CNC Chip Auger

Capstone Presentation

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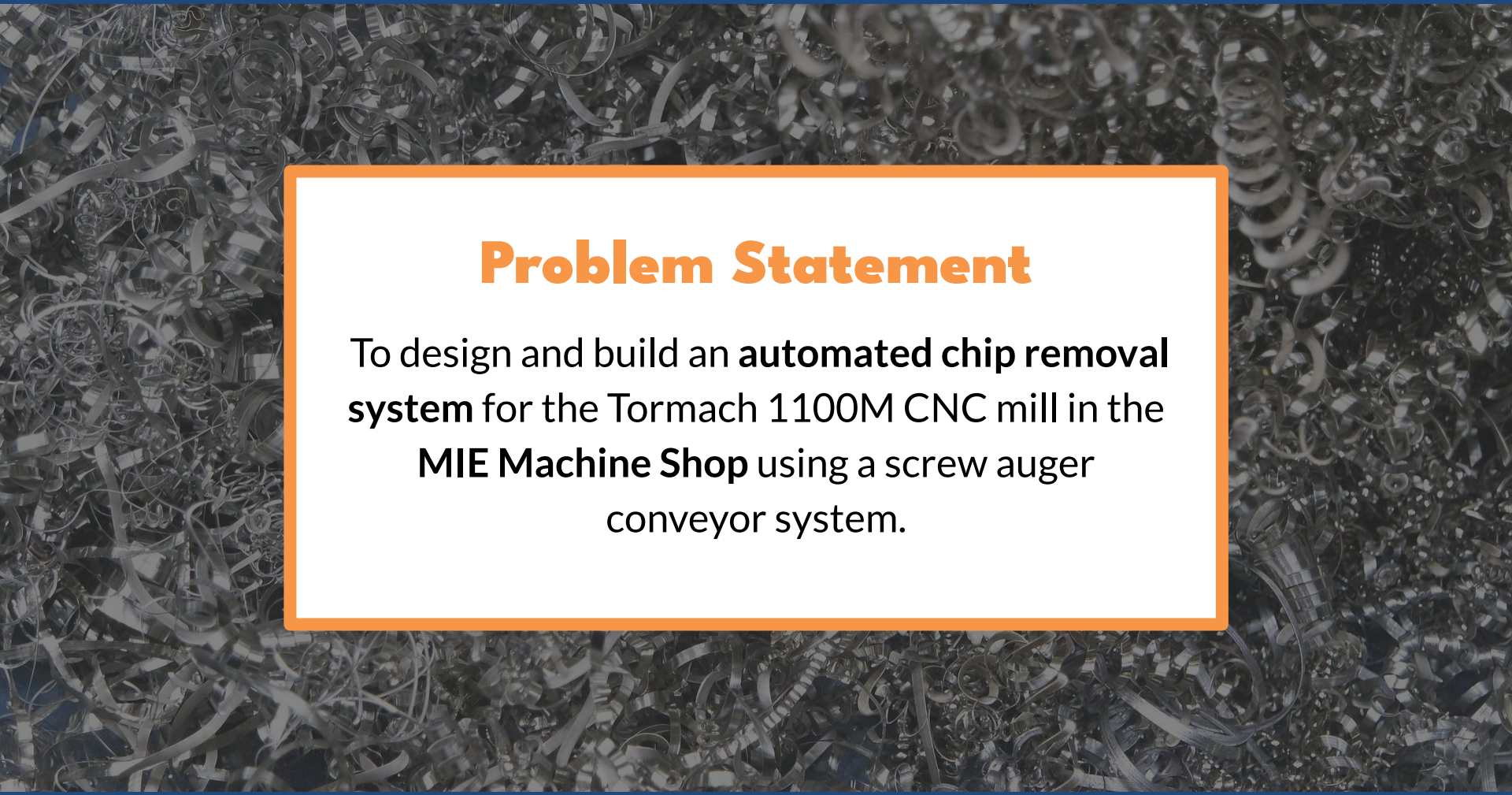
Advisor: Prof. Scott Julien

Client: MIE Machine Shop

Fall 2023



Problem Statement

To design and build an **automated chip removal system** for the Tormach 1100M CNC mill in the **MIE Machine Shop** using a screw auger conveyor system.

