



University
of Idaho

AUTOCLAVE UPGRADE FOR CORROSION FATIGUE TESTING

**A PROJECT BY THE AUTOCLAVE
EXPERTS**

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Jones, Larry Schwab, Bahram Sobbi*

SCOPE OF PROJECT



- Design and build load frame system that conforms to the product requirements of Dr. Stephens and fits budget of \$40,000
- Design and build specimen platform gripper arms and dynamic seal.
- Design and code LabView user interface (UI)
- Validate system in time for use after Fall Senior Design class ends

VALUE PROPOSITION



EXPANDING THE UNIVERSITY OF IDAHO'S TESTING CAPABILITIES



- Load Frame/Autoclave combo will be a unique addition to U of I's research equipment
- Project will expand Dr. Stephen's ability to test fatigue of experimental materials
- Similar product previously quoted by Cortest at \$100,000+

Similar Cortest System

INITIAL EQUIPMENT



THE CORTEST AUTOCLAVE



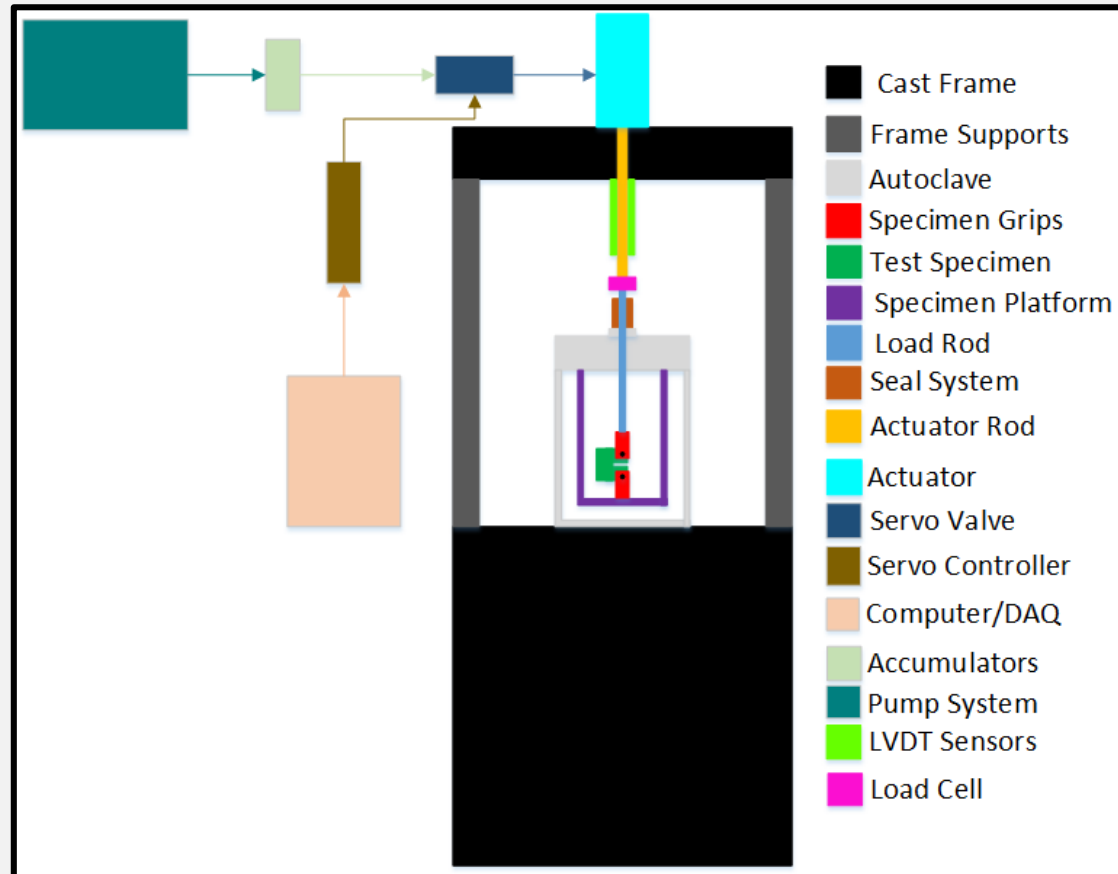
- This autoclave is not currently in use by the college.
- Autoclaves like this are used to create a high temperature/pressure environment. This model can also accommodate corrosive conditions.
- Capable of reaching 300 °C and 4000 psi (setting our design goal).
- Designed to accommodate a load frame system with its heavy structure.

