Advancing the Understanding of Maker Communities

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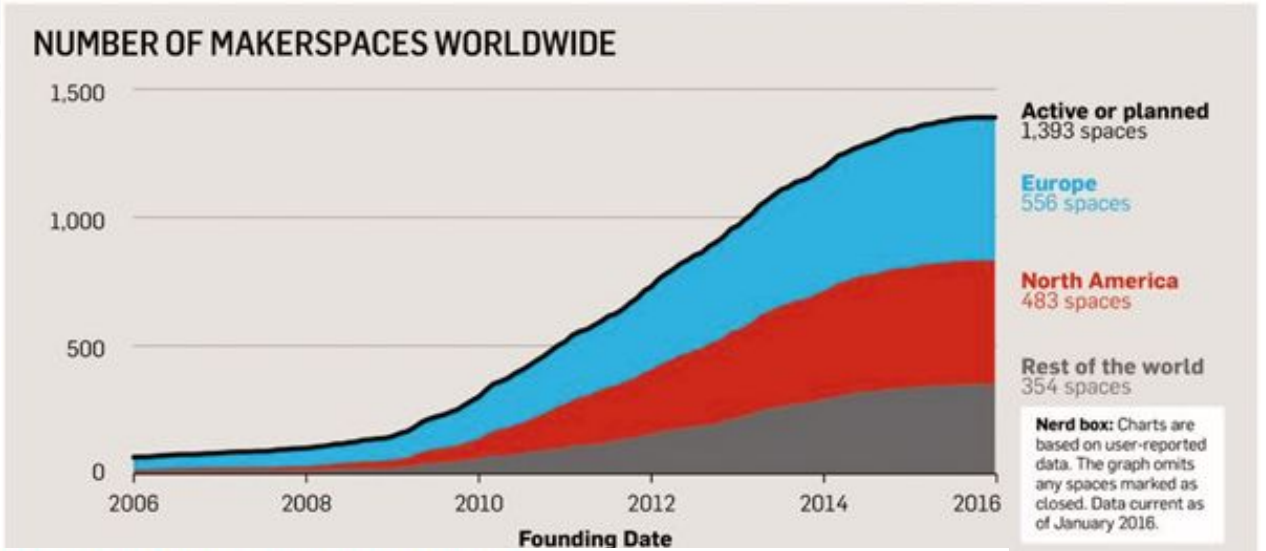
ETI Thrust Area 2: Advanced Manufacturing for Non-Proliferation (July 2020)

What is a makerspace?

A collaborative work space to make, learn, explore and share

- Peer-to-peer learning
- Hands-on
- Shared Ownership
- Creative self-efficacy



Lou, Nicole, and Katie Peek. "By the numbers: The rise of the makerspace." Popular Science 288.2 (2016): 88

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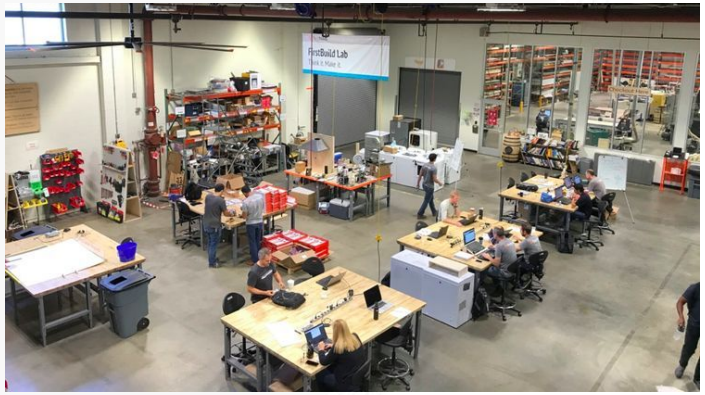
Examples of makerspaces

