# Q-06-SC

# Artificial intelligence integrated near-infrared hyperspectral imaging for rapid prediction of percent wood failure (PWF) in laminated wood products

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**Anticipated Start Date:** *August 2024* | **Expected Duration:** *24 Months*

# Need & Industrial Relevance | Goals & Objectives

## Need & Industrial Relevance

Rapid and accurate prediction of percent wood failure (PWF) in adhesive bonds is a crucial QC task, however accurate and rapid assessment is problematic. Owing to the importance of PWF there is strong interest in developing an alternative.

## Research Roadmap Topics

The research proposed corresponds to Research Theme A. Improved Performance and Functionality, 3b. Performance Evaluation - Improved test methods.

## Long Term Goals

Our goal is to utilize visible and near infrared hyperspectral imaging (Vis-HSI and NIR-HSI respectively) combined with artificial intelligence (AI) modeling to provide an objective, smart assessment of PWF in shear samples. Specifically, we are interested in using the spectral data collected from veneers prior to adhesive application and hot pressing to predict the PWF.

## Objectives (year 1)

- An AI model for rapid evaluation of PWF based on hyperspectral image data.
- Evaluation of AI model performance based on different wavelength ranges.
- Vis-HSI and NIR-HSI data collection from veneer.

# Materials and Methods

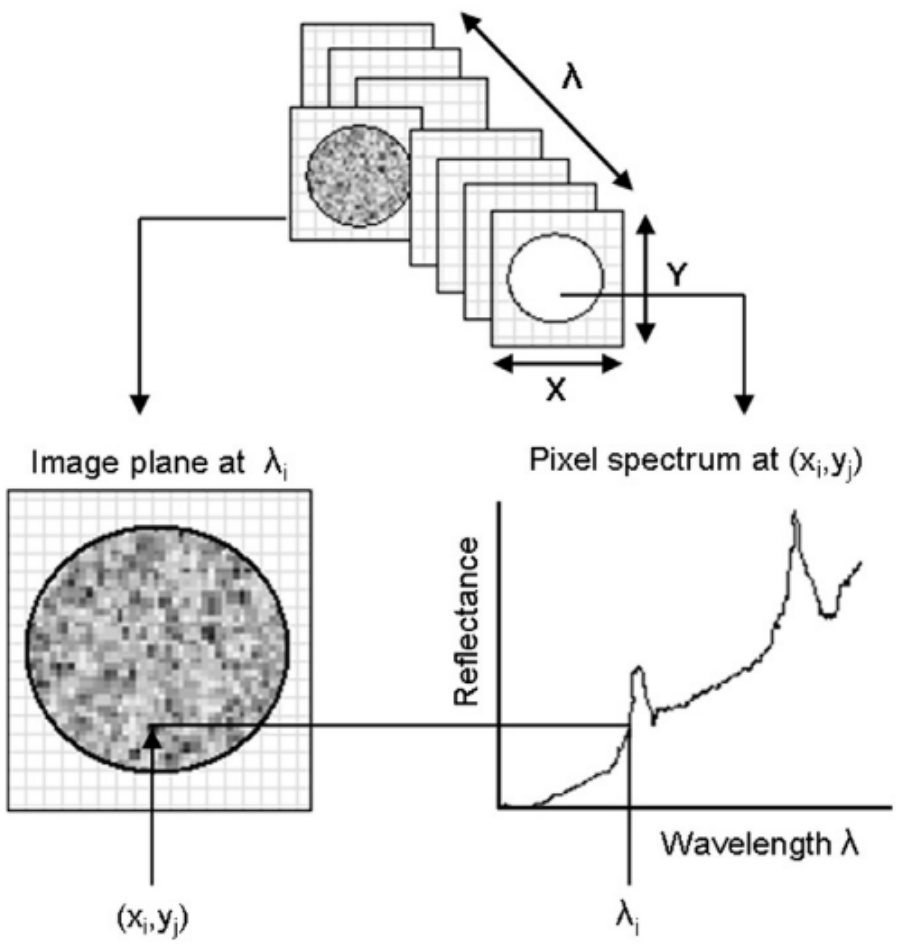


**Fig. 1.** Hyperspectral image cube (hypercube).

Hyperspectral imaging (HSI) combines spectroscopy and digital imaging generating a hyperspectral image (hypercube) of 3D multivariate data. Pixels in a hypercube may contain different spectral responses associated with different chemical compositions.

Two Specim Hyperspectral imaging (HSI) cameras will be used:

FX10 397-1004 nm, 448 wavelengths
FX17 931-1718 nm, 224 wavelengths
X-Y axis = 321x716 pixels, Z-axis = 448 (FX10) and 224 (FX17) wavelengths
(max. sample dimensions = 200 x 350 mm)

HSI data will be used for AI model development

- Deep learning (e.g. convolutional neural network)

Spectral data collected from veneer prior to adhesive application and hot pressing will be used to predict PWF. AI-based modeling of PWF, could be used for simulation of different layup scenarios, an important step towards an intelligent system for production planning.

*J. Burger, A. Gowen / Chemometrics and Intelligent Laboratory Systems 108 (2011) 13–22*

# Outcomes and Deliverables

| Expected Outcome | Deliverable (s) | 2023 | | | 2024 | | | | | | | | | | | 2025 | | | | | | | | | | | | 2026 | | | | | | | | | | |
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| | | O | N | D | J | F | M | A | J | J | A | S | O | N | D | J | F | M | A | J | J | A | S | O | N | D | J | F | M | A | J | J | A | S | O | N | D |
| Spectral data for AI model development | Vis-HSI and NIR-HSI data acquisition | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| AI – based model for prediction of PWF | AI model development | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Veneer samples for use in second year project | Sourcing veneer for plywood (months 6-8) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Spectral data from veneers for AI models | Vis-HSI and NIR-HSI data collection from veneer | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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# Expected Practical Implications/Impacts

- New approaches for estimating PWF based on NIR-HSI data collected from block shear samples.
- AI-based modeling and using deep learning eliminate the need for manual feature extraction/selection on spectral data.
- A potential new approach for estimation of PWF utilizing NIR-HSI data collected from veneers prior to plywood manufacture, an important step towards an intelligent production planning.

# Budget

- We request funding for a graduate student (0.49 FTE). The totals provided are based on current costs associated with supporting a graduate student for one year at OSU College of Forestry.
- $1,500 are requested to support expected student travel (to visit partner facilities).

| BUDGET | AMOUNT |
|---|---|
| First Year Expenses | |
| GRA & Benefits | $37,500 |
| Tuition & Fees | $19,000 |
| Materials/Supplies | |
| Travel | $1500 |
| Other (specify): | |
| **YEAR 1 TOTAL:** | $58, 000 |
| ***Expected future request amounts:*** $56,500 | |

# Thank You

# Questions?