DESIGN CONCEPT



Our design work includes:

- Computer & data acquisition equipment
- Hydraulic pump equipment and actuation system
- Sensors for monitoring and data output
- High temperature/pressure dynamic seal
- Specimen retainment system



HARDWARE REQUIREMENTS



THE CORE REQUIREMENTS DRIVING OUR DESIGN

Actuation System

- Extension rate of at least 0.05mm/s during testing
- Capable of delivering a load of 10,000 lbf

Specimen Testing

- Specimen platform will fit in autoclave without modification
- Design shall accommodate standard test specimens
- Grip design will conform to ASTM E647 requirements

Internal Components

- Need to survive 300 °C & 4000 psi environment
- Must withstand same corrosives as 316H stainless

SOFTWARE REQUIREMENTS



- Emulate LabVIEW user interface of other University of Idaho load frames in use.
- Monitor system sensors to provide control feedback & emergency stop functionality.
- Programmable loading waveforms.
- Fatigue sample crack measurement.
- Manual linear load frame control.

PUMP FRAME

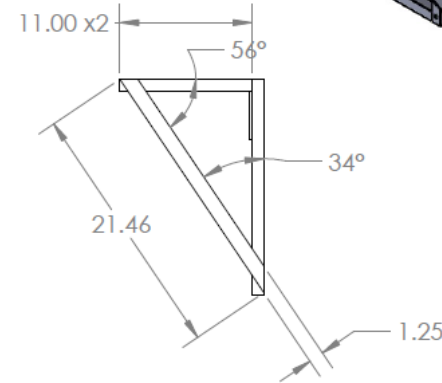
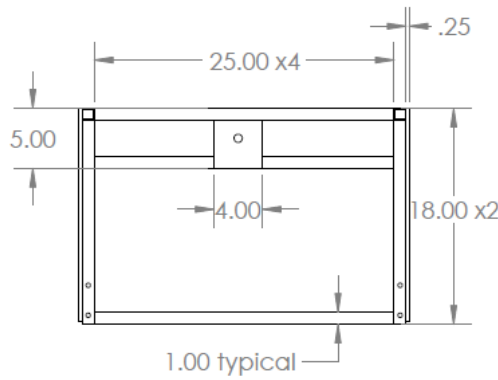
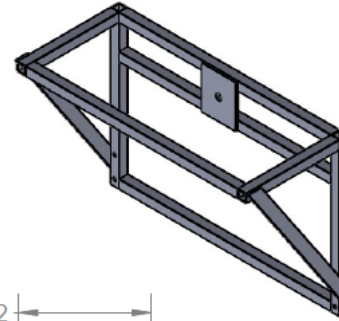
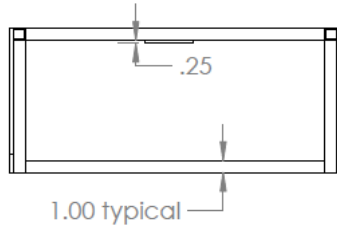


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A

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| | | | | | | | | |
|-------------|---------|--------------------------------------|--|-----------|------|----------------|----------|--------------|
| | | UNLESS OTHERWISE SPECIFIED: | | NAME | DATE | | | |
| | | DIMENSIONS ARE IN INCHES | | DRAWN | | TITLE: | | |
| | | TOLERANCES: | | CHECKED | | | | |
| | | FRACTIONAL: ± | | ENG APPR. | | | | |
| | | ANGULAR: MACH ± BEND ± | | MFG APPR. | | | | |
| | | TWO PLACE DECIMAL ± | | Q.A. | | | | |
| | | THREE PLACE DECIMAL ± | | COMMENTS: | | | | |
| | | INTERPRET GEOMETRIC TOLERANCING PER: | | | | SIZE | DWG. NO. | REV |
| | | MATERIAL | | | | Frame Assembly | | |
| NEXT ASSY | USED ON | FINISH | | | | SCALE: 1:8 | WEIGHT: | SHEET 1 OF 1 |
| APPLICATION | | DO NOT SCALE DRAWING | | | | | | |

