



University
of Idaho

AUTOCLAVE UPGRADE FOR CORROSION FATIGUE TESTING

**A PROJECT BY THE AUTOCLAVE
EXPERTS**

*Kevin Brewer, Titus Hansen, Tyler
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



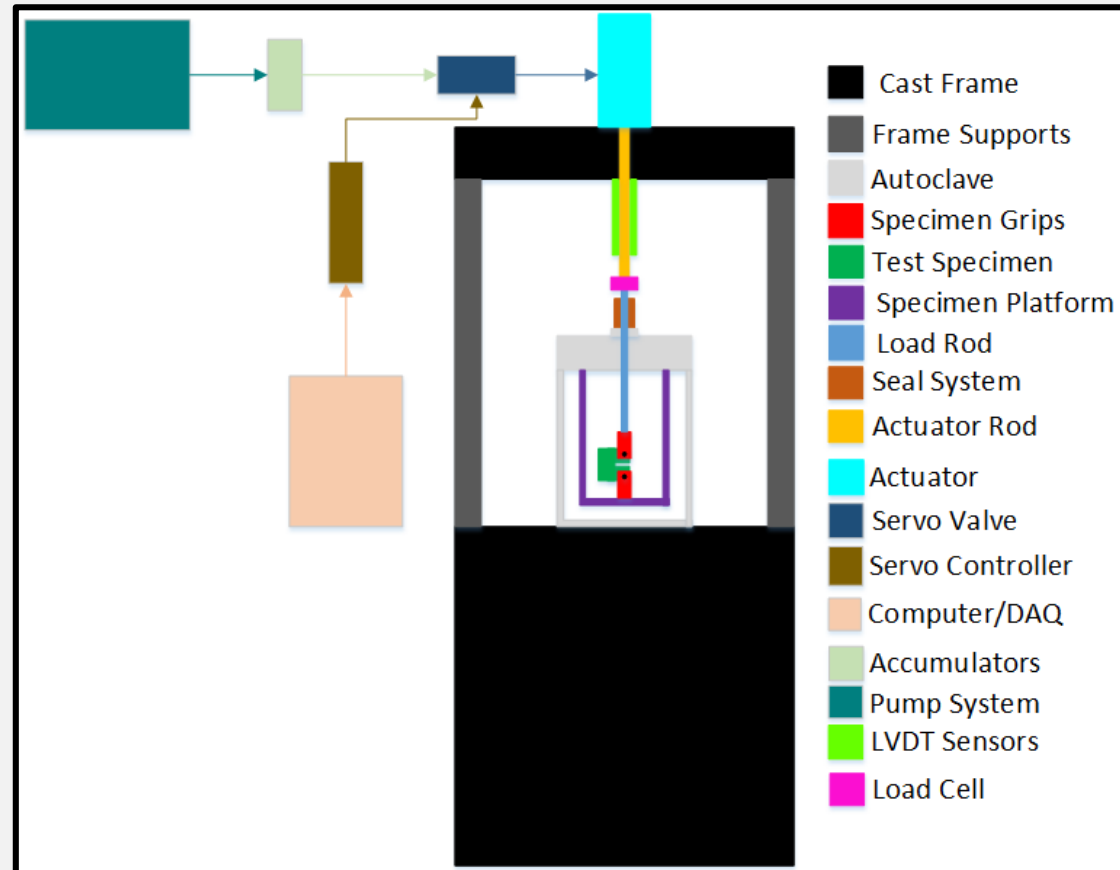
- This autoclave is not currently in use by the college.
- Autoclaves like this are used to create a high temperature/pressure environment. This model can also accommodate corrosive conditions.
- Capable of reaching 300 °C and 4000 psi (setting our design goal).
- Designed to accommodate a load frame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

