

PROCESS

- Evaluate shortcomings of old manuals
- Identify needed changes through observation of current processes, interviews with key stakeholders, and data collection during farm visits

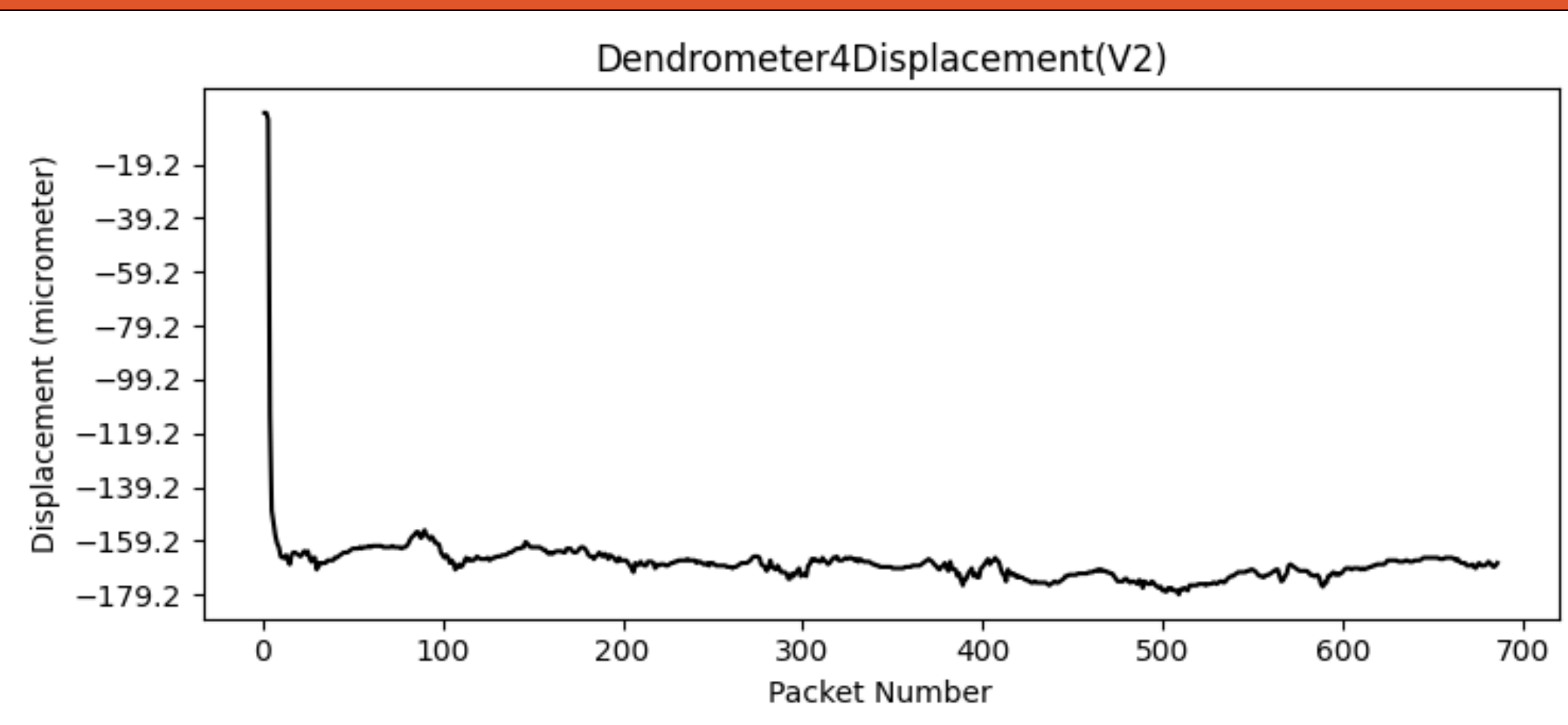
Manual Types to Update:

- Manufacturing Manual
- User Manual

Improvement Areas to Assess:

- Deployment installation process and stability while installed
- Data collection process
- Overall usability and ease of use

TESTING



Plot generated from collect data on stem displacement

To assess improvement areas:

- Visits to LB Farm were conducted to evaluate installation process, stability of dendrometer, and test data collection



DENDROMETER IMPROVEMENTS

UNDERSTANDING PLANT BEHAVIOR AND WATER INTAKE

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BACKGROUND

- Dendrometers are sensors used to precisely measure the growth of plants through stem diameter
- The improved dendrometer created by the OSU OPEnS Lab is designed to collect data using sensors that can ultimately be used to determine the optimal amount of water a plant needs.