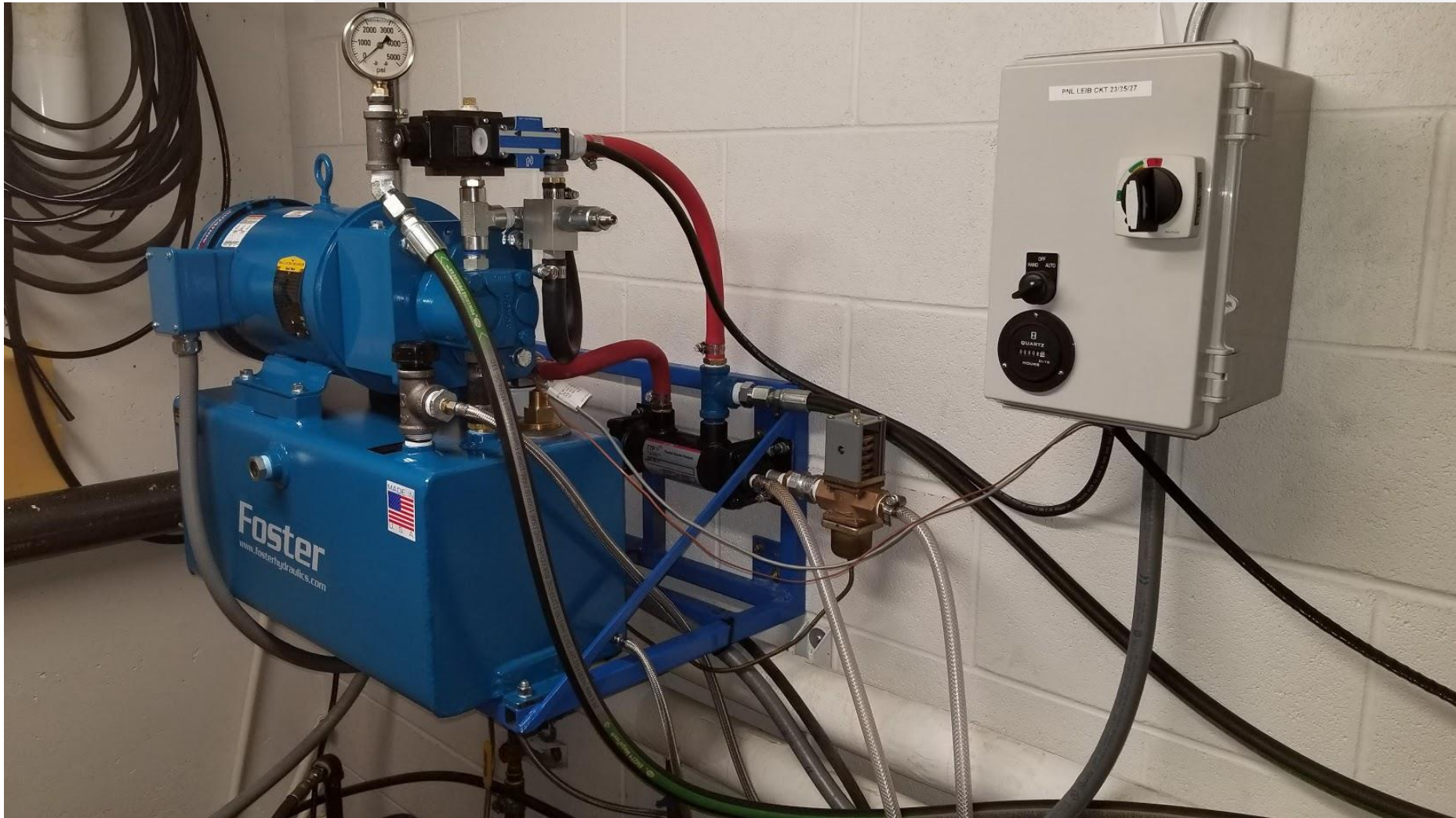
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