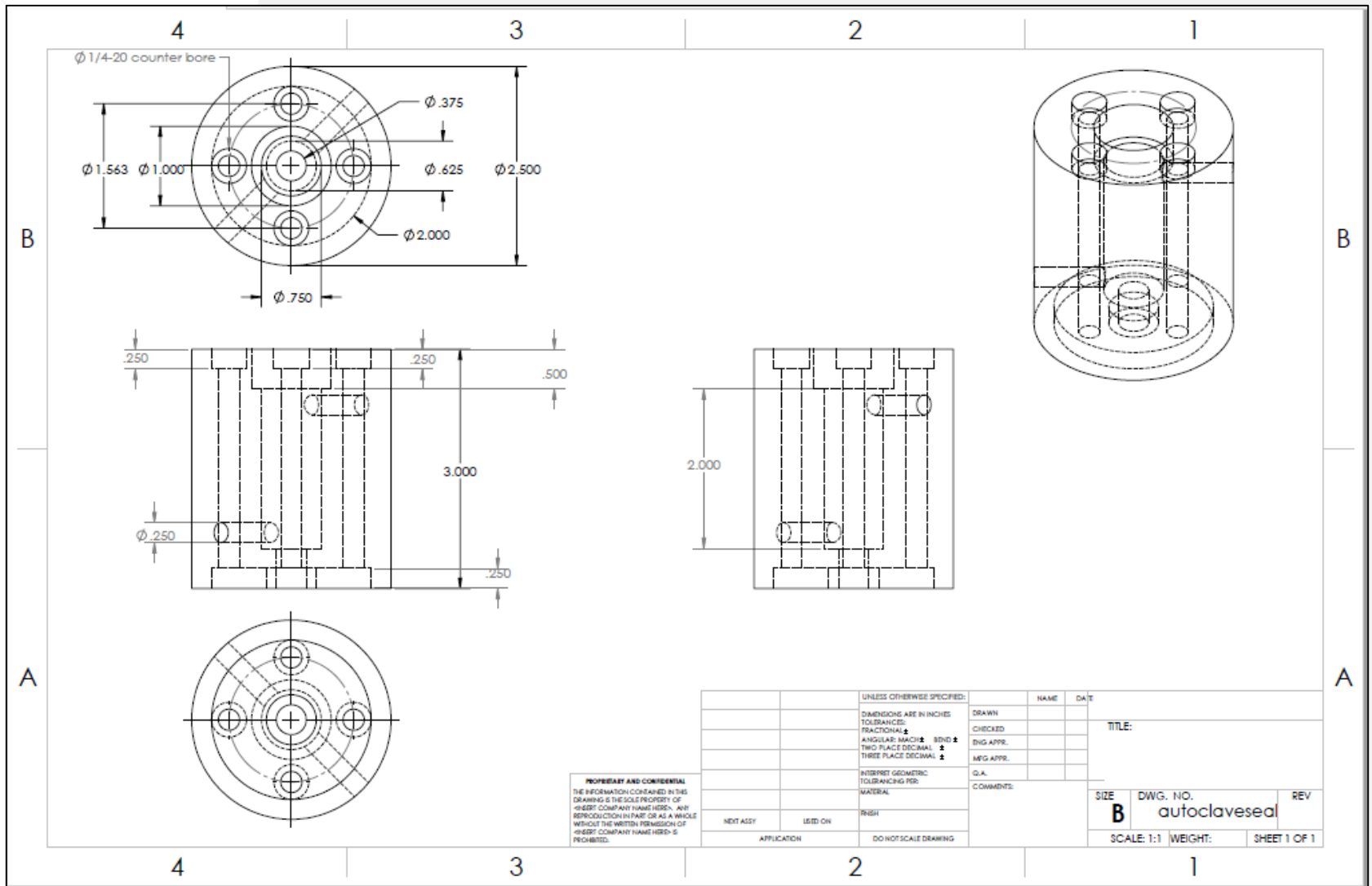


- Emulate LabVIEW user interface of other University of Idaho load frames in use.
- Monitor system sensors to provide control feedback & emergency stop functionality.
- Programmable loading waveforms.
- Fatigue sample crack measurement.
- Manual linear load frame control.

DYNAMIC LOAD ROD SEAL



DESIGNED TO SURVIVE A HARSH ENVIRONMENT



DYNAMIC SEAL VALIDATION



- Purely pressure sealing ability test
- Autoclave not heated
- Filled chamber to top with water
- Used hand hydraulic pump to generate pressure
- Design worked



HYDRAULIC VS ELECTRIC ACTUATION



DESIGN PATH DETERMINED BY DECISION MATRIX

Load Frame Actuation System Decision Matrix

Criteria	Cost	Explanation	Complexity	Explanation	Meets Specifications	Explanation	Footprint	Explanation	Maintenance	Explanation	Total Value
Weight	7		5		10		2		6		10
Hydraulic System	8	Actuator ≈ \$100-2000 Pump ≈ 50-1000 Servo Valve ≈ \$1000 Accumulators ≈ \$900 Other parts ≈ \$200 Total = \$2200-5100	6	Nick and member of team have relevant experience with hydraulic systems.	10	Full cost range will meet ideal specifications.	7	May need a new pump.	7	Pump and actuator needs occasional maintenance.	38
<i>Weighted Values</i>			30		60		14		42		202
Electric System			5		Servo Motor ≈ \$400-3000 Actuator/Screw ≈ \$250-13,000 Controller ≈ \$500 Other Parts ≈ \$200 Total = \$1350-13,700		4		Team has little-to-no experience with large servo motor systems.		7
<i>Weighted Values</i>	35	20		42		16	36	149			

