The Cora vehicle has a Maximum Operating Temperature (MOT). This is dictated by the glass transition temperature (Tg) of the resin system used in the composite material of the Cora airframe. The temperature of the surface of the aircraft always exceeds the environmental temperature. This is due to absorption of solar radiation at the surface. The color of the aircraft determines the delta between the aircraft temperature and the environmental temperature.

I led a study to correlate ambient weather conditions to maximum temperature of composite panels wrapped in a variety of vinyl wrap colors. We left these panels, over 30, next to a weather station on the roof of our headquarters for two years. Our sampling rate was 0.2 samples per minute. The memory card could hold two weeks worth of data. Every two weeks a technician would download all of the thermocouple and weather station data (csv format) and upload into a Drive folder.

At the end of the study I wrote a program in Python, utilizing the pandas library, to parse every csv file and aggregate into a single data frame. I synchronized all of the data based off of timestamp, which required resampling. I also had to clean the dataset, such as remove error codes from sensors. I saved the dataframe into an excel file for final analysis.

In excel, I wanted to plot ambient temperature versus maximum temperature for each color. I used pivot tables to determine the maximum temperature recorded for each ambient temperature value.

Results:

- We were able to screen for viable Vinyl Wrap colors from these plots.
- For each color, we could determine a maximum flight temperature. For example, given the color yellow we could determine that the surface would exceed the MOT at a certain ambient temperature. That ambient temperature would then be the maximum flight temperature.

Bonus

- We did not want to have to conduct this study again if we became interested in a new color. I rented a solar reflectometer and measured the solar reflective index (SRI) of each color that was studied. I made a linear regression model to correlate SRI to maximum temperature at a few different ambient temperatures. At a given ambient temperature and SRI, we could determine with a 95% confidence that the surface would stay below a certain temperature 99% of the time.

- Cora - eVTOL aircraft
- Cora airframe is made almost entirely of carbon-fiber / epoxy matrix composites
- Maximum Operating Temperature (MOT) dictated by Glass Transition Temperature (Tg) of structural composite material
- Solar radiation of certain vinyl wrap colors may cause airframe surface to exceed MOT

"What vinyl wrap colors are acceptable for Cora?"

Experimental Setup

Goal: Correlate ambient weather conditions to surface temperature for each prospective color

Experimental Setup

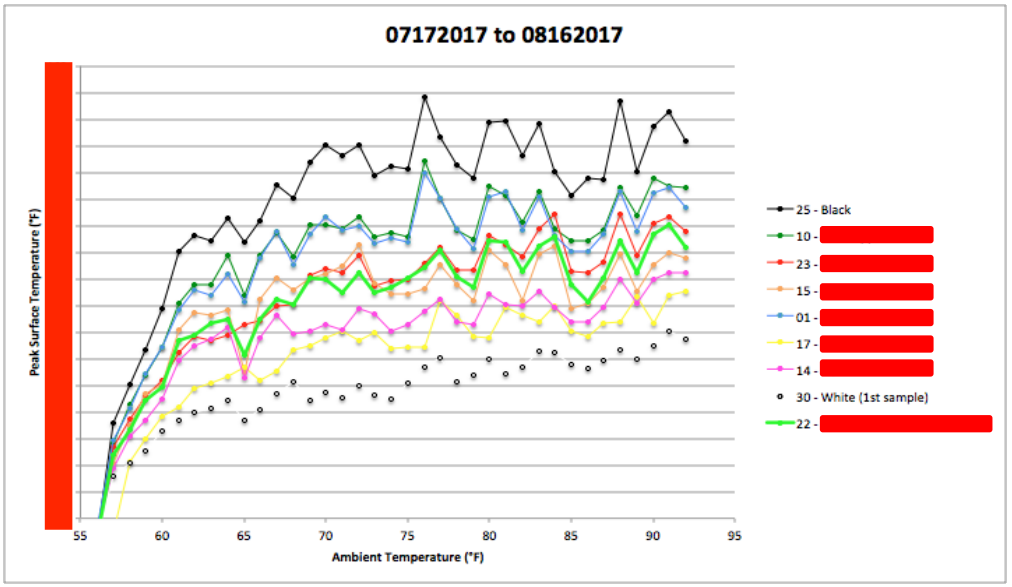
- Over 30 test panels
- Thermocouples sampling at 0.2 samples per minute
- Weather station sampling at 1 sample per minute
- 2 year study

There were multiple other boards like this

Data Wrangling Steps

- Parse directory of csv files and aggregate data into Pandas dataframes (thermocouple data frames and weather data frame)
- Synchronize separate dataframes into single master dataframe via timestamp, required resampling
- Clean dataset (e.g. remove error codes from sensors)
- Save master dataframe into Excel
- Use pivot tables in Excel to determine maximum surface temperature of each vinyl wrap color for given ambient temperature intervals

Results Shared with Director of Design and CTO



Before

After

Bonus: Determine Max Surface Temperature From Solar Reflective Index (SRI)