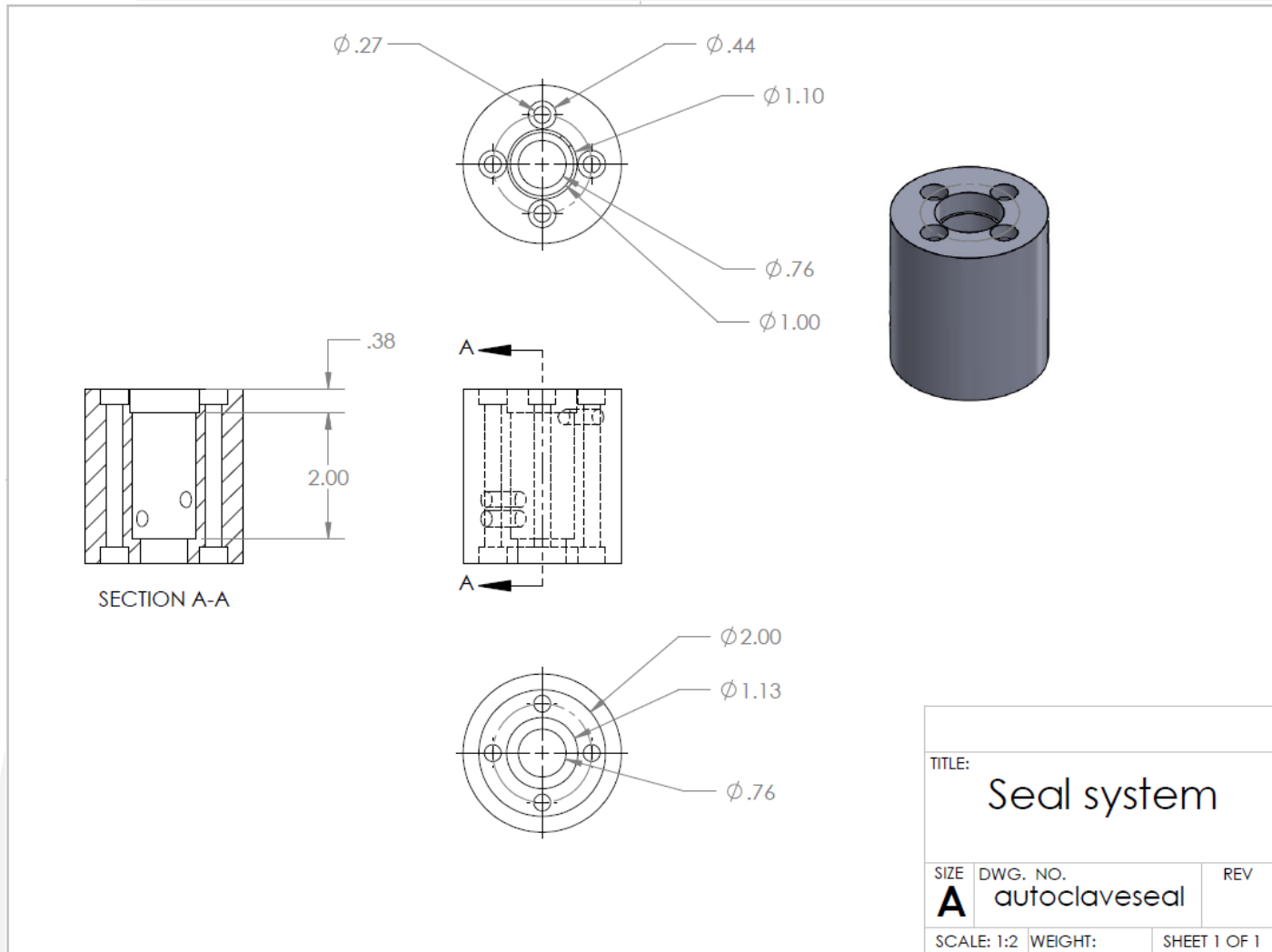
PUMP SYSTEM



