Bearing Installation

Instructors: Robert Bittle, Hubert Hall
Team Lead: Cameron Vieck
Sub Leads: Addison Hudelson, Jason Murphy
Kateland Brewster, Nick Choquette, John Covell, Bennett Cox, Ryan Golden, Jannet Leon Padilla

Abstract

In partnership with Aero Components, LLC - this project developed a bearing installation and proof-load testing system that meets aerospace standards. A modified HSP-30M hydraulic press was enhanced with digital force/pressure monitoring and a PLC-controlled interface. The system ensures accurate staking forces via open-loop feedback using a touchscreen display. A custom jaw improves versatility for different bearings. The result is a standardized, durable, and user-friendly solution.

Background & Research

We researched staking and swaging methods to determine force requirements. Using bearing OD and material hardness, we built reference tables for operators. Estimated forces guide press selection and are verified through testing to ensure reliability.

Tensile Strength of 140,000 (HC 30)						
	Pounds Force			Tons		
Bearing OD	*Type A*	*Type B*	*Type C*	*Type A*	*Type B*	*Type C*
0.5	3,850	6,000	8,850	1.9	3.0	4.4
1.0	7,700	12,000	17,700	3.9	6.0	8.9
1.5	11,550	18,000	26,550	5.8	9.0	13.3
2.0	15,400	24,000	35,400	7.7	12.0	17.7
2.5	19,250	30,000	44,250	9.6	15.0	22.1
3.0	23,100	36,000	53,100	11.6	18.0	26.6
3.5	26,950	42,000	61,950	13.5	21.0	31.0
3.75	28,875	45,000	66,375	14.4	22.5	33.2

The Press

The 30-ton HSP-30M hydraulic press serves as the base. The press is manually controlled, while the PLC and transducer enable real-time monitoring. The system includes an Arduino Opta Lite, PX309 pressure transducer, and Nextion HMI inside a sealed enclosure. A scroll chuck distributes force across various bearing sizes.

Programmable Logic Controller

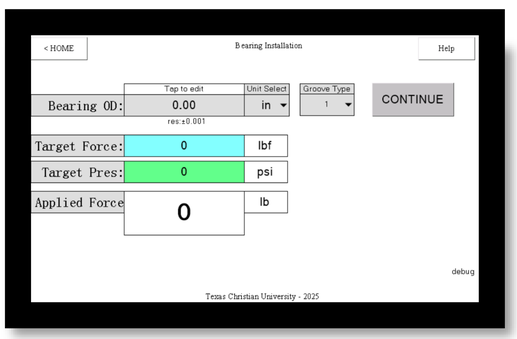
The Arduino Opta Lite PLC replaced microcontrollers due to better signal handling and EMI resistance. It processes signals from a 0–10V pressure transducer, offers accurate readings, and integrates via Modbus-TCP. Its compact, DIN-mount design improved system reliability. A serial output breakout board was added to the PLC to send UART communications to the HMI. Conveniently, the Opta lite takes an input voltage of 24V, which is identical to the pressure transducer used.

Software Integration

The feedback system ensures easy use and helps prevents overshoot. The pressure transducer reads hydraulic pressure, which is processed by a PLC, converted to applied force, then displayed on the Nextion HMI.

Features include:

- **Max Force Readout:** Peak force during operation
- **Target Force:** Display install force or proof load
- **Target Pressure:** Estimated pressure needed to achieve target force (based on analog gauge)
- **User Friendly Interface:** Features menus for installation, proof load testing, and informational tools.



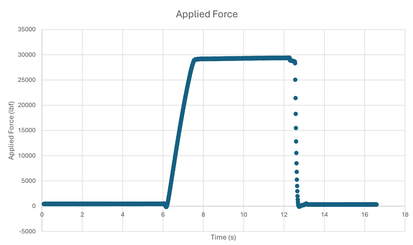
Modified Components

The upgraded HSP-30M press includes a 3-point chuck, pressure transducer, and PLC display. Real-time feedback enables precise control. A VEVOR enclosure houses components, powered by a DIN-mount supply. The system is wired directly to the press but can be powered on/off using the switch on the side.

Testing

The project involved several testing phases to guide key decisions:

- **Compression force tests**: Determined required force for deforming materials up to Rockwell C-38 and bearing sizes from 0.5” to 2”.
- **Instron testing**: Used Instron & strain gauge block to measure force and strain on a testing block. Used to calibrate the press’ force readout.
- **Hydraulic hose testing**: Verified new hoses matched original pressure output. Enabled transducer feedback, improving control with real-time force readout.
- **Transducer testing**: Used the previously calibrated strain gauge block to measure force and relate the pressure readings from the transducer. Final load testing confirmed readiness for staking and proof loading.



Final Design

Testing confirmed force requirements, guiding component selection. Key upgrades include a removable 3-point chuck (up to 3”), new hoses with a pressure transducer, and a PLC controlled display for live pressure and force monitoring. These ensure accuracy, adaptability, and compliance with aerospace standards.

The 30-ton HSP-30M manual press, with its adjustable table and hand pump, serves as the base. The added PLC and transducer provide real-time monitoring during staking, bushing installs, and metal forming.

Software runs on the Arduino Opta Lite in conjunction with an Omega PX309 and Nextion HMI. The PLC converts analog input to force readings and displays data on the 7” HMI. The system is enclosed in a VEVOR NEMA 4X-rated steel box, powered by a Mean Well HDR-30-24 supply.

Custom proof load supports ensure consistent results. Stored in labeled bins, they streamline use and maintain quality across installations.

Conclusion

This project delivered an integrated system for bearing installation, staking, and proof-load testing that meets aerospace standards. Upgrading the HSP-30M press with digital pressure monitoring and real-time feedback ensures precise, repeatable results. The Arduino Opta Lite PLC enables live monitoring and touchscreen control, while a custom jaw adds versatility. The result is a standardized, efficient, and durable solution for consistent, high-quality installations.