FirstBuild Microfactory - For Profit

Freeside Atlanta - Public Nonprofit

Stevens STEM Truck - Mobile



GE FirstBuild - Corporate

Case Western THINKBox - Higher Education

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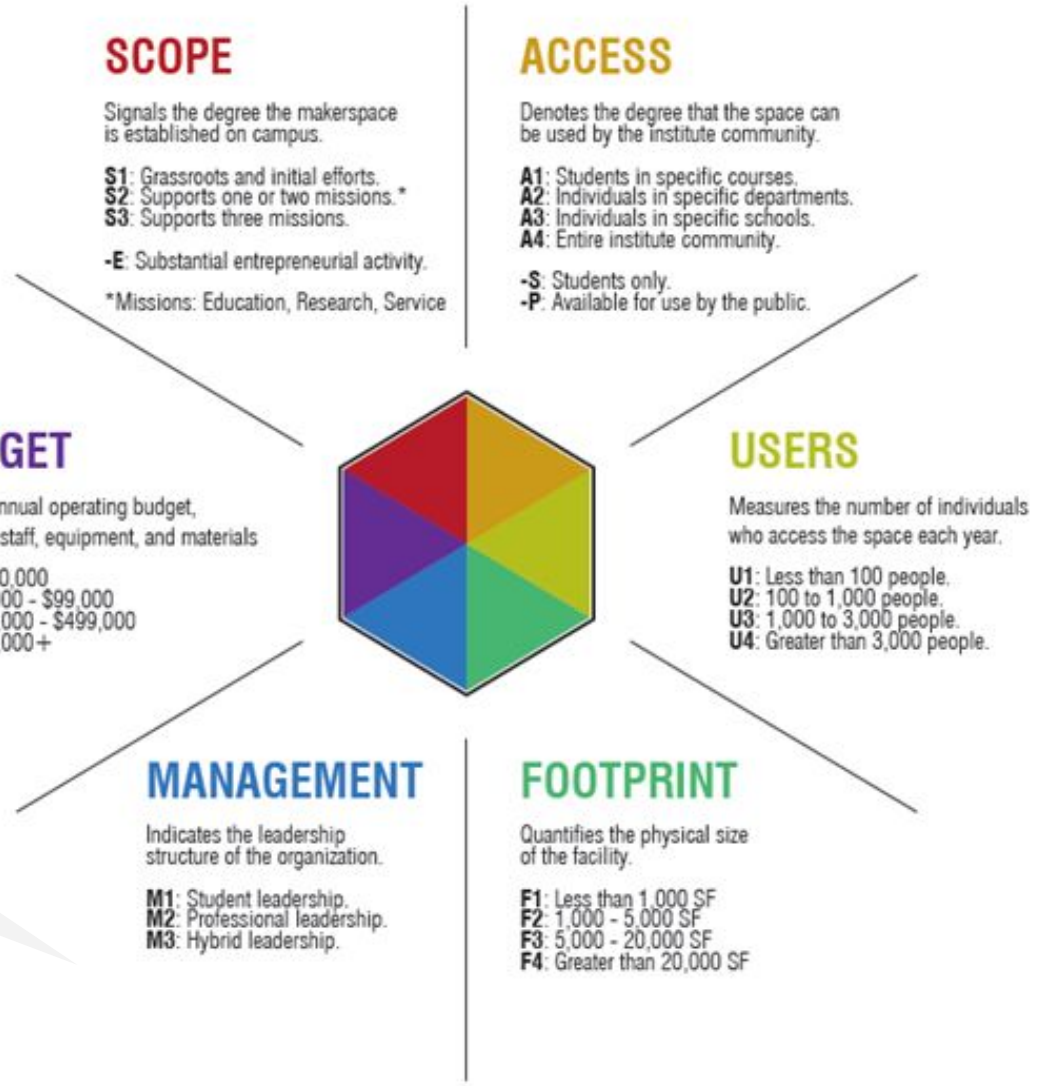
How to classify makerspaces?

- M-1: Primarily Student managed and staffed
- M-2: Faculty/Professionally managed and professionally staffed
- M-3: Faculty/Professionally managed with a hybrid (professional and students) staff



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How to classify makerspaces?

