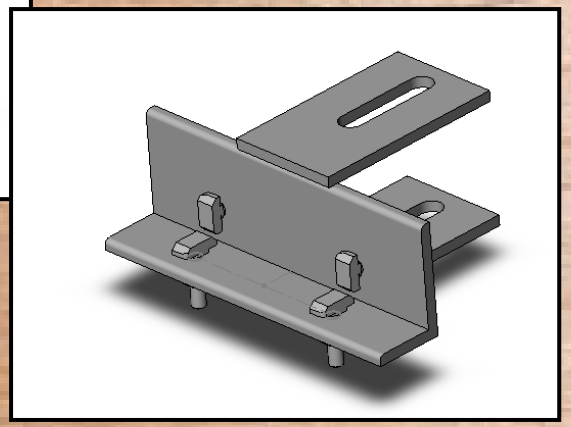
DESIGN SOLUTION

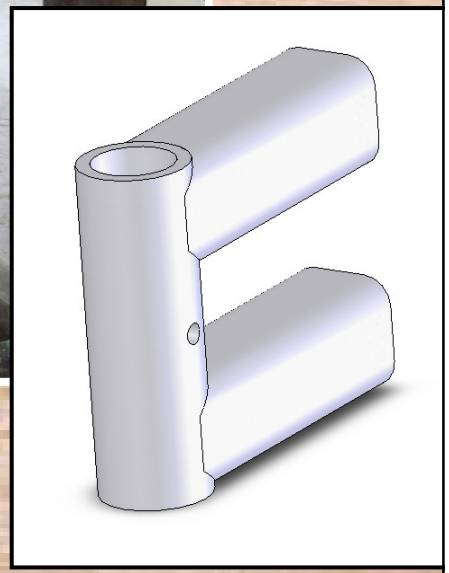
Adjustablility











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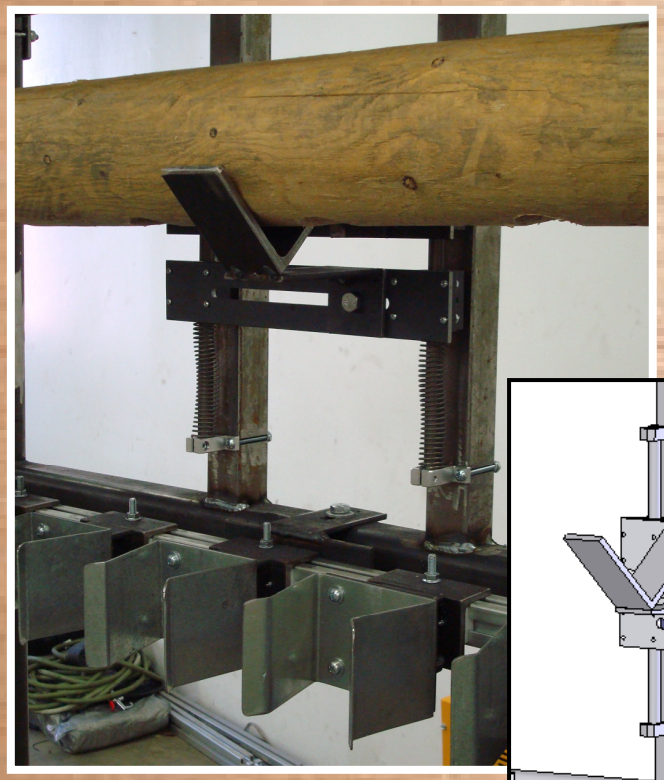
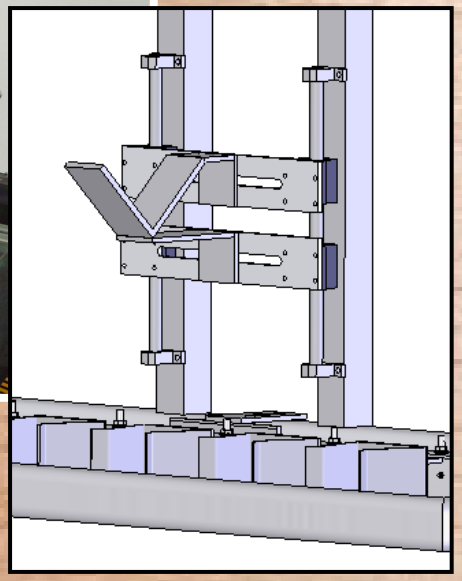
DESIGN SOLUTION