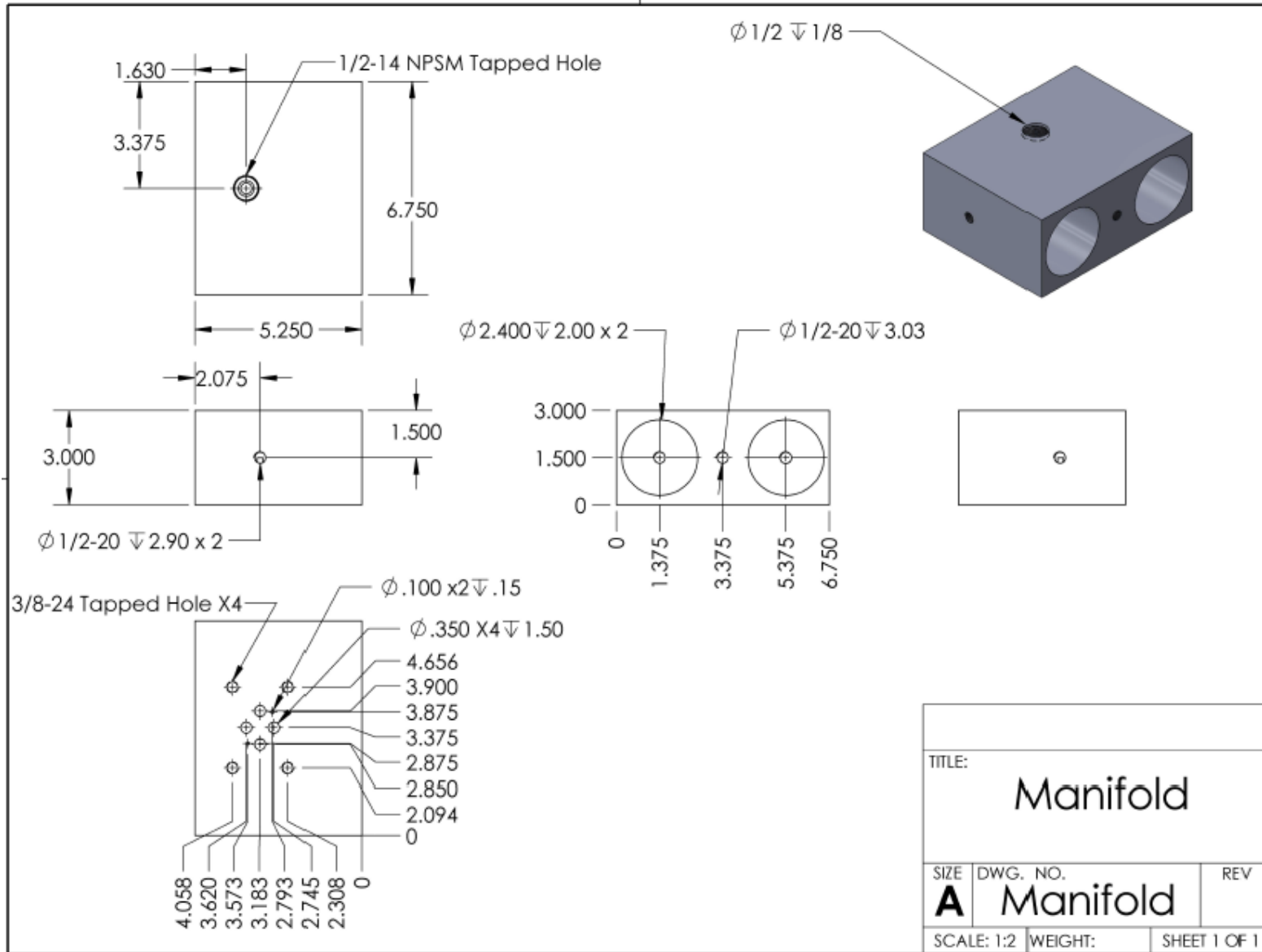
DYNAMIC LOAD ROD SEAL



DESIGNED TO SURVIVE A HARSH ENVIRONMENT

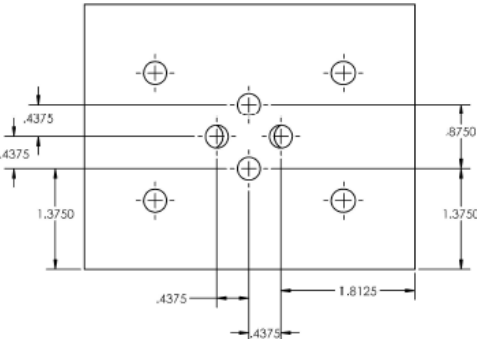
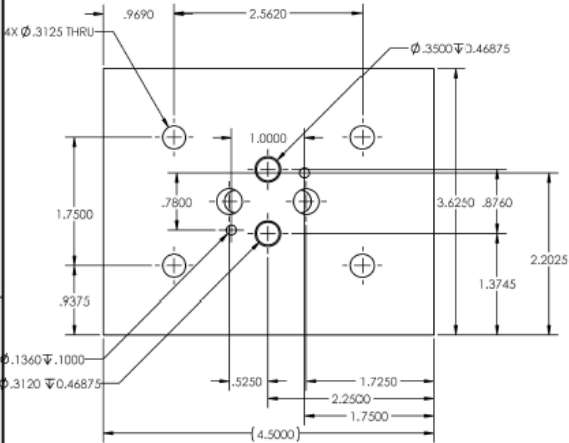
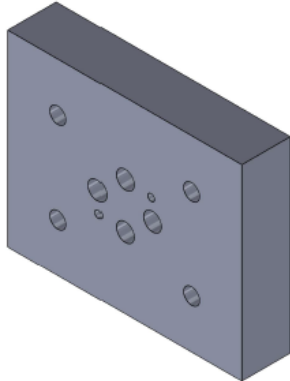