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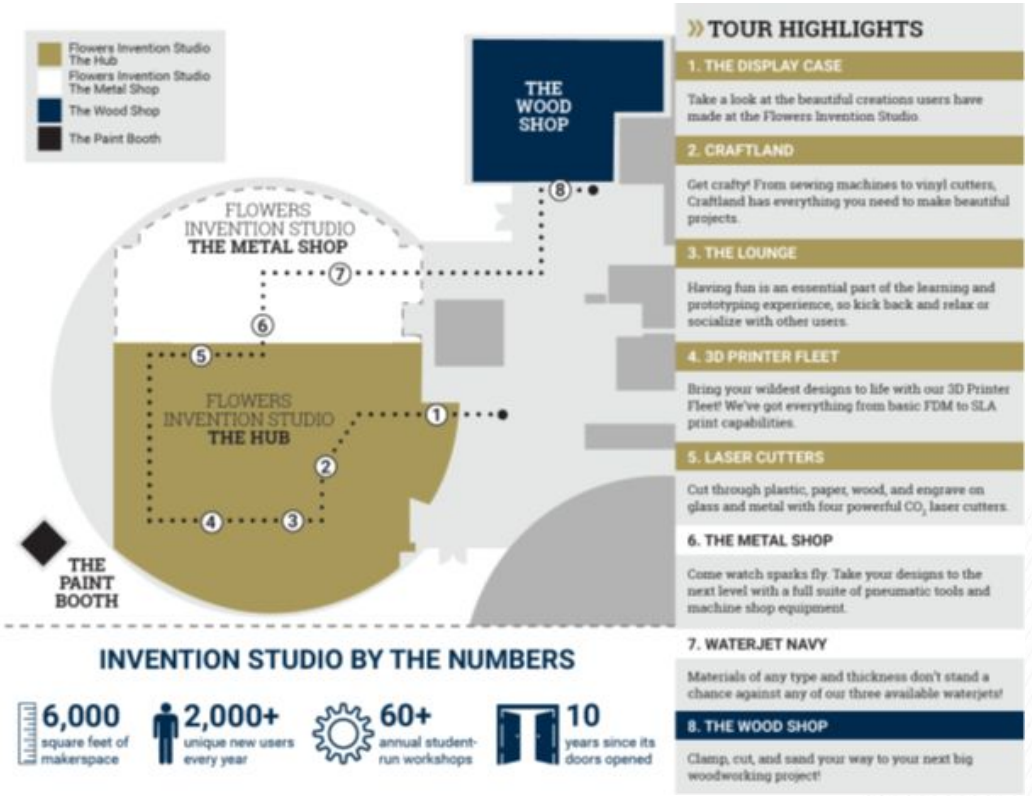
What is the Invention Studio?

- Accessible during work hours by anyone at Georgia Tech
- Staffed entirely by student volunteers who receive 24/7 access

2,268	Unique Users
34,245	Tools Used
196,984	Total Tool Usage Hours
118	Total Student Volunteers