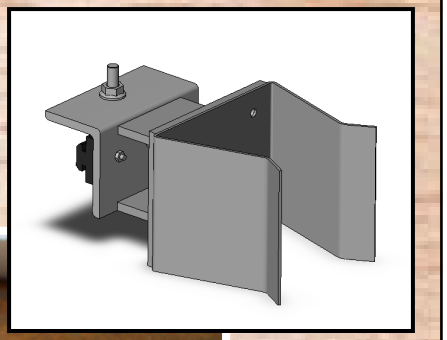
Alignment

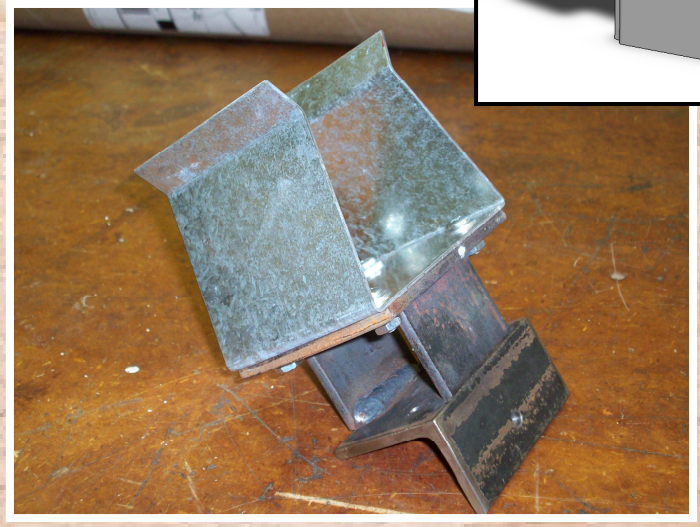


Top Rail Alignment



Baluster Guide





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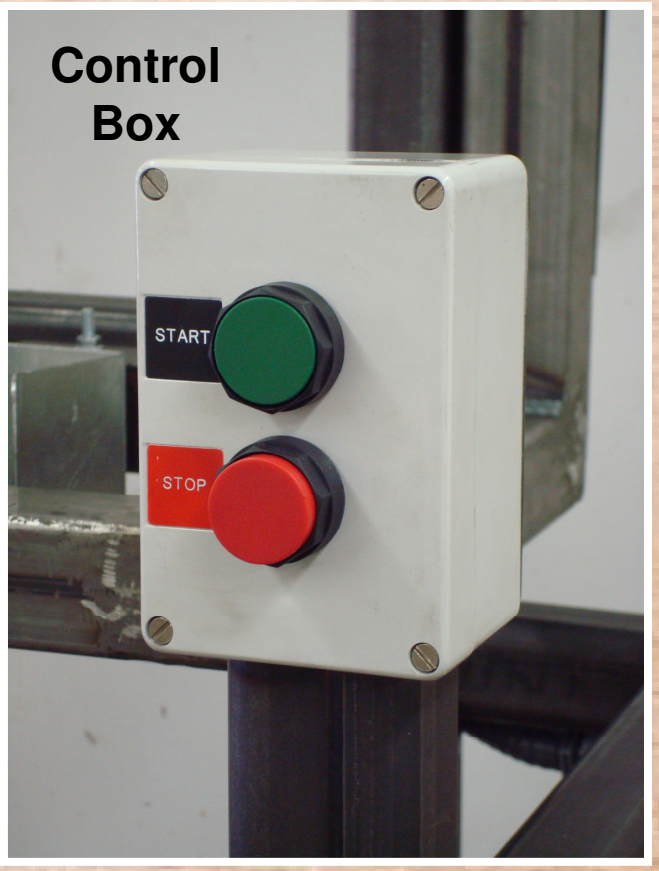
DESIGN SOLUTION

