INDUSTRIAL SOLUTIONS LABORATORY

Company Information

Company Name	Elnik Systems	**Date Submitted**	11/17/2023
Project Title	Design of an Automated Molybdenum Wire Forming Machine (ELNIK_FORM)	**Planned Starting Semester**	*Spring 2024*

Senior Design Project Description

Personnel

Typical teams will have 4-6 students, with engineering disciplines assigned based on the anticipated Scope of the Project.

Please provide your estimate of staffing in the below table. The Senior Design Committee will adjust as appropriate based on scope and discipline skills.

Discipline	Number	Discipline	Number
Mechanical	4	Electrical	1
Computer	1	Systems	

Company and Project Overview:

Elnik Systems is a globally recognized, innovation leader in manufacturing of equipment used to debind and sinter Metal Injection Molded (MIM) and Metal Additive Manufactured components. We design, manufacture, and develop processes for the high temperature, partial pressure, inert atmosphere furnaces required to finish these product types. Our headquarters and primary manufacturing facility is in Pineville, NC and we proudly manufacture and source only in the USA. See below for an example of an Elnik Vacuum Debind and Sinter Furnace:

INDUSTRIAL SOLUTIONS LABORATORY

Elnik Systems is a family owned and operated organization that prides itself on excellence, quality, customer service, and innovation. These guiding principles are instilled into everything we do, and this project is no exception. We are a small company of less than 50 employees that leads the global MIM and AM metal processing industry valued at over $3.9 Billion annually.

Elnik furnaces can reach internal temperatures up to 1600C (2900F). This forces us to utilize specialty high temperature alloys including Tungsten, Molybdenum, and TZ Molybdenum. The furnace internal structure requires hundreds of “Shield Pack Anchors” which are retaining anchors formed from molybdenum wire to hold all the critical heat shielding in place. Manufacturing these anchors is an extremely time-consuming process and is currently done 100% manually. We would like the team to design, manufacture, and test an automated manufacturing system that can receive a spool of raw molybdenum wire, then cut, form, and eject these anchors as a finished piece. The intention of such a system is to speed up the process and allow our technician to do more technically challenging tasks. In addition, we want to see an increase in the dimensional reliability of the pieces from this process compared to the manual process used today. See below for pictures of the anchors as well as their installation locations marked by the red circle.

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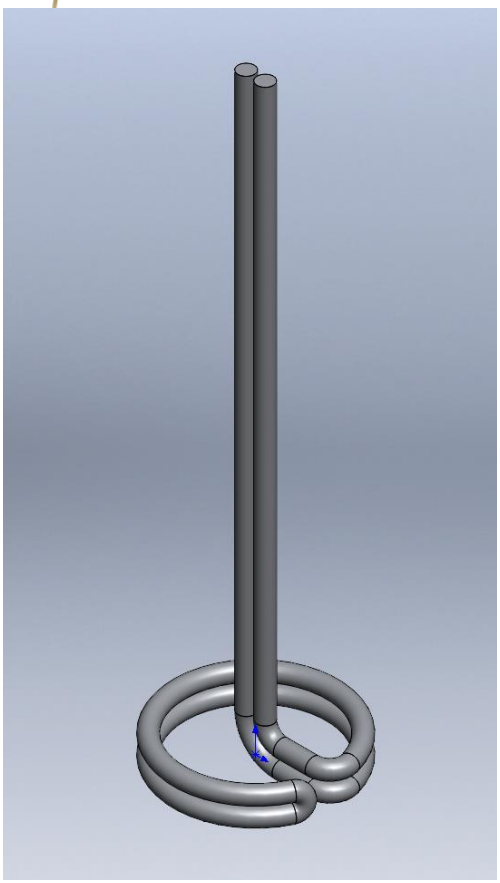