Annual data from 2019



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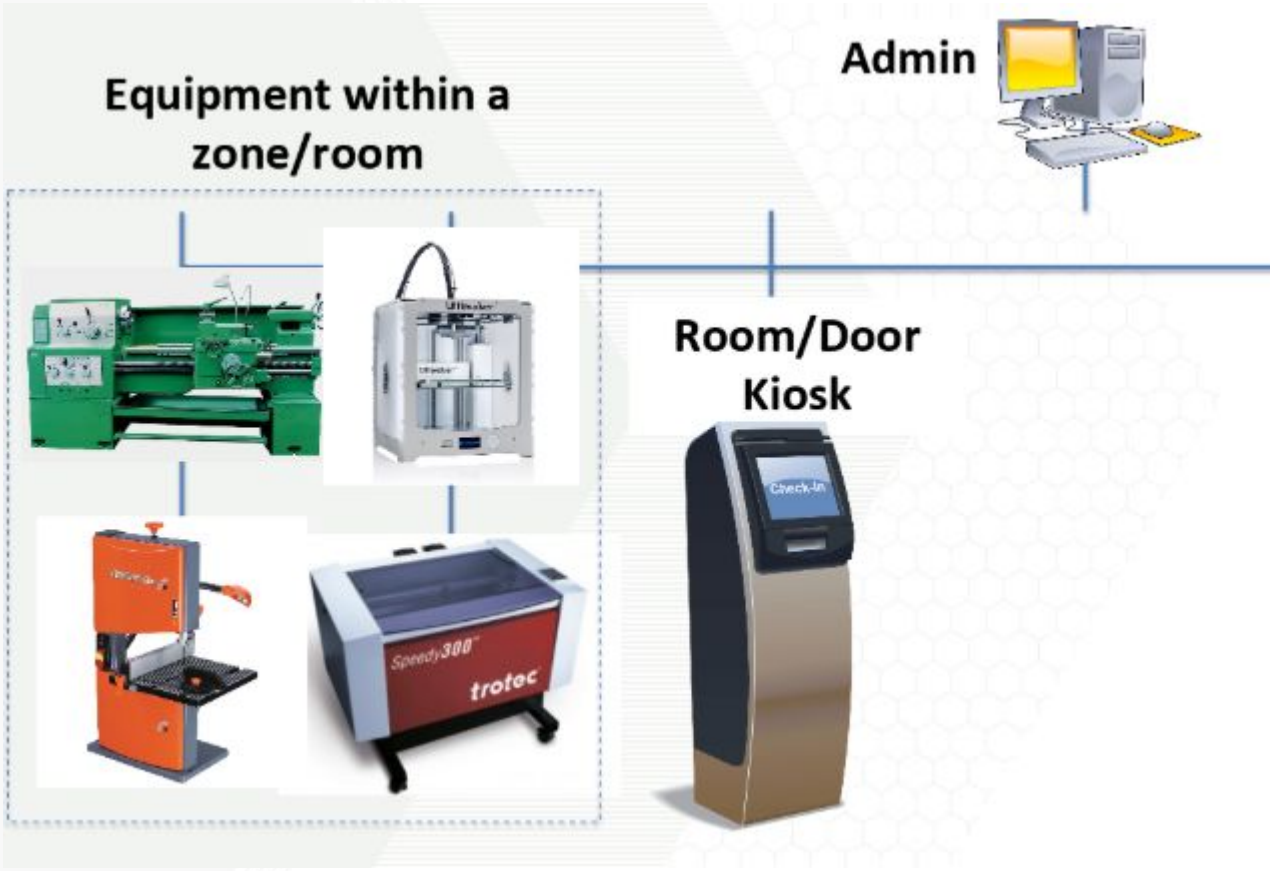
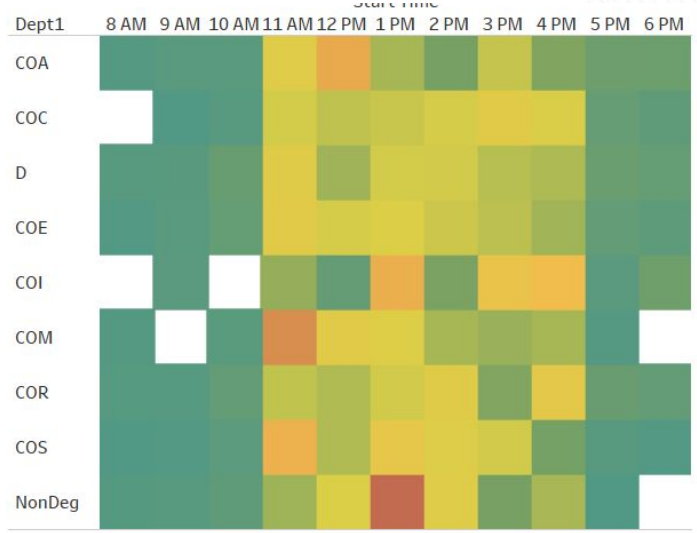
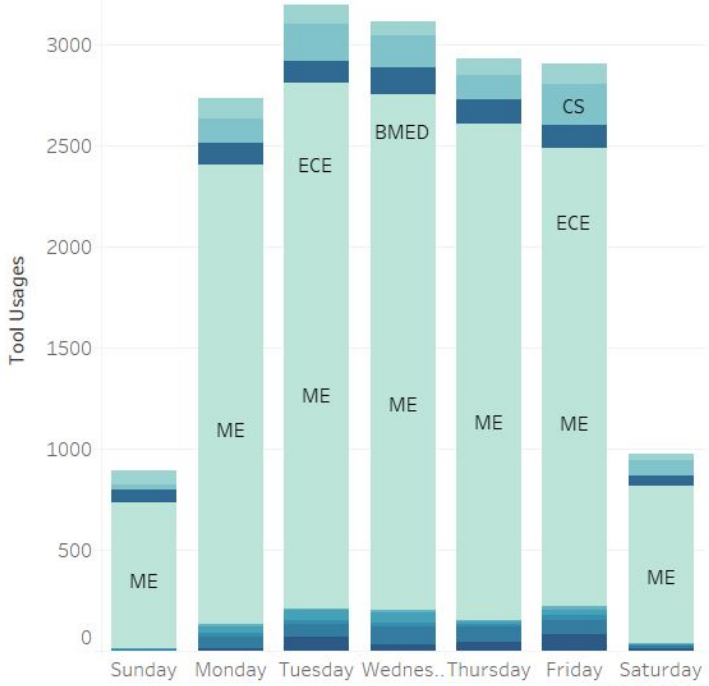
Makerspace usage Data Streams
(through manual intervention)



