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FACULTY OF ENGINEERING

MECH Group 1

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Improvements to the Process of Cutting Plastic Lumber

Introduction

LakeCity Works engaged MECH Group 1 to assist in an ambitious new project to repurpose single-use plastics. LakeCity has been using plastic lumber, made from recycled plastic, to produce outdoor furniture such as picnic tables and planters. However, this material is impure and inconsistent, leading to significant difficulty in processing.

The primary focus of the project, as requested by LakeCity, was to improve the process of cutting. Plastic lumber is an abrasive material, full of metallic impurities that cause excessive blade wear. Additionally, the composition of plastic can vary, leaving large differences in the brittleness of the material and influencing both blade life and cutting quality.

The primary issue addressed by MECH Group 1 is blade tooth deterioration, which makes the process of cutting lumber time consuming and expensive. The main goal of this project is to lower cutting cost and increase blade life by characterizing the cutting process.

Design Process

The experimental design investigated all major components of cutting. These components include:

1. Blade rotational speed
2. Blade size
3. Tooth pitch
4. Rake angle
5. Blade Material
6. Cutting force
7. Temperature
8. Gullet size

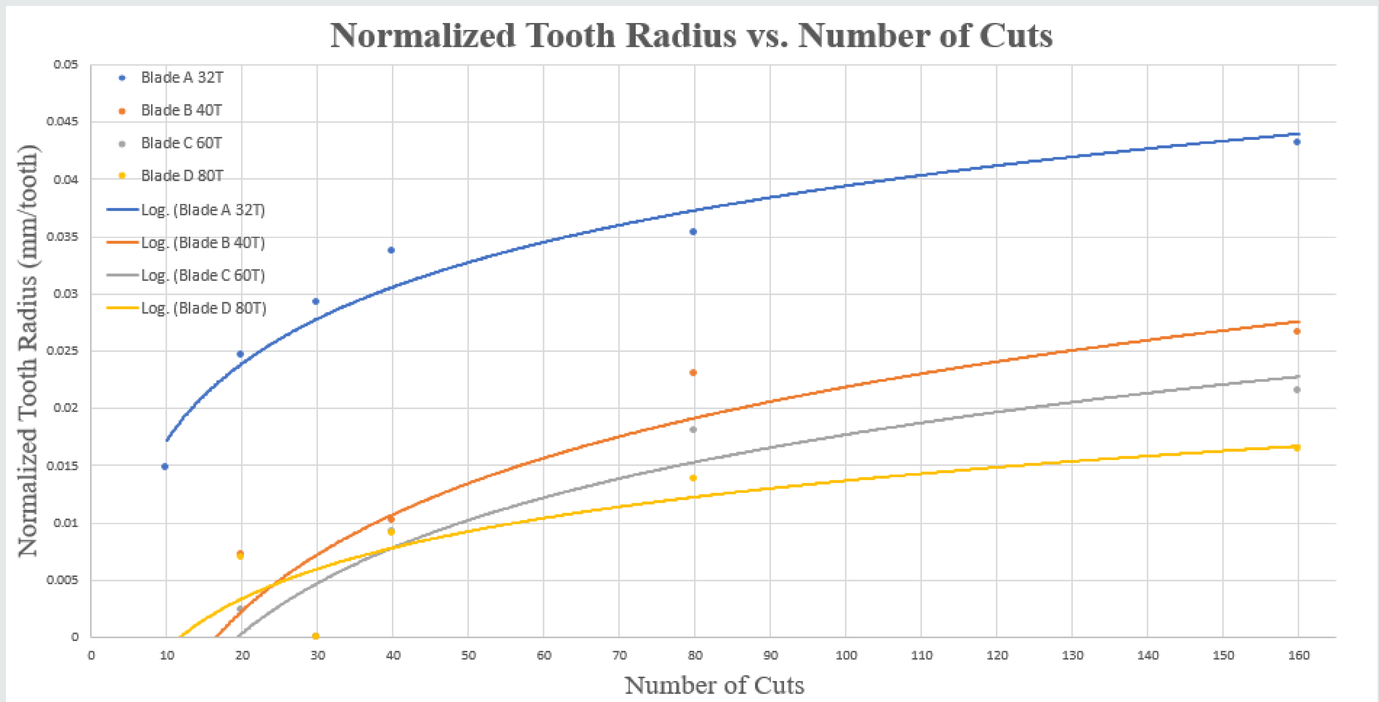
After preliminary research and initial testing, several variables were determined unnecessary or untestable at the current operational scale. The variables that were chosen to be excluded include: rotational speed monitoring, blade material, temperature altering (cooling), and cutting force measurements.