Safety



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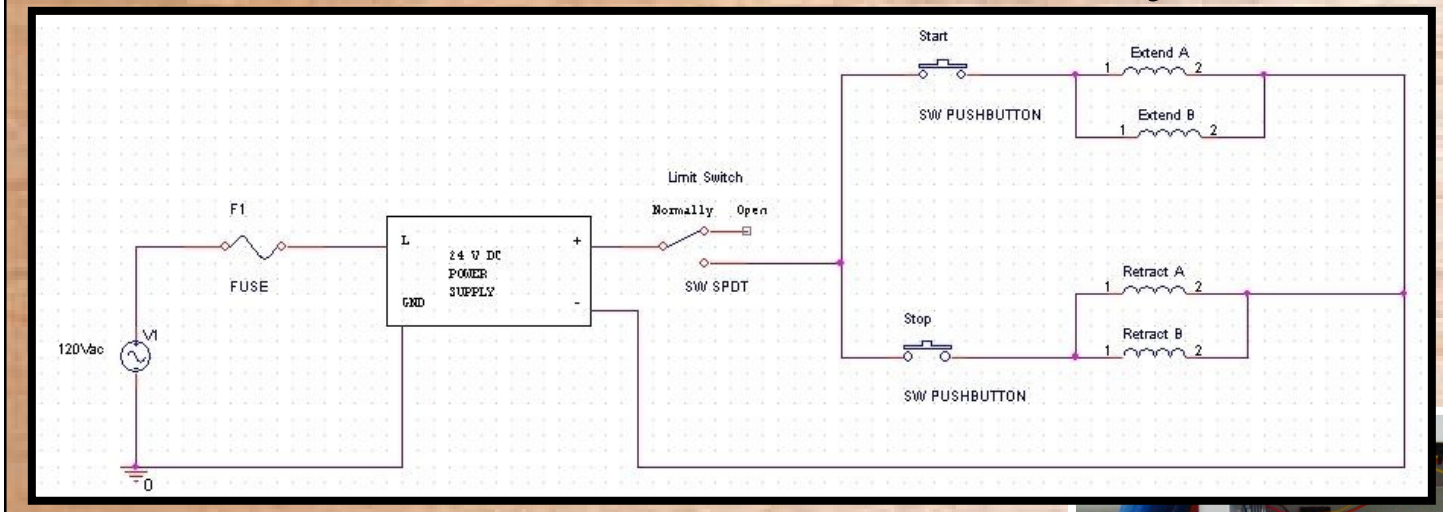
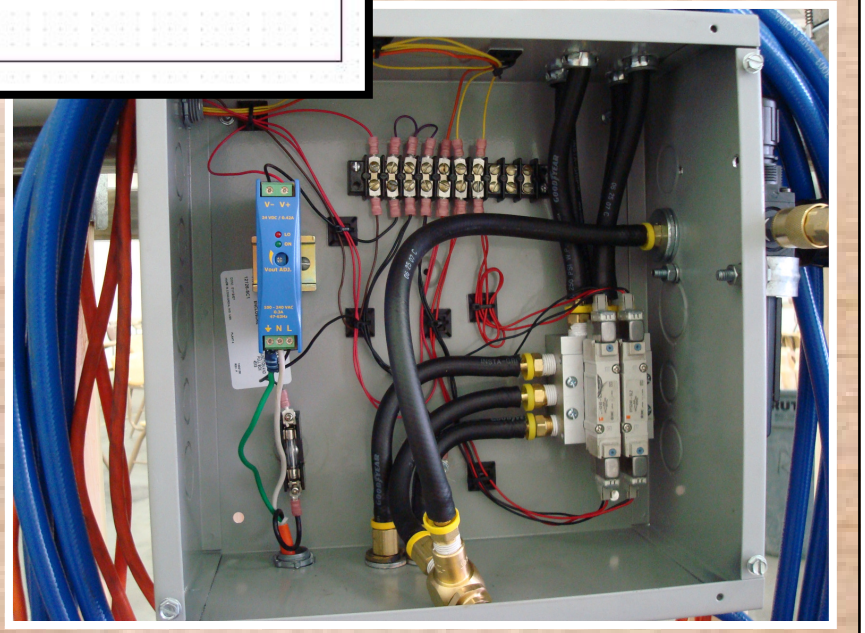
DESIGN SOLUTION