TIME OF DAY



WEEKDAY



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Makerspace side-channel data streams

- What can side channel tool data tell us about the user and the activity?
- How can it help with accessing,comparing and benchmarking makerspaces?

Side Channel Data Collection Techniques - WIP

- Development of material detection utilizing gas sensing and classification technologies for laser cutting usage characterization is ongoing.

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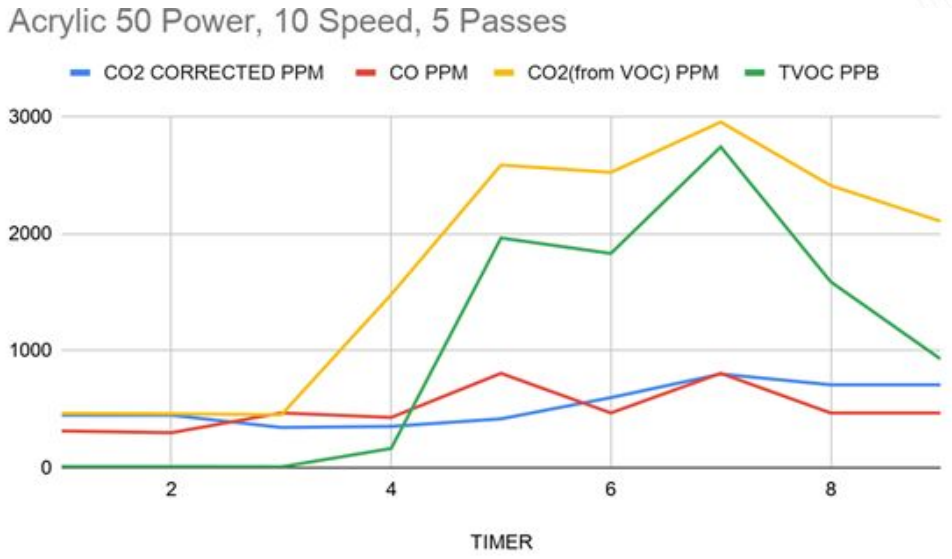
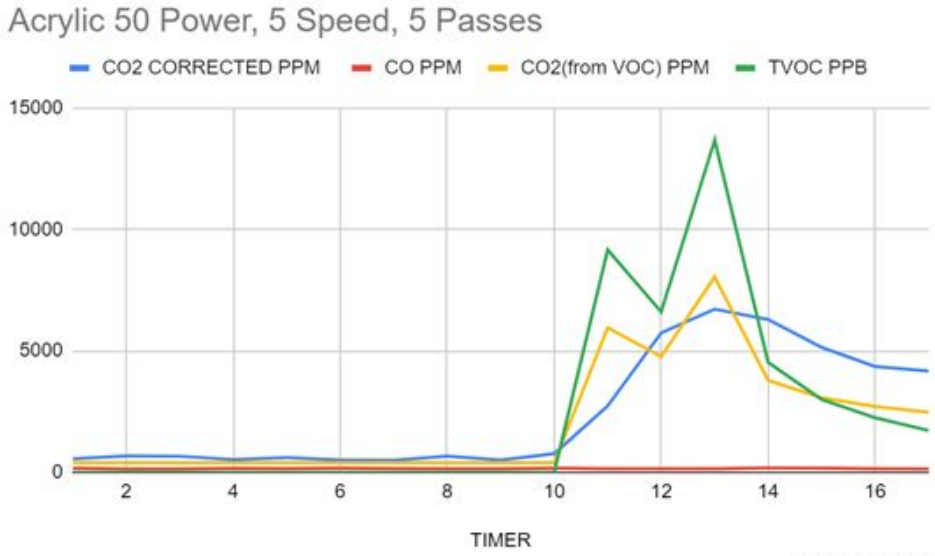
Ongoing Side Channel Data Development - Current Status

