The Power of Prediction

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"Learn Today, You Shall"

Briefers

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Integrity - Service - Excellence

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“Those who have knowledge don’t predict. Those who predict, don’t have knowledge.”

Lao Tzu

6th Century BC Chinese Poet

Outline

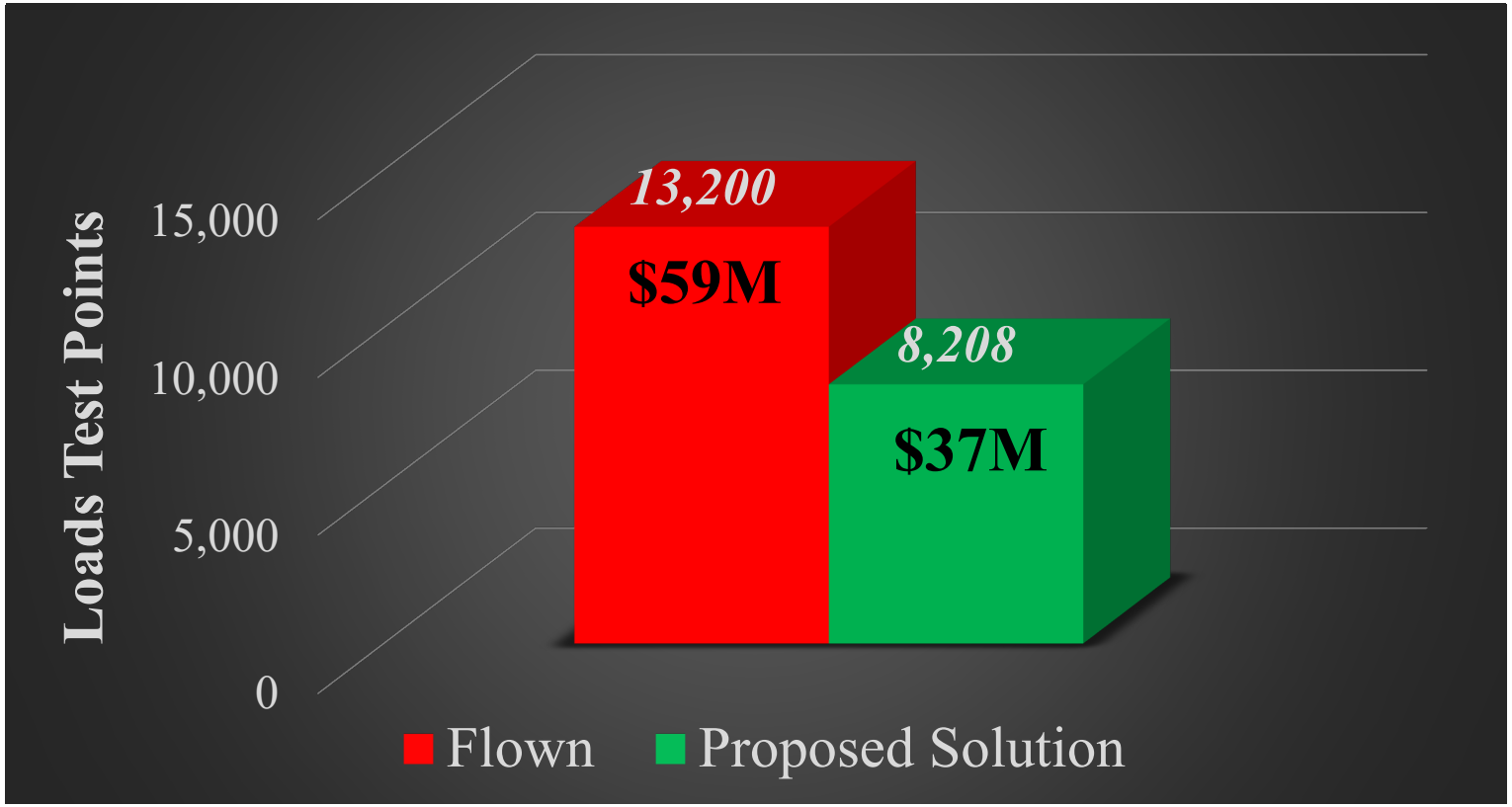
- Problem
  - Example
- Solution
  - The Recipe
  - Choosing the Ingredients
- Result
- Success Stories
- Moving Forward

Problem

- High fidelity updated loads predictions are not available.
  - Loads predictions are provided at the start of a program and are not frequently updated, by contractor, as the program progresses.