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			
Stuffing seal	\$48.14		
Hydraulic lines			
Water line hook up	\$130	✓	✓
Bolts	\$5.99	✓	✓
Total	\$934.13		

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	✓	
Relief valve	\$145.00	✓	
Johnson control	\$181.47	✓	✓
Pint accumulator	\$250.00	✓	✓
Quart accumulator	\$296.67	✓	✓
Temperature/level gauge			
Pressure valve			
Servo valve	\$1,349.25	✓	
Total	\$5,921.33		
Sum Total	\$15,372.70		

FUTURE WORK AND CHALLENGES



- Component Machining: Load rod, specimen grippers, specimen platform, load cell adaptor, autoclave lid modification
- Complete seal design and integrity verification
- Continue work on LabView UI
- Assemble system and test design integration
- Validate completed system



TABLES

Column 1	Column 2	Column 3
Basic Gold		

Column 1	Column 2	Column 3
Alternating Rows Gold		

Column 1	Column 2	Column 3	Column 4
Alternating Columns Gold			

Column 1	Column 2	Column 3
Basic Black		

Column 1	Column 2	Column 3
Alternating Rows Black		

Column 1	Column 2	Column 3	Column 4
Alternating Columns Black			



TABLES

Row 1	First Column Gold	
Row 2		
Row 3		

Row 1	First Column Black	
Row 2		
Row 3		

	Column 1	Column 2	Column 3
Row 1	Header + First Column Gold		
Row 2			
Row 3			

	Column 1	Column 2	Column 3
Row 1	Header + First Column Black		
Row 2			
Row 3			

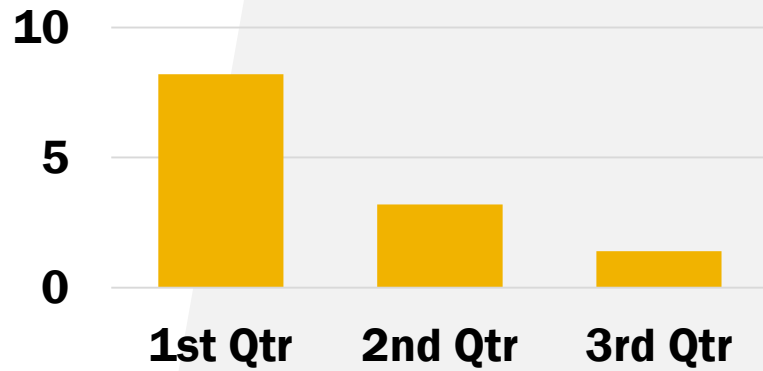
	Column 1	Column 2	Column 3
Row 1	Adv. Gold/Black		
Row 2			
Row 3			
TOTAL			

	Column 1	Column 2	Column 3
Row 1	Adv. Black/Gold		
Row 2			
Row 3			
TOTAL			

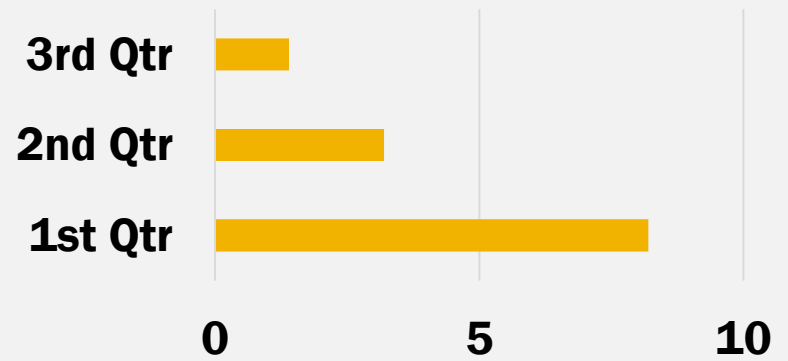


CHARTS

Sales



Sales





PIE CHARTS