- Designed and built low cost circuits to collect emission data and conducted design of experiments to determine parameters needed to identify cut materials
- Initial data showed feasibility in the ability to detect the differences in categories of materials (Plastics vs woods, etc.)
- Increased granularity is expected to be attainable through improved sensor selection.
- Reaching out to Honeywell and others for sensor recommendations





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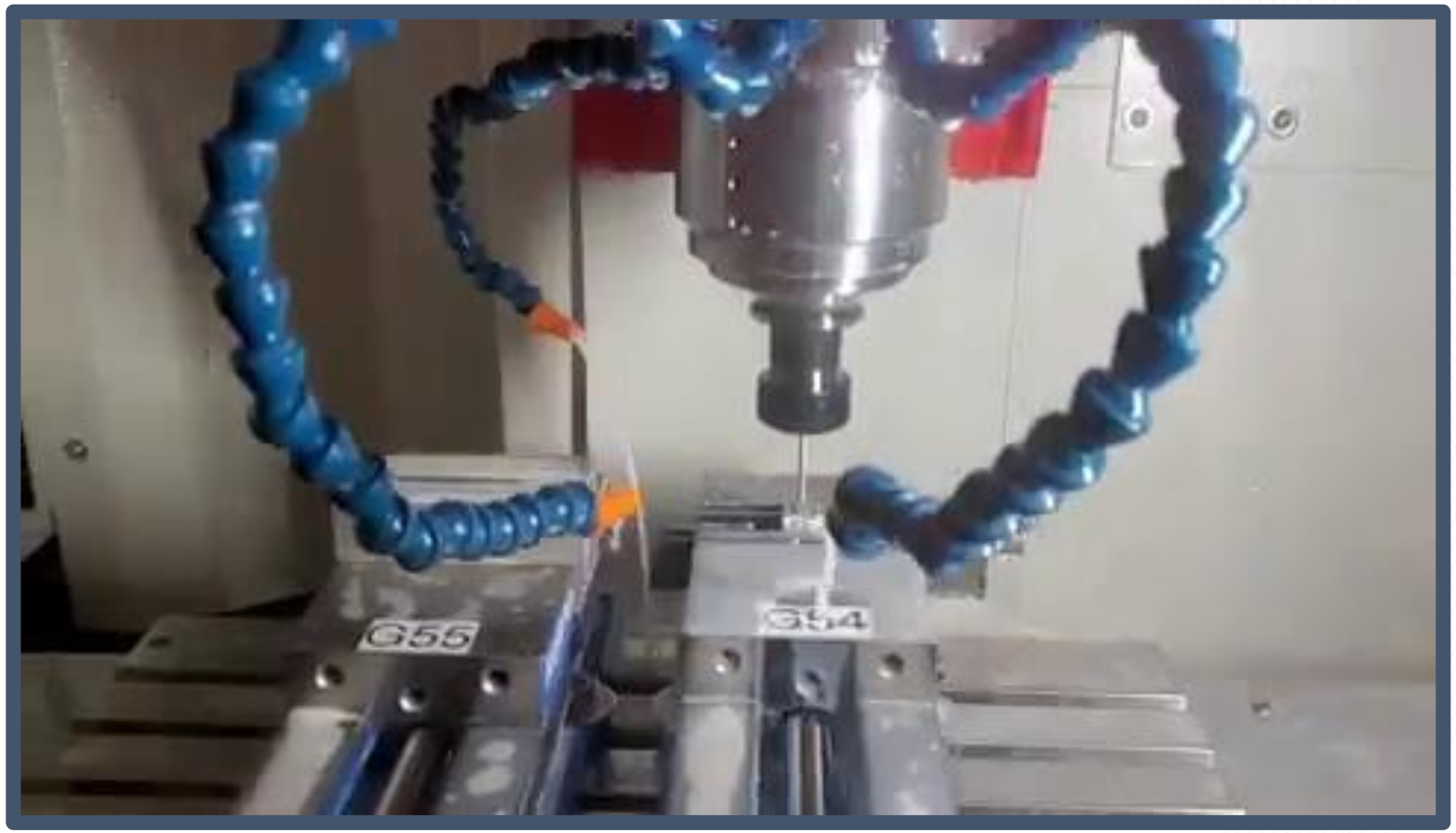
Ongoing Side Channel Data Development - Future Plan

- Develop the granularity of the types of materials the system is able to distinguish
- Solve the issue of sensor fouling due to exhaust soot
- Work with the manufacturer (Trotec) to broaden the testing and verification of our system
  - Variety of machine types and materials
  - Fiber Laser marking may be of interest with its applications in production batch tracking
- Alert system for users and staff for detected unsafe or questionable condition - will help make makerspaces safer!