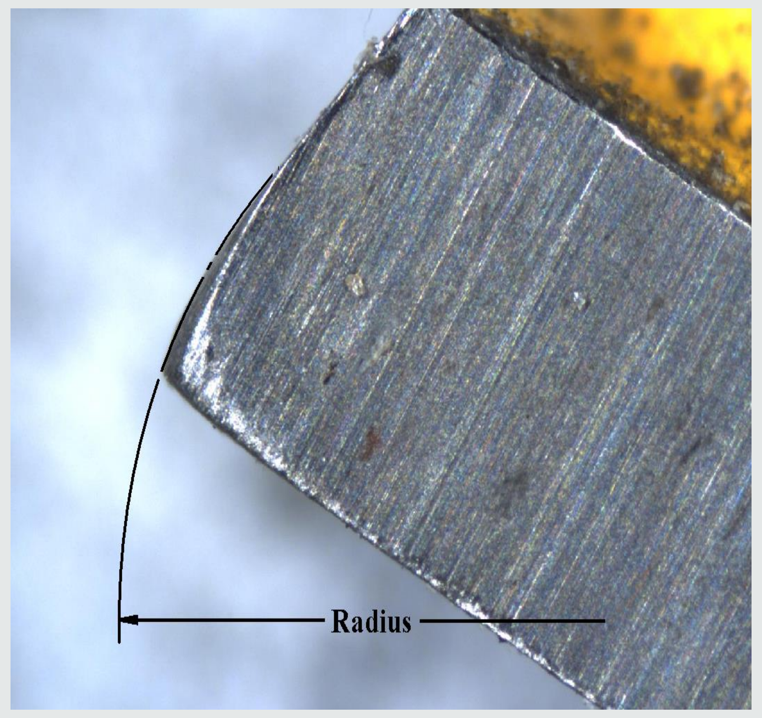
The independent variables altered during testing were tooth pitch, tooth geometry, and rake angle. The dependent variables and performance indicators included cutting temperature, cutting speed, saw tooth wear, chip formation, and surface finish.