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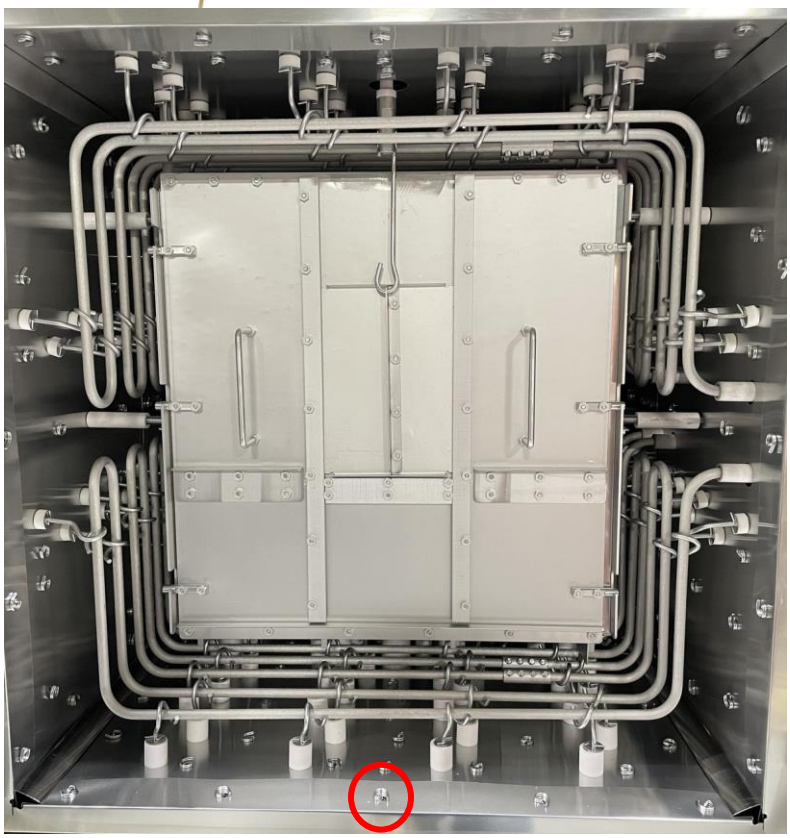

Project Requirements:

As described previously, the intent of this project is creating an automatic manufacturing machine that can take in raw molybdenum material as a spool of 0.060” wire and through a powered forming process cut, bend, and eject a finished anchor as shown in the previous image. The operation of this machine should be as the name implies, allowing the operator to load material onto a spool holder, initiate the machine with a “start” function and then the machine continues to run unattended until either it has used up the available material or the operator stops the machine, in which case the machine clears any remaining material and then powers down. In the current process, the wire passes through 4 stations that cut and form the wire into the specified length and shape. The student team will be able to go to Elnik to see these stations. They are all currently manually operated, and the goal is to automate it.

Molybdenum is a powdered metal and then sintered, which makes it difficult to form quickly, so special attention must be paid to the material properties, including plastic and elastic limits, as well as the behavior of said material at room temperatures. We DO NOT want this machine to heat the material as this changes the material properties. The machine should be able to operate in a safe manner, protecting the operator from injury with guards around moving components and any other critical safety concerns. The machine must be powered by 110/120V power and

current consumption should not exceed that of a standard 20amp circuit breaker. If higher power requirements are necessary, consideration must be given to Elnik by the close of the spring semester.

Elnik plans to provide raw material to the design team to aid in understanding its workability as well as for initial and final testing of the machine's functionality.

For the cutting mechanism, the shearing surfaces should use a modular blade system or cutting insert. This machine will likely process thousands of pieces in a year and tens of thousands in its lifespan. The intended design lifespan of this machine should be 100,000 cycles.

The UI of this machine should be a main power switch accompanied by a center spring-return toggle switch to allow for easy loading and unloading of the material spool. Also, there should be a green button to start the machine's primary function as well as an industry standard E-Stop in the event of a failure or emergency. Lastly, there should be a simple screen that can display the machine's status (working, idle, or out of material) and the number of pieces it has processed since the last power cycle.

Expected Deliverables/Results:

- An operational machine that automatically cuts, forms, and ejects shield pack anchors from a raw spool mounted to the machine.
- A machine that when a problem occurs, can shut down or clear faults in a safe and controlled manner.
- A machine that can keep track of the number of anchor pieces it has manufactured since its last power cycle.
- A machine that can operate without input (unattended) from the operator after the initial startup sequence.
- 3D models of all parts/ assemblies
- 2D drawings of all manufactured parts
- An Excel BOM of all materials used to construct the machine
- An overview of any maintenance the machine requires and the steps to complete it
- A copy of any program or control software used in the machine functions.

Disposition of Deliverables at the End of the Project:

Students are graded based on their display and presentation of their team's work product. It is mandatory that they exhibit at the Expo, so if the work product was tested at the supporter's location, it must be returned to campus for the Expo. After the expo, the team and supporter should arrange the handover of the work product to the industry supporter. This handover must be concluded within 7 days of the Expo.

INDUSTRIAL SOLUTIONS LABORATORY

List here any specific skills, requirements, specific courses, knowledge needed or suggested (If none please state none):

- Machine Dynamics
- Machine Programming
- Industrial Machine Design
- Automation and Controls
- Industrial Machine Safety
- Fabrication
- Ability to travel to Elnik Global Headquarters in Pineville, NC as required.