Problem Space

- Requested by the machinists in the MIE Capstone Lab
- Will benefit the machinists, capstone students, and any general students who use the lab for projects

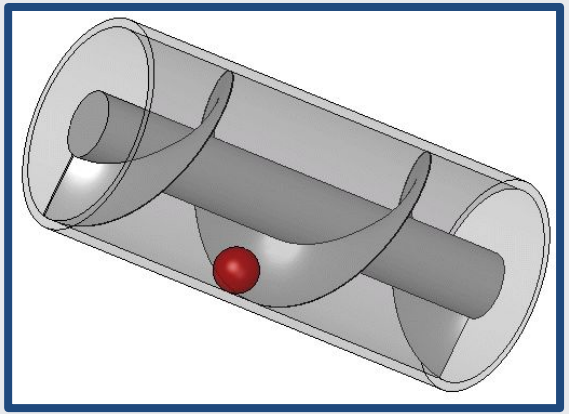
Motivation

- The Tormach 1100M does not have automatic chip management
- Chips are funneled into a small drawer at the bottom of the machine
- Drawer is emptied manually with a scoop

Prior Work

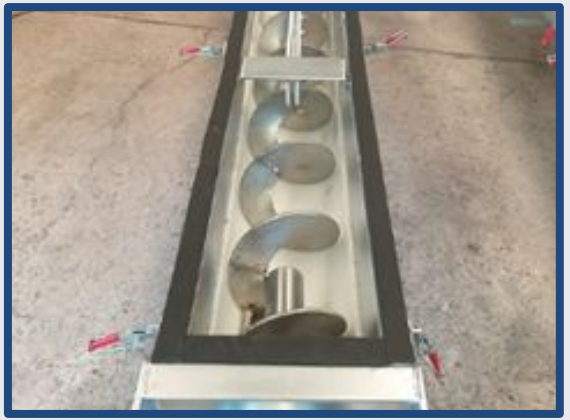
Chip Conveyor

- Pros: Lifts chips into taller bin, carries large volume
- Cons: Only works externally, expensive



Screw Auger

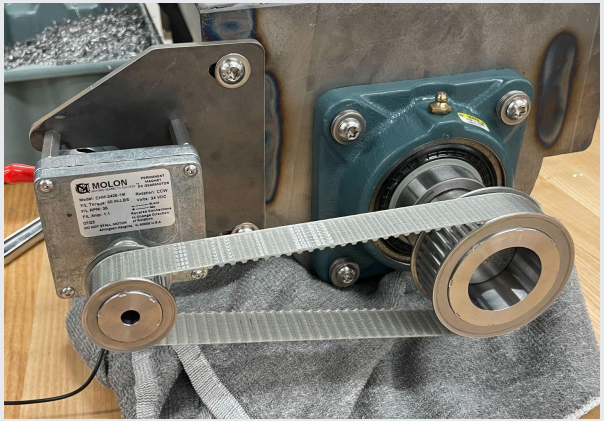
- Pros: Works internally, cost effective, withstands large torques
- Cons: Heavy

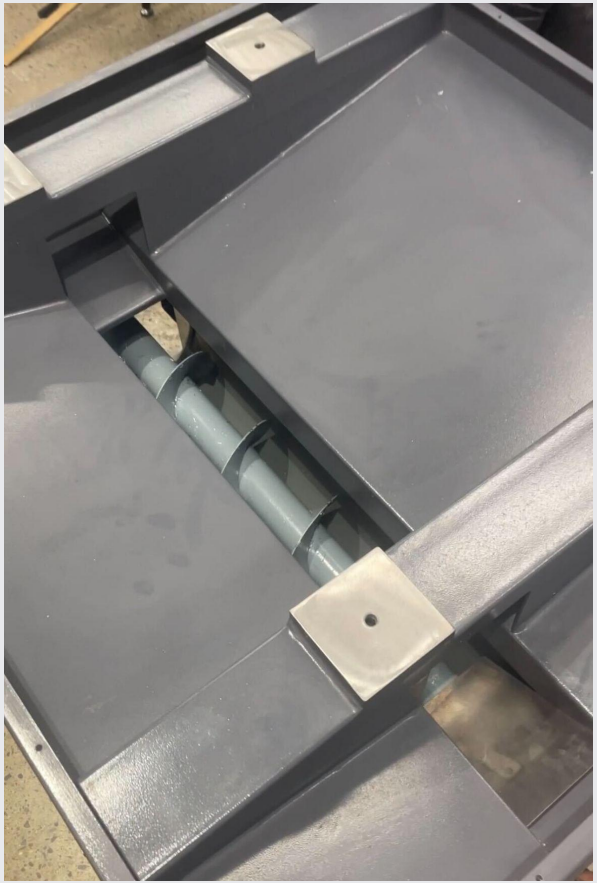


Shaftless Screw Auger

- Pros: Least likely to jam, uses less material, cost effective
- Cons: Not readily available

