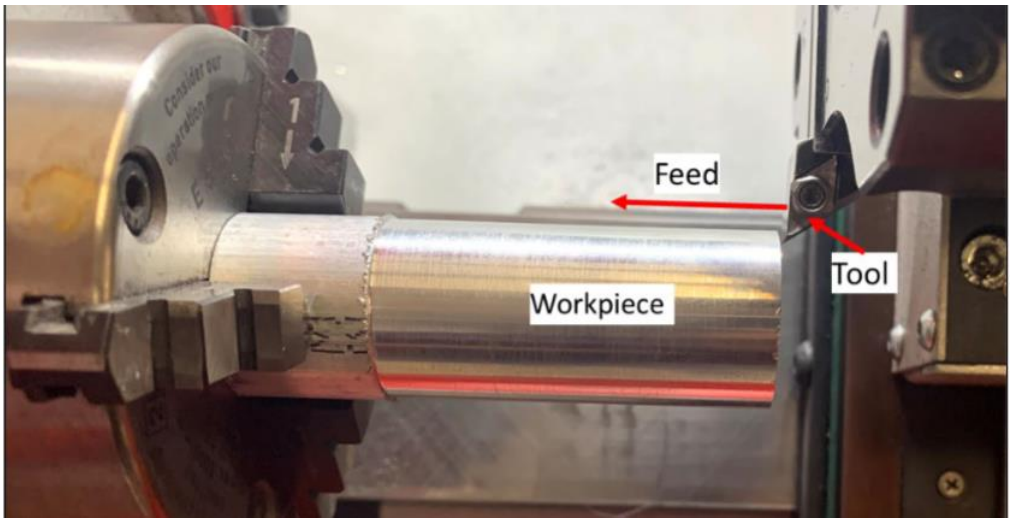
Machining Process Analysis

Additive and Subtractive Processes in Custom Manufacturing Graduate Level Project:

This project is intended to demonstrate the difference in values between theoretical and experimental calculations of power consumption and surface roughness in CNC turning machining. Specifically, aluminum alloy and cast-iron pieces are cut with a carbide insert while spindle power and surface roughness are sampled and tabulated. Each material is tested twice, with each trial conducted at different cutting speeds. Experimental machining power and surface roughness can be determined with the comma separated value data. With the following parameters, theoretical machining power and surface roughness can also be estimated.

In this project, it can be seen how accurate the theoretical calculations are for power consumption and surface roughness and what the limiting factors may be. The project is based on a CNC turning experiment that was conducted in Dr. Tai's lab at Texas A&M Mechanical Engineering department. The setup is shown in the picture. The cutting tool was a carbide insert with a 95° major cutting-edge angle and a 30° minor cutting edge angle and it had a nose radius of 0.1 mm. Two materials, cast iron (CI) and aluminum alloy (Al), were selected as work-materials with the machining parameters listed below. Note this is a two-factor (material and speed) full factorial experiment. During the cutting process, spindle power was sampled using a power cell at 250 Hz (i.e., 250 data points per second). After machining, each sample was measured using a profilometer to obtain surface profile data at every 0.5 μm interval (i.e., 2000 data point per 1 mm). In the attached Excel file, two sets of data sorted in two columns for each test can be seen.

	Feed (mm/rev) -controlled	**Speed (m/min)**	a_p (mm) - controlled
Test 1 - Al	0.1	**75**	0.5
Test 2 - Al	0.1	**120**	0.5
Test 3 - CI	0.1	**30**	0.5
Test 4 - CI	0.1	**50**	0.5



Problem Statement & Goal:

Calculate theoretical machining power and Ra for all the four cases. Use the data provided to calculate machining power and Ra for each of the cases. Compare the machining powers and analyze discrepancies. Explain possible causes for the over- or underestimated power prediction. Compare the roughness values. Explain possible causes for discrepancies and their dependency on speed and material.

Concepts learned while working in this project:

- **Select** proper **manufacturing methods** for a custom design.
- Evaluate **pros and cons between subtractive and additive manufacturing** processes.
- Describe the capabilities of traditional and non-traditional machining processes.
- **Analyze the surface finish based on the process and material**.
- Describe the mechanisms of different additive manufacturing processes.
- **Design** and analyze **manufacturing processes** via team projects.