Example: 6 year Envelope Expansion Test Program on Base

- 574 Flights
- 23 Maneuver per Flight
- $105K per Flight Sciences Sortie



Solution

- Regression Prediction Generator (RPG)
  - Multiple Linear Regression Model with Interactions
    - Loads Prediction Equations

The Recipe

- Compile a database of flight sciences maneuvers.

  <u>Note</u>: more data = more accurate model
- Organize data (configuration, bins, time slice, etc.)
- Predictor(s) selection
  - What could affect the load?
- Assess the model (regression equation)

$$\textit{Predicted Load} = c0 + c1*v1+c2*v2+\ldots cn*vn*wn$$

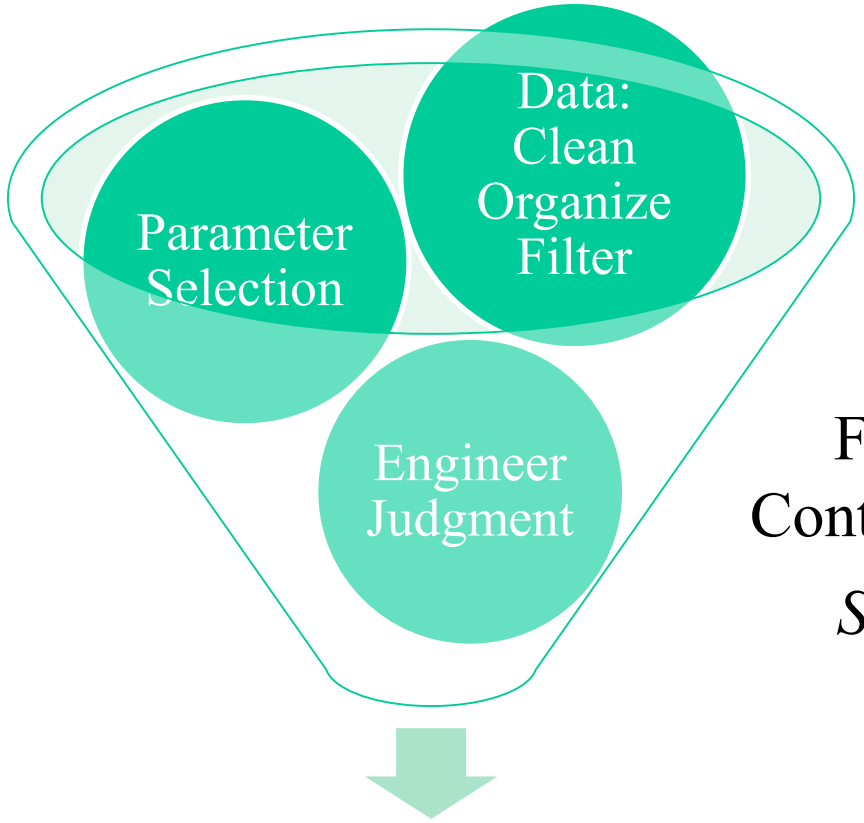
  - Where: c0 = intercept coefficient

    c# = predictor coefficient

    v# & w# = predictor value

Choosing the Ingredients

Predictors are parameters that affect aircraft loads.