Procedure

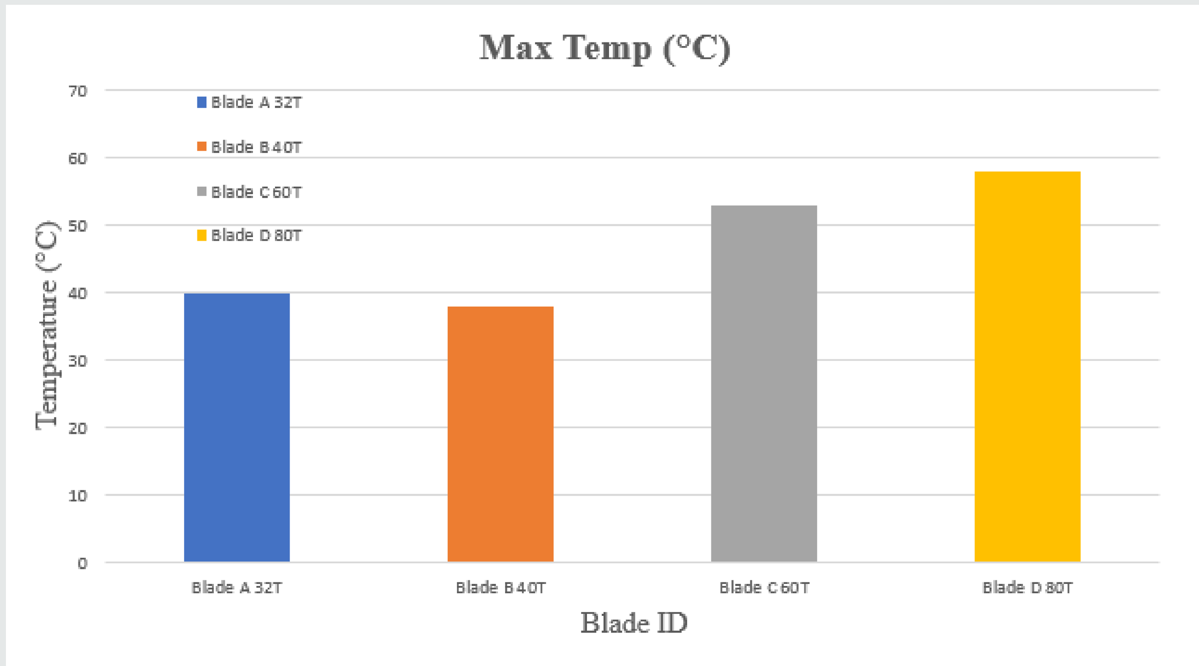
Data was collected through a controlled cutting procedure. Cutting was conducted in timed sets of ten, and blade temperature was measured throughout. Peak temperatures were recorded. Images of cutting edges were photographed under a stereo microscope prior to cutting and at intervals of 20, 40, 80, and 160 cuts thereafter.