New Side Channel Data Collection from CNC machines

- Another common tool found in other local makerspaces are CNC Mills
- The ability to identify the materials being processed here would allow for many different formats of monitoring by capturing G-code and built-in sensor data.
- Reliant on data from solely the internal sensors of the machine
- Data transmission through existing industry standards and protocols to an AWS server for predictive analysis



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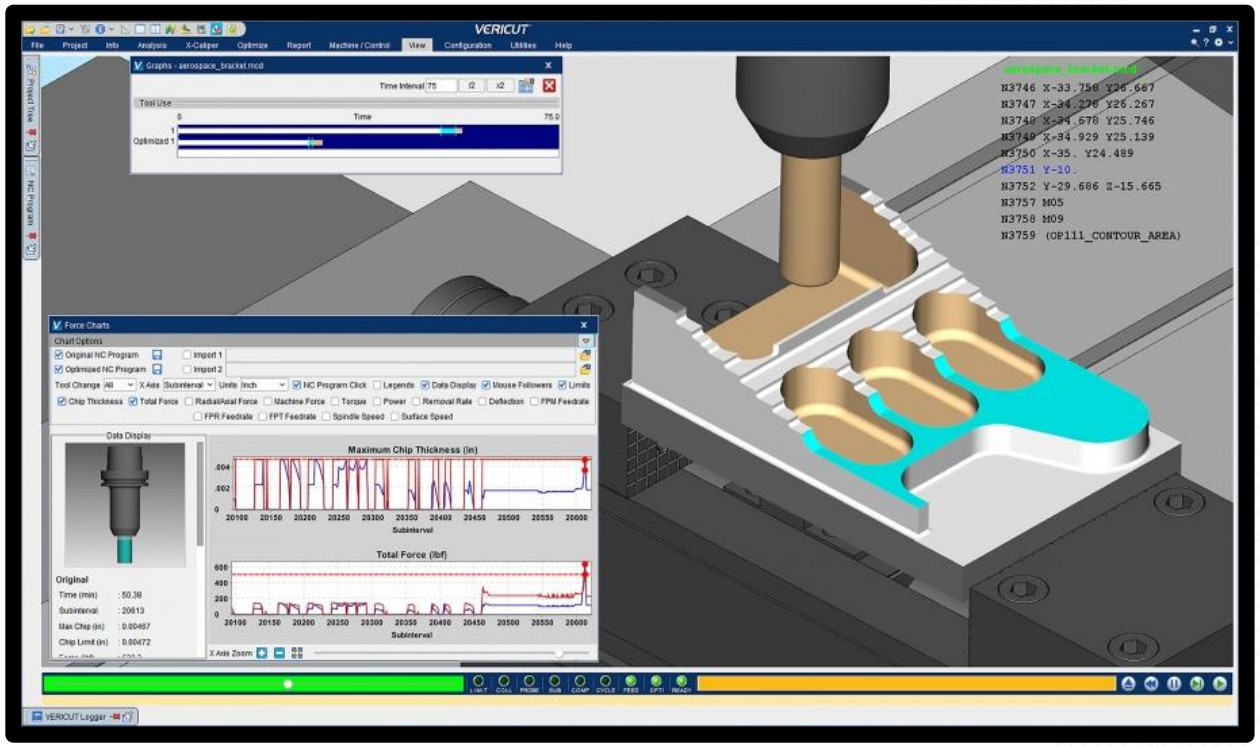
New Side Channel Data Development - Current Status

- Current simulation software is already developed to estimate cutting forces and cutting loads (VeriCut by CGTech).
  - Used here for the baseline comparison between material types.
- The system we propose is designed to compare the simulation data with the measured machine data to make a material prediction.
- The license key has been obtained for the OPC-UA and VeriCut software



- The raw data export and storage system is being configured for testing to start later this month.