Flight Condition &
Control Surface Positions

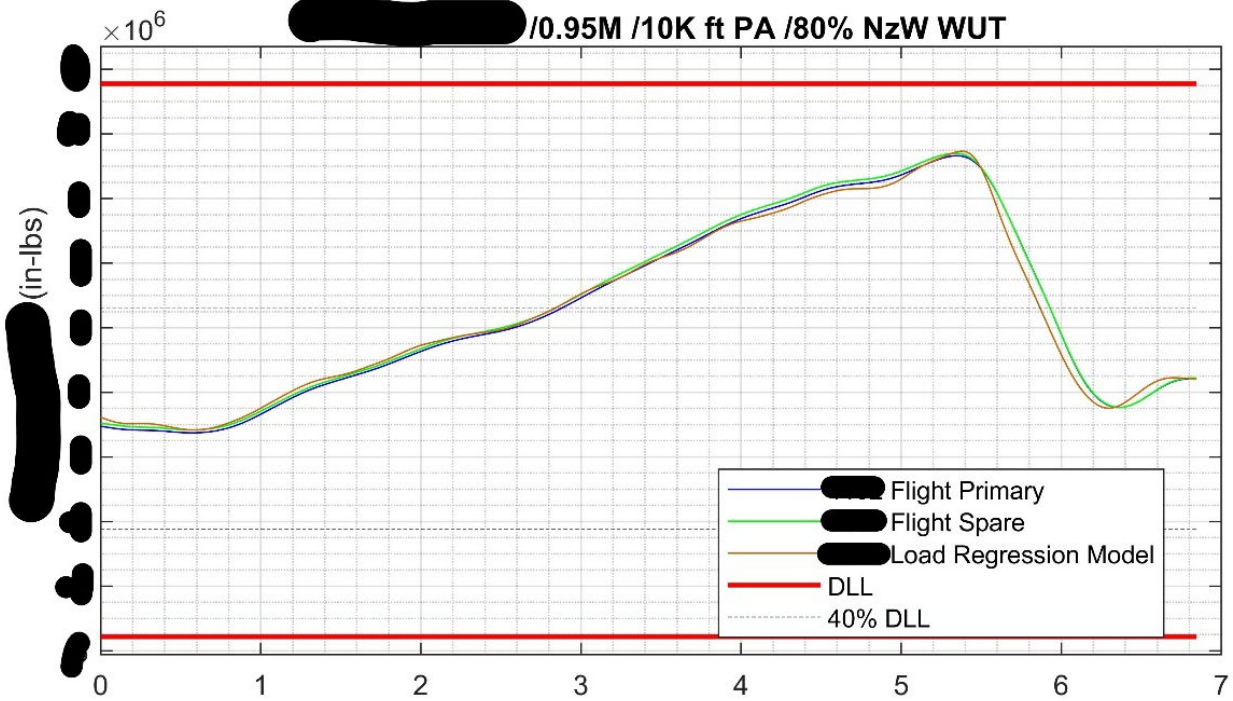
Surface Dependent

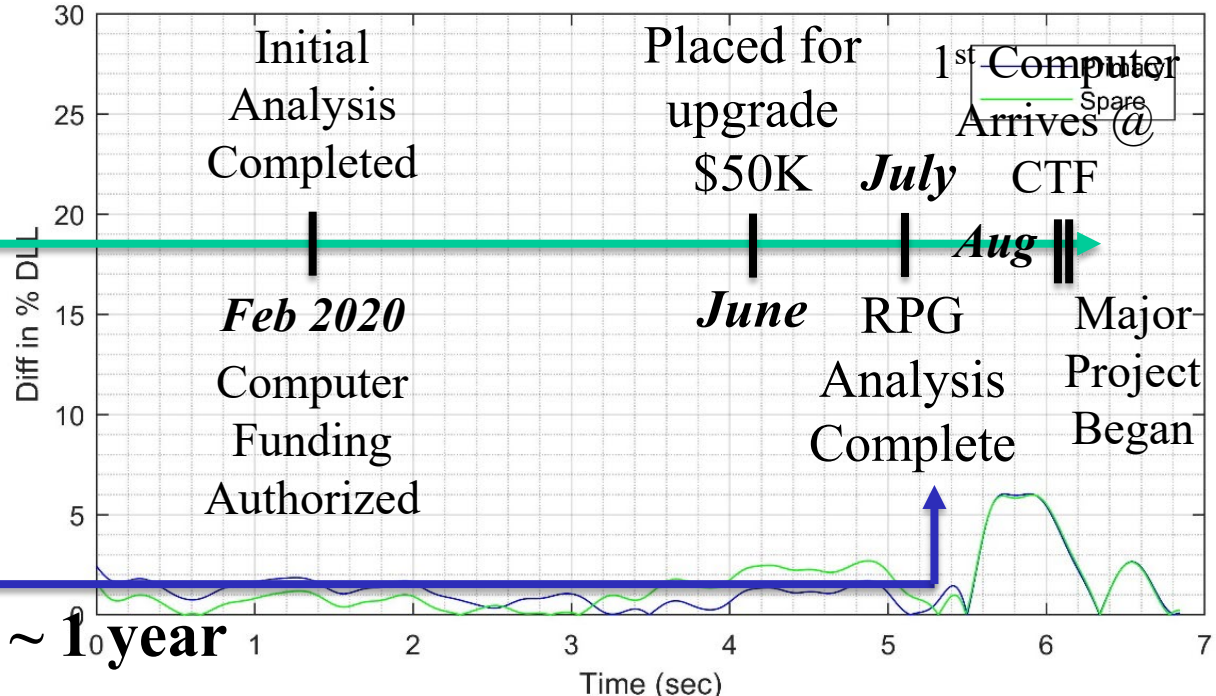
Load Equation

It is an iterative process.