Air and Electrical Systems





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DESIGN SOLUTION

Air System Components

Solenoid Valves and Manifold

Pressure Regulator w/ Air Filter

Pneumatic Cylinder

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FABRICATION

1500 Fab Hours

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Testing

- Testing Procedures
  - All testing was done in PLMS 121
  - The qualitative requirements were tested by observation.
  - To confirm compliance with our quantitative requirements, twelve handrails were assembled according to the assembly process.

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Assembly Process

1. Adjust bottom rail for appropriate baluster height
2. Lift safety bar & lock top rail alignment mechanism
3. Load bottom rail
4. Load balusters into clamps
5. Place top rail on top of balusters
6. Unlock top rail alignment mechanism
7. Ensure that each baluster is approximately aligned with its top rail hole
8. Lower safety bar
9. Press green start button
10. Allow pneumatic cylinders to compress log handrail
11. Press red stop button to reverse cylinders

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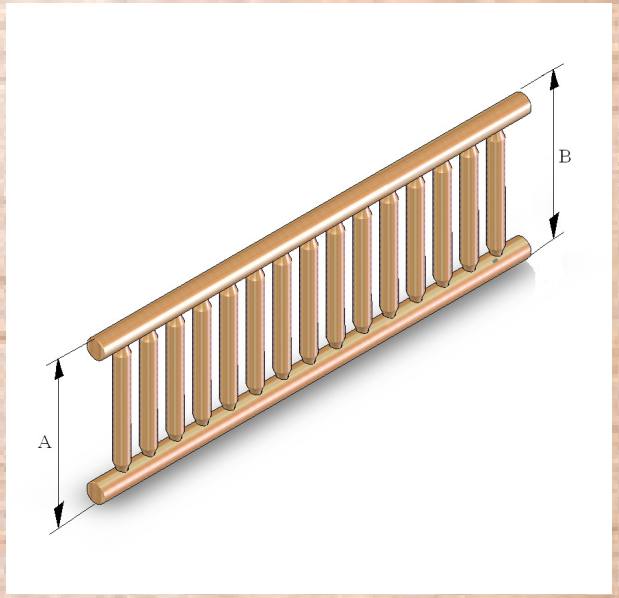
TEST RESULTS

The set of test data in the table below provide test results for each of the quantitative requirements.

(i.e. rail length, baluster height, time to assemble, # of operators and the successful assembly)

Trial	Rail Length	Baluster Length	Time	A	B	Successful Press Fit?
1	12'	31"	2min46sec	37 1/8"	37 1/8"	Yes
2	12'	31"	2min4sec	37"	37"	Yes
3	12'	31"	3min33sec	37"	37"	Yes
4	12'	31"'	2min52sec	37 1/16"	37 1/16"	Yes
5	12'	31"	1min54sec	37"	37"	Yes
6	8'	31"	3min 6sec	37"	36 7/8"	Yes
7	6'	31"	3min24sec	36 13/16"	36 13/16"	Yes
8	12'	25"	4min36sec	31 1/8"	31 1/4"	No
9	8'	25"	4min5sec	31 5/16"	31 1/4"	No
10	8'	25"	4min10sec	31 1/16"	31 1/16"	Yes
11	6'	25"	4min15sec	30 15/16"	30 15/16"	Yes
12	6'	25"	3min19sec	30 3/4"	30 7/8"	Yes