MANIFOLD



| | | |
|------------|----------|--------------|
| TITLE: | | |
| Manifold | | |
| SIZE | DWG. NO. | REV |
| A | Manifold | |
| SCALE: 1:2 | WEIGHT: | SHEET 1 OF 1 |

MANIFOLD ADAPTOR

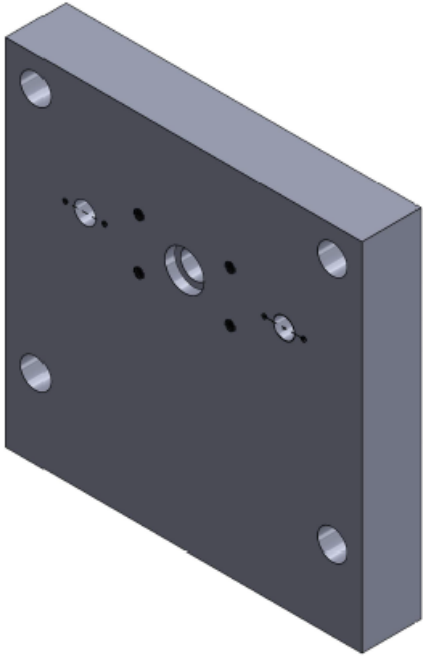
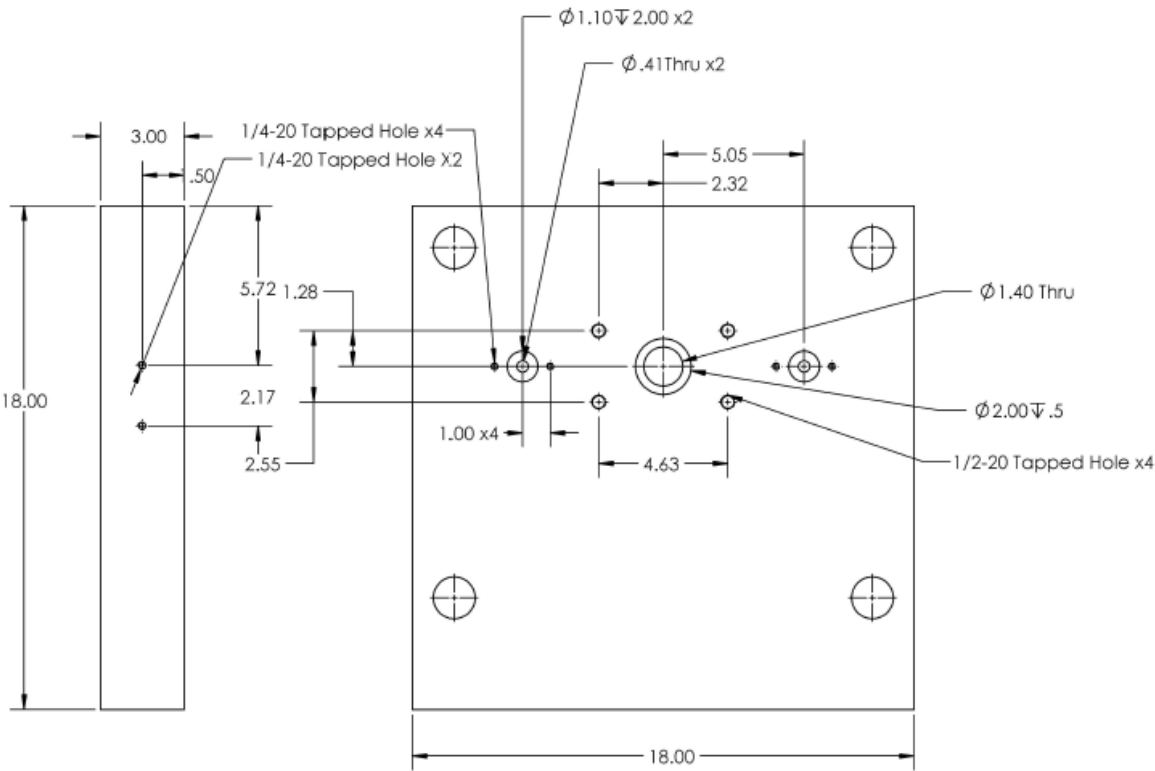


