Bringing Legacy Small and Medium Enterprise Manufacturers into Digital Manufacturing and Towards a Distributive Manufacturing Network

Daniel Abernathy
Greg Harris, Ph.D., PE
Gregory T. Purdy, Ph.D.
Thomas Holtslander
• Design and Manufacturing Lab (DML)
• Required for Mechanical Engineering students
• 300-400 students per year
• Repeat same project
• Investigating methods to connect machines that were never intended to be connected.

• Help SMM understand benefits of a connected system.

• Provide a resource to the SMM to determine the options they have for connecting equipment.

• What data can be captured from legacy manual equipment not intended to be connected to the internet?

• How can the information from the sensors be best used?

• Evaluate configuration of sensors and collectors to determine the cost benefit relationships.

• Educational benefit of replicating the experience of a knowledgeable/seasoned expert machinist by capturing acoustic signals and connecting those to outcomes of parts.
Data Needs

- Predictive Maintenance
  - Vibration
  - Acoustics
    - Spindle Speed
    - Motor Current Draw
  - Position
  - Operator Tracking

- Teaching

- Quality
Data Needs

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  - Vibration
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Data Needs

- Predictive Maintenance
- Teaching
- Quality

- Vibration
- Acoustics
- Spindle Speed
- Motor Current Draw
- Position
- Operator Tracking
Sensor Selection

- **Vibration**
  - Accelerometer in head
  - Accelerometer on the vise
- **Acoustics**
  - Acoustic emission sensor near tool
- **Spindle Speed**
  - Hall effect sensor on spindle
  - Infrared sensor on spindle
- **Motor Current Draw**
  - Current transducer on motor power
- **Position**
  - Magnetic scales on table
  - Encoder on lead screws
- **Operator Tracking**
  - RFID tags and scanner on machine
## Possible Sensor Array

### Multiple price point sensor arrays

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• Initial Focus
  ▪ Mills

• Two different models
  ▪ Shop Fox
  ▪ Grizzly
Lab Wide Implementation

SYSTEM CONTROL CENTER

SERVER

COLLECTION AND ROUTING SYSTEM

SENSORS

MILLS

LATHES
RFID Tracking

• Track operator usage of machines
  ▪ Log which operator is using the machine
  ▪ Log progress through project

• Track tools used in lab
  ▪ Track total service time of tool
  ▪ Track abnormal use

• Align outcomes with operator actions
  ▪ Before sensor installment feature quality
  ▪ After sensor installment feature quality
Plan Forward

• Data Analytics
  ▪ Large volume of non-IP manufacturing data

• Campus Dashboard
  ▪ Centrally located display with:
    o Machine status
    o Machine statistics

• Initial Node of Distributed Manufacturing
  ▪ Connected machines
  ▪ Trained operators
  ▪ Project monitoring process
  ▪ Machine statistics