Design Solution





Main Challenges

Technical Challenges:

- Size constraints - Needs to fit in the base of the Tormach 1100M mill
- Durability - Needs to have a long life with constant usage
- Power Supply - Needs to run directly off of the mill power supply
- Safety - Needs to be safe for all users of the MIE machine shop

[1]

Logistical Challenges:

- Limited options - Very few screw augers available in the smaller size we require
- Budget - Needs to stay within the allotted Capstone budget
- Lead time - Need to purchase parts with a short enough lead time to come before Capstone Day

[2]

Team Design Process

Background research

Choose auger and trough design solution based on budget and size constraints

Create first prototype

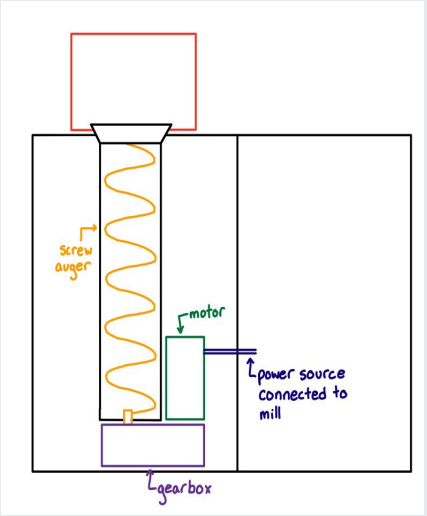
Test prototype

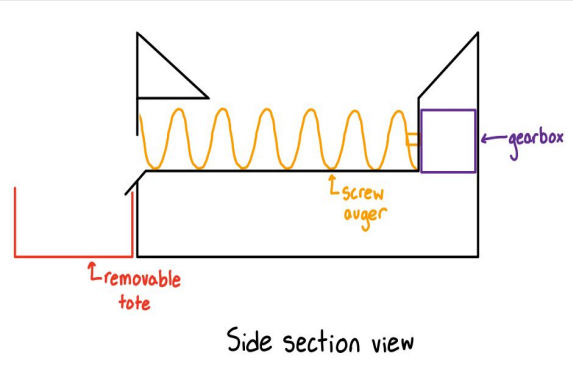
Modify components and implement motor and pulley system

Create second prototype

Modify mill base to house prototype and install

User testing



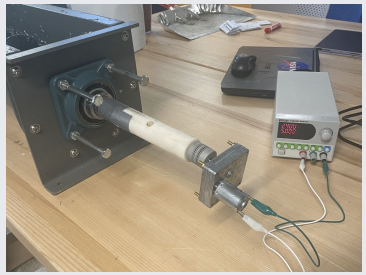


Initial Sketches

First Prototype Setup

Motor #1 Testing

Full Auger



Motor Setup

Discharge Spout

$$\tau = \frac{P}{\omega} = \frac{\eta I V}{\omega} \rightarrow \tau \propto I$$

$$safety\ factor = \frac{\tau_{jam}}{\tau_{max}} = \frac{I_{jam}}{I_{max}}$$

Motor Experimental Results

Experimental Values	Minimum	Maximum	Forced Jam
Current (A)	0.089	0.311	0.4
Power (W)	1.709	5.971	7.68
Torque (N-m)	1.360	4.752	N/A (w=0)
Torque (lbf-ft)	1.003	3.505	N/A (w=0)

The first motor had a torque safety factor of **1.2**

Second Prototype Setup

Motor #2 Testing

Discharge and Waste Tote

Motor Setup

Motor Experimental Results

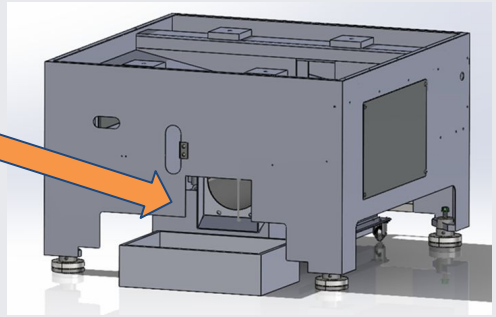
Experimental Values	Minimum	Maximum	Forced Jam
Current (A)	0.18	0.7	1.1
Power (W)	4.32	16.8	26.4
Torque (N-m)	3.3	12.834	N/A (w=0)
Torque (lbf-ft)	2.434	9.466	N/A (w=0)