| LIST OF DIMENSIONS SPECIFIED | | NAME | DATE |
|---|----------------------|------|------|
| QUANTITY | DATE | | |
| TOLERANCES | CHECKED | | |
| FRACTIONS | DRG APPR. | | |
| ANGULAR UNITS | ISO APPR. | | |
| TWO PLACE DECIMAL | S.A. | | |
| THREE PLACE DECIMAL | COMMENTS | | |
| ENTER GEOMETRIC TOLERANCES PER ASME Y14.5 | | | |
| DATE | | | |
| TIME | | | |
| ISSUED ON | | | |
| NEXT ASSY | | | |
| APPLICATION | DO NOT SCALE DRAWING | | |

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SIZE DWG. NO. REV
 Manifold adaptor
 SCALE: 1:1 WEIGHT: SHEET 1 OF 1

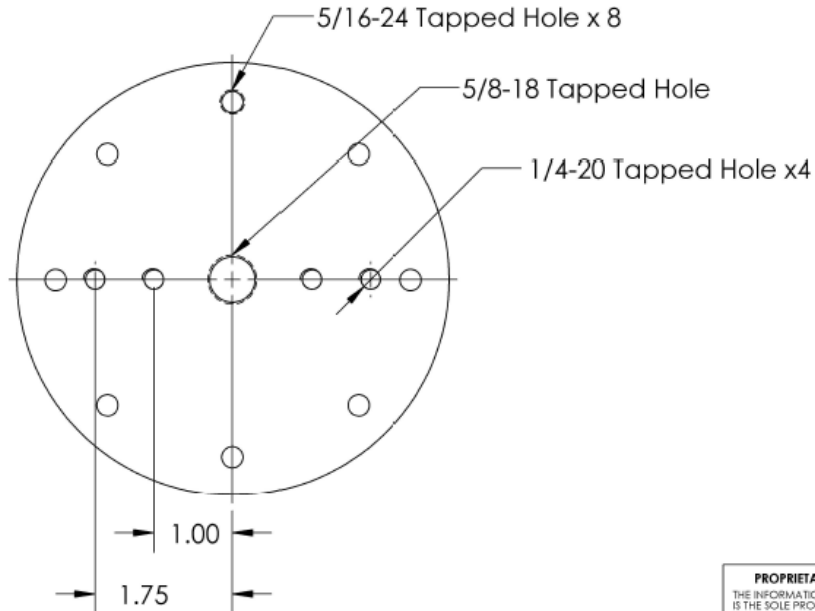
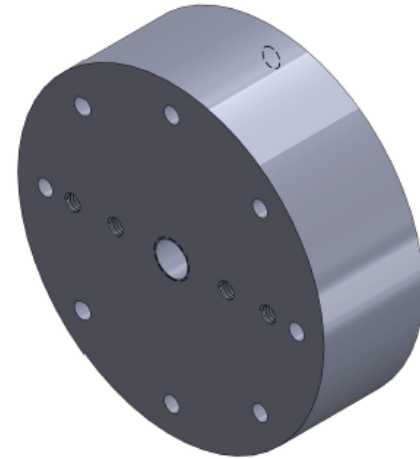
TOP BLOCK OF LOAD FRAME



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| | | UNLESS OTHERWISE SPECIFIED: | | NAME | DATE |
| | | DIMENSIONS ARE IN INCHES | | DRAWN | |
| | | TOLERANCES: | | CHECKED | |
| | | FRACTIONAL ± | | ENG APPR. | |
| | | ANGULAR: MATCH ± BEND ± | | MFG APPR. | |
| | | TWO PLACE DECIMAL ± | | | |
| | | THREE PLACE DECIMAL ± | | | |
| | | FREEFORM GEOMETRIC TOLERANCING PER: | | COMMENTS: | |
| | | MATERIAL | | | |
| | | FINISH | | | |
| NEXT ASSY | USED ON | | | | |
| APPLICATION | | DO NOT SCALE DRAWING | | | |
| TITLE: Load Frame Block | | | | | |
| SIZE B | DWG. NO. | | | REV | |
| SCALE: 1:4 | WEIGHT: | SHEET 1 OF 1 | | | |