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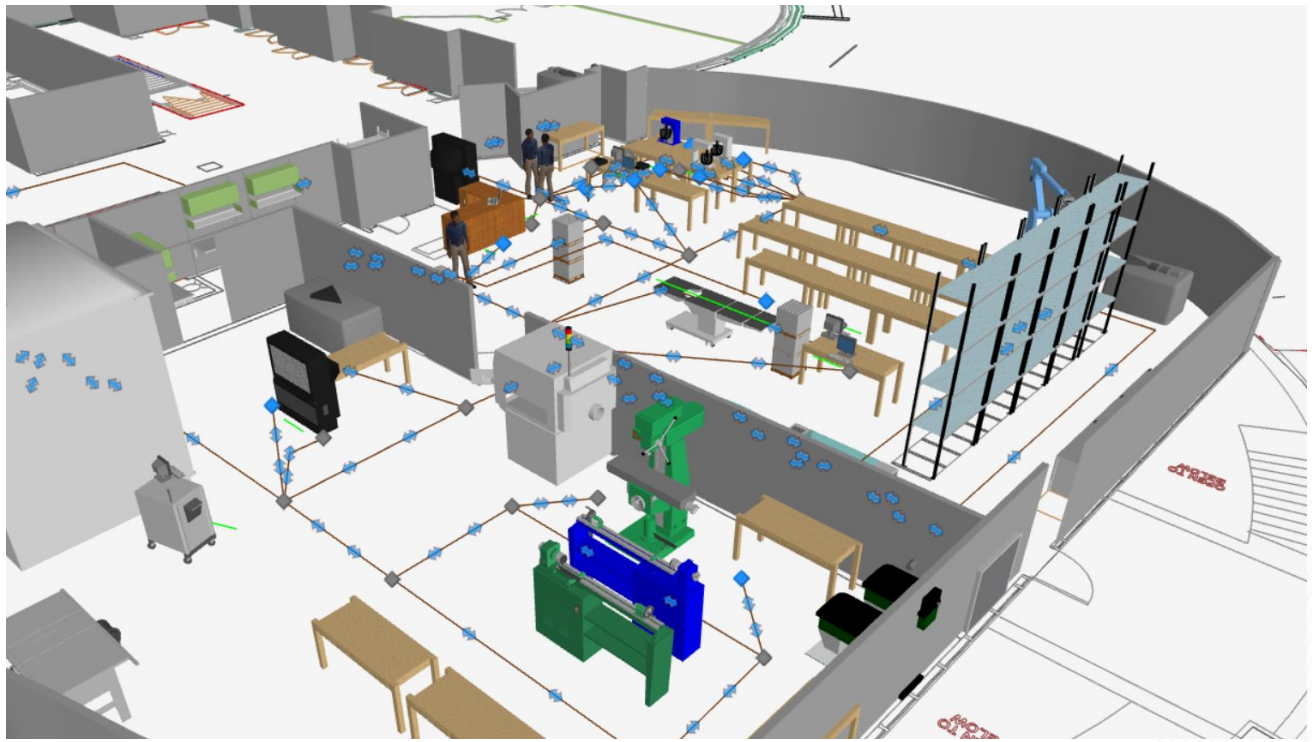
New Side Channel Data Development - Future Plan

- Development of a ML algorithm for analysis of the machine data and matching to a material cut profile.
- Determine the effect on this algorithm from the tool path selected.
  - Tool paths to be tested:
    - 2D / 3D Adaptive
    - Conventional pocketing
    - Drilling
    - Side Milling
    - Slot Milling
    - Facing
  - Ideally, one of these will be able to be shown to be an easy indicator of the material type.

Simio

Forward Thinking



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Thank You

- Summary of current and ongoing work
  - A framework to assess/compare makerspaces to better understand maker communities
  - Novel techniques to extract data from makerspace equipment/tools to create insights about the community and the activities within the space
  - Study and analysis of side channel data from manufacturing equipment like laser cutters and CNC machines to estimate materials being used

- Potential wider impact of research
  - Improve understanding of makerspaces used for education, training and innovation
  - Enhance safety features and reliability of advanced manufacturing tools
  - Improve final product quality resulting from manufacturing