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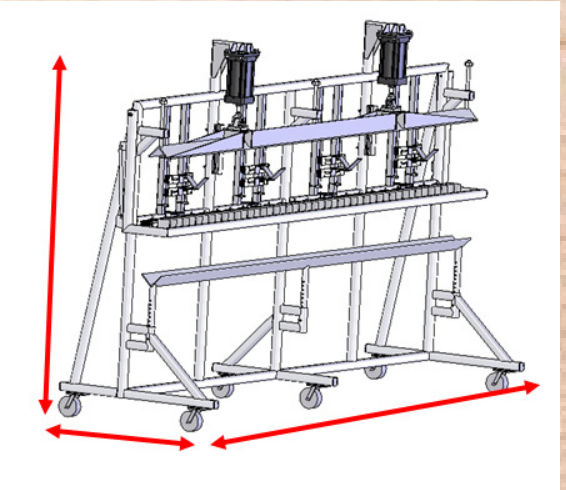
TEST RESULTS (CONT.)

- The table below shows compliance to the overall dimensions requirement. The LHAD must fit into a 15'x8'x8' box



Device Dimensions	Requirement Met?
Length = 12ft 8in	Yes
Height (Safety Bar Closed) = 7ft 7 1/2in	Yes
Height (Safety Bar Open) = 8ft 6in	No
Width = 3ft 7 3/4in	Yes

- Results for the rest of the qualitative requirements

Qualitative Requirements	Requirement Met?
1. Components that require routine maintenance and/or replacement must be accessible	Yes
2. Balusters and rails must be secured while under compressive loading	Yes
3. Operator must be able to stop and reverse the assembly process at any time	Yes

BUDGET

Components	**~**	**$2,000.00**
Hardware	**~**	**$450.00**
Material	**~**	**$1,250.00**
	Total:	**$3,700.00**

LABOR (2000 HOURS)

Salary ($33.58/hr)	**$33.58**	**$67,160.00**
Benefits (37% hourly rate)	**$12.42**	**$24,849.20**
Overhead (40% hourly rate)	**$13.43**	**$26,864.00**
	Total:	**$118,873.20**

Total Cost w/ Labor: **$122,573.20**

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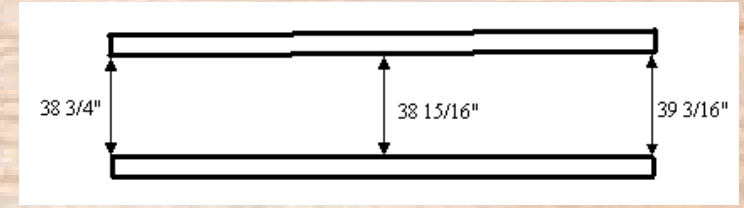
Unique Problems Encountered

- Offset top rail assembly
  - Cylinder mount spacer
- Deflection
  - Structural reinforcements added
- Binding of bottom rail assembly
  - Removed guides and bearings
- Removal of completed handrail
  - Added hinge locking mechanism
- Space and time to fabricate
  - Utilized open lab access hours
  - Baja team
  - PLMS 121



FUTURE OF THE L.H.A.D.

- Recommendations
  - Design Changes
    - Clamp design
    - Less range of fastener sizes
    - Increased tolerances on linear guides
    - Bolt together assembly
    - Improved design of cylinder brackets
- More Log Handrail Assembly Devices?

THANK YOU!

- Rafi Segal and Segal Woodshop
- Dr. Mike Ward (Project Advisor)
- Parker-Hannifin, Racor Division
  - Donation of pneumatic cylinders
- Igus Incorporated
  - Donation of top-rail alignment components
- For Fabrication Assistance
  - Scott Brogden (MFGT) –lab access
  - Jeff Ferrara and SME students –welding and advice
  - Leonard Fallscheer (MFGT) –CNC assistance
  - Steve Eckart (ECC) –air systems and circuitry assistance
  - Mike Renwick and Andrew Libby –fab of aluminum parts

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QUESTIONS?

LeAnne Cossairt

JP Holcomb

Joaquin Nungaray

Jennifer Tourtillott