LOAD CELL ADAPTOR



| | | | | | |
|---|---|--|----------------|--|------|
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| DEFAULT TOLERANCES: | | DESCRIPTION: | | UNIVERSITY OF IDAHO ME DEPARTMENT | |
| LINEAR: X. ± .25 X.X ± .1 X.XX ± .01 X.XXX ± .002 | ANGULAR: X. ± 2 X.X ± 1 X.XX ± 0.30° | CHECKED BY: XXXXXXXXXXXX | DATE: XX/XX/XX | PART #: | QTY: |
| DRAWN BY: | | DATE: 9/10/2018 | | SCALE: 1:2 | |
| FILE NAME: load cell adaptor.SLDprt | | | | SHEET: 1 OF 1 | |

AUTOCLAVE ASSEMBLY



SYSTEM BUILT

BEFORE:



AFTER:



BILL OF MATERIALS



Purchase Rundown

| Products | Prices | Purchased | Received |
|----------------------|-------------------|-----------|----------|
| Electronics | | | |
| Computer | \$699.00 | ✓ | ✓ |
| Screen | \$100.00 | ✓ | ✓ |
| HDMI cable | \$5.00 | ✓ | ✓ |
| input card | \$224.99 | ✓ | ✓ |
| DAQ | \$5,415.88 | ✓ | ✓ |
| DCPD | \$0.00 | ✓ | ✓ |
| Load cell | \$829.37 | ✓ | ✓ |
| LVDT | \$1,243.00 | ✓ | ✓ |
| Total | \$8,517.24 | | |
| Hardware | | | |
| All metal stock | \$750.00 | ✓ | ✓ |
| Spring seal | \$11.28 | ✓ | ✓ |
| Stuffing seal | \$48.14 | ✓ | ✓ |
| Hydraulic lines | \$485.00 | ✓ | ✓ |
| Water line hook up | \$130 | ✓ | ✓ |
| McMaster Carr Orders | \$166 | ✓ | ✓ |
| Bolts | \$5.99 | ✓ | ✓ |
| Total | \$1,596.36 | | |

| | | | |
|-------------------------|-------------------|---|---|
| Hydraulic system | | | |
| hydraulic filter case | \$294.17 | ✓ | ✓ |
| Actuator | \$1,753.43 | ✓ | ✓ |
| Hydraulic filter | \$78.00 | ✓ | ✓ |
| Pressure gauge | \$13.99 | ✓ | ✓ |
| Heat exchanger | \$217.03 | ✓ | ✓ |
| Motor starter | \$349.00 | ✓ | ✓ |
| Trumeter (hour) | \$18.32 | ✓ | ✓ |
| Pump | \$905.00 | ✓ | ✓ |
| Return line filter | \$70.00 | ✓ | ✓ |
| Hydraulic pump | \$79.00 | ✓ | ✓ |
| Relief valve | \$145.00 | ✓ | ✓ |
| Johnson control | \$181.47 | ✓ | ✓ |
| Johnson control | \$181.47 | ✓ | ✓ |
| Pint accumulator | \$250.00 | ✓ | ✓ |
| Quart accumulator | \$296.67 | ✓ | ✓ |
| control valve | \$164.97 | ✓ | ✓ |
| Temperature/level gauge | \$291.74 | ✓ | ✓ |
| Thermocouple | \$54.50 | ✓ | ✓ |
| Switches and buttons | \$131.00 | ✓ | ✓ |
| Relay | \$41.00 | ✓ | ✓ |
| Metal | \$108.62 | ✓ | ✓ |
| Servo valve | \$1,349.25 | ✓ | ✓ |
| Total | \$6,973.63 | | |
| | | | |
| Sum Total | 19,630.54 | | |

FUTURE WORK AND CHALLENGES



- Component Machining: Specimen grippers
- Continue work on LabView UI
- Test design integration
- Validate completed system