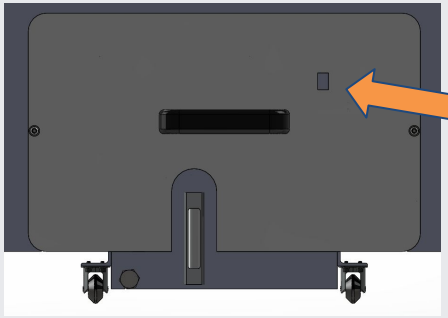
The final motor had a torque safety factor of **1.57**

Implementation Into Base

Finally, we cut four holes into the base of the CNC machine to make room for our prototype

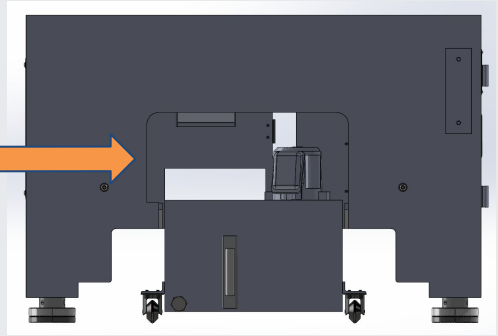
Discharge Hole

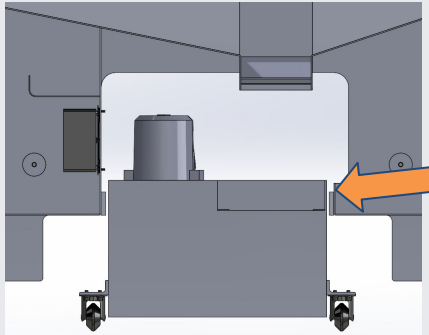




On/Off Switch Hole

Front Hole for Trough Clearance





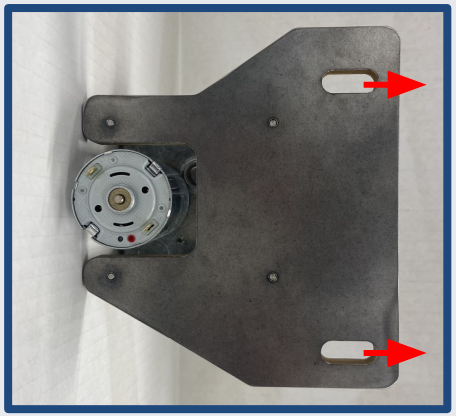
Drawer Hole for Trough Clearance

Key Successes

The team designed a prototype that...

- Removes over **95%** of chips
- Completes a full chip removal cycle in less than **45 seconds**
- Has been tested with a max. volume of **10800 ml** of chips

CNC Chip Auger 3.0

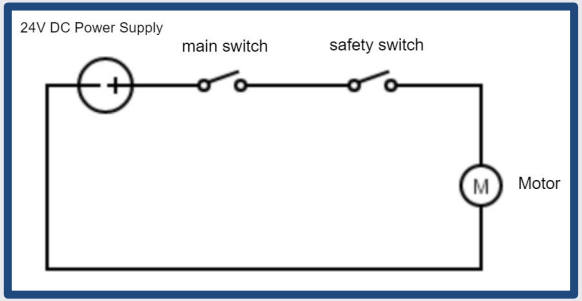


Motor Mounting Plate

- Edit to allow for more belt tensioning

Base Components

- Add a lock to the base drawer
- Better support the trough within the drawer

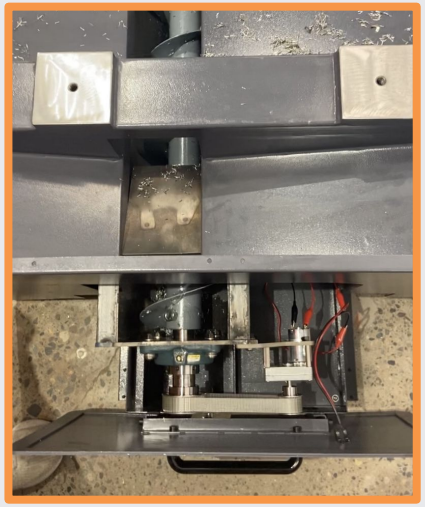


Wire Routing

- Complete wire routing to connect the chip auger to the CNC mill power supply

Impact & Exit Strategy

Our prototype offers an automatic, mess-free approach to chip management for the Tormach 1100M



- Hand off project to NEU machinists
- Provide part drawings and necessary information to manufacture
- If the system is successful, four more models will be made and put into the CNC mills in the machine shop


THANK YOU!
Questions?