Results

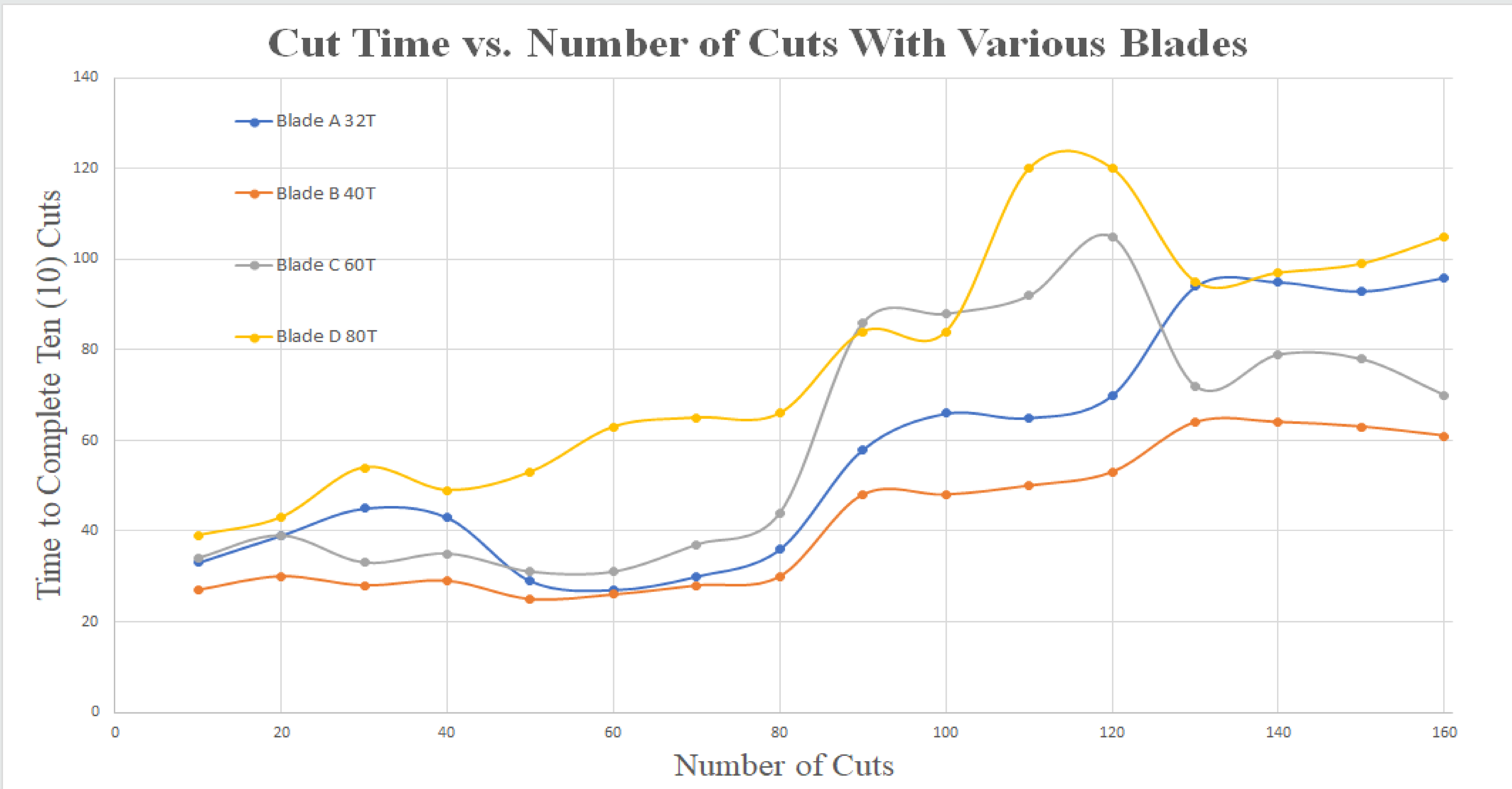




Stereo microscope images were taken of specific teeth on all blades after each cutting interval. The images were imported into SolidWorks and sketching tools were used to determine tooth radius. The graph above shows that low tooth pitch (teeth per inch) blades wear faster than high tooth pitch blades.



Less teeth tended to produce long continuous chips, which removed heat more effectively. Higher tooth blades tended to melt the plastic, resulting in a build up of molten plastic, which clogged the blade teeth. Rake angle was found to only slightly affect heat generation during cutting.



Cutting time increased with the number of cuts preformed on a blade. Blade B cut plastic the fastest, however it's geometry resulted in a rough surface finish. Blade A provided a very fine surface finish, while also operating quickly within its effective lifespan. Blade D gave an excellent surface finish, however its long cutting times precluded it from being a top choice.

Conclusion and Recommendations

- It was found that tooth pitch and gullet size were the most influential on the dependent variables. A summary of the effect of tooth pitch and gullet size is given below.
  - ↑Tooth Pitch, ↓ Wear rate
  - ↑Tooth Pitch, ↑ Cut Temperature
  - ↑Tooth Pitch, ↑ Cut Time
  - ↑Gullet , → Abrasive finish
  - ↑ Gullet. ↓ Cut Time
- While recommendations were primarily made using the quantitative conclusions as justification, team members also applied qualitative data such as how the cutting felt, and cut profile aesthetics to issue recommendations to LakeCity.
- Recommendations for LakeCity include:
  - Investing in cheap, low tooth pitch, high rake angle blades (See Blade B);
  - For high quality finish use small gullet (tooth pitch) blades; and
  - Engage a Dalhousie senior design team next year to design a saw blade cooling system.

References and Acknowledgements

- Dr. Noubar Yemenidjian
- Dr. Alex Kalamkarov
- Mr. Robert Warner

- Kalpakjian, Serope, and Steven R. Schmid. *Manufacturing Engineering and Technology*. Pearson/Prentice Hall, 2014.
- Hibbeler, Russell C., and Kai Beng Yap. *Mechanics of Materials*. Pearson, 2018.
- Incropera, Frank P. *Fundamentals of Heat and Mass Transfer*. Wiley, 2013.
- Moran, Michael J., et al. *Fundamentals of Engineering Thermodynamics*. John Wiley & Sons, Inc., 2018.