PROBLEM STATEMENT

- Evaluate new dendrometer design for effectiveness, usability, speed of installation, ease of use, maintenance considerations, and pain points
- Update the user and manufacturing manuals to increase performance and usability of the dendrometer system



Installed dendrometer with protective casing



The Dendrometer: Installed onto stems to measure stem diameter fluctuations

FINAL DESIGN/RESULTS

- Manual Formatting:
 - The **hybrid layout** was chosen due to the increased effectiveness of processing and learning in documents containing both written text and images (shown in IMPLEMENTATION section)
- Evaluation of New Design:
 - Suggestions for installation and structure of dendrometer and protective case to increase efficiency and lower installation time

RESEARCH IN PROCESS IMPROVEMENT

- When presented with text and images simultaneously, improvements are seen in:
 - Recall
 - Comprehension
 - Processing speed
 - Reading speed

	1: Image-focused user manual (IKEA-esque layout)	2: Writing-focused user manual	3: Hybrid layout manual (Equal amounts of writing and images)
Pros	Organized and concise, universal, and clean design	Easy to convey all details needed and can fit more into one page when compared to images	More detail than the image focused, not as busy as the writing focused
Cons	Omits detail, unclear image or misprint will cause confusion and potentially lacks explanation	Busy, easier to get lost in the details	Must have very clear layout and sections or images and writing will get muddled. May require more pages

Example of table used to determine best manual layout

IMPLEMENTATION

- Large blocks of text were converted into smaller sections with tables and reference images

BEFORE

LED Indication System

The LED Indication System is implemented to easily check that the dendrometer is actively collecting data. When the button is pushed, the device will check the distance between the magnet and sensor to see if it is still within the required range of 0.2 - 0.4mm. If it is aligned, the LED will turn **green** for a few seconds; this indicates that the dendrometer is still accurately recording data. Will flash when it's correct.

If the LED turns **red**, something may have caused the magnet to shift relative to the sensor, in which case the data may no longer be valid during the previous testing period (when looking at the data, you will likely be able to see a jump when the misalignment event occurred). If this happens, use the LED indication system to adjust the magnet and Sandwich Grip (until the LED is green when the button is pushed. Alternatively, open the Pelican Case and hit the "Reset" button on the Hynpos board, then refer back to step 7 of the setup process to get everything up and running again. This approach will create a new data file on the SD for the coming measurements. In rare cases, the LED will appear **yellow**; this means that the alignment is still in range but is on the very edge. This could impact the precision of the measurements; it is recommended that the same procedures for adjustment be followed as when the LED is red. However, if yellow, the data trends can be expected to still be valid, although slightly less accurate.

AFTER

Verifying Alignment with Sensor

LED Indication System

The LED Indication System is implemented to easily check that the dendrometer is actively collecting data.

When the button is pushed, the device will check the distance between the magnet and sensor to see if it is still within the required range of 0.2 - 0.4mm

Light Indication Key:

Light Color	Meaning	Action
Continuous Green, then flash	Proper alignment	If the light stays solid green for 5 to 10 seconds, then it will flash after, indicating that the dendrometer is ready to collect data.
Yellow	Close to misalignment	If misaligned in that time then timer is reset and it goes to red or yellow. Not suitable when setting up the device, shift alignment until the green light occurs.
Red	Improper alignment	The distance between the magnet and sensor are not within the required range. The data may no longer be valid during the previous testing period (when looking at the data, you will likely be able to see a jump when the misalignment event occurred).
Flashing Orange	Magnet and/or sensor cannot connect to board	The plug-in sensor or magnet sensor is broken.

If light is red:

- Use the LED indication system to adjust the magnet and Sandwich Grip (Wishbone) until the LED is green when the button is pushed.
- Alternatively, open the Pelican Case and hit the "Reset" button on the Hynpos board, then refer back to the setup process to get everything up and running again.
 - This approach will create a new data file on the SD for the coming measurements.