Result

- 9M data points analyzed for a given aircraft.
  - Matched test flight data





Jan 2019

STS up & Running

June

Regression Method for Data Analysis

Data Organized

July

Sep

Insufficient computer power @ CTF

Initial Analysis Completed

Feb 2020

Computer Funding Authorized

Placed for upgrade $50K

June

July

RPG Analysis Complete

1st Computer Arrives @ CTF

Aug

Major Project Began

~ 1 year

Success Stories

- Load Prediction for Major Project
  - Input Sensitivity Study
- Loads Evaluation Card

Complete

Complete

Maneuvering in 3, 2, 1

(0.80M, 10K ft, +4g WUT)

Clear

Expect

Recorded **21%** Load

59% Load

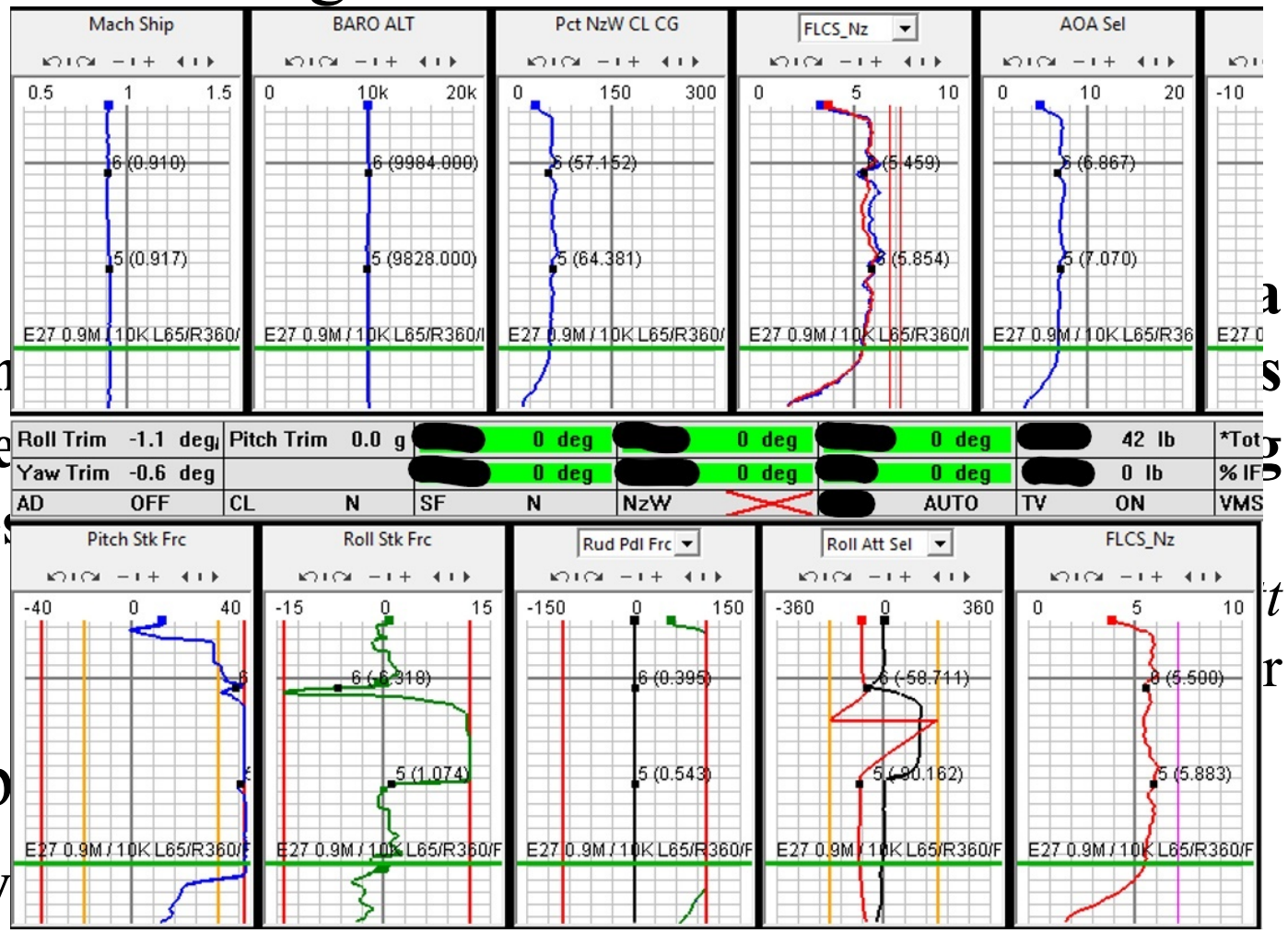
Uhm, Recorded **61%** Load

  - Contractor believed 61% was an outlier point
  - CTF engineers not satisfied with explanation
    - RPG investigation demonstrated that 61% was valid and that 21% was incorrect (true reading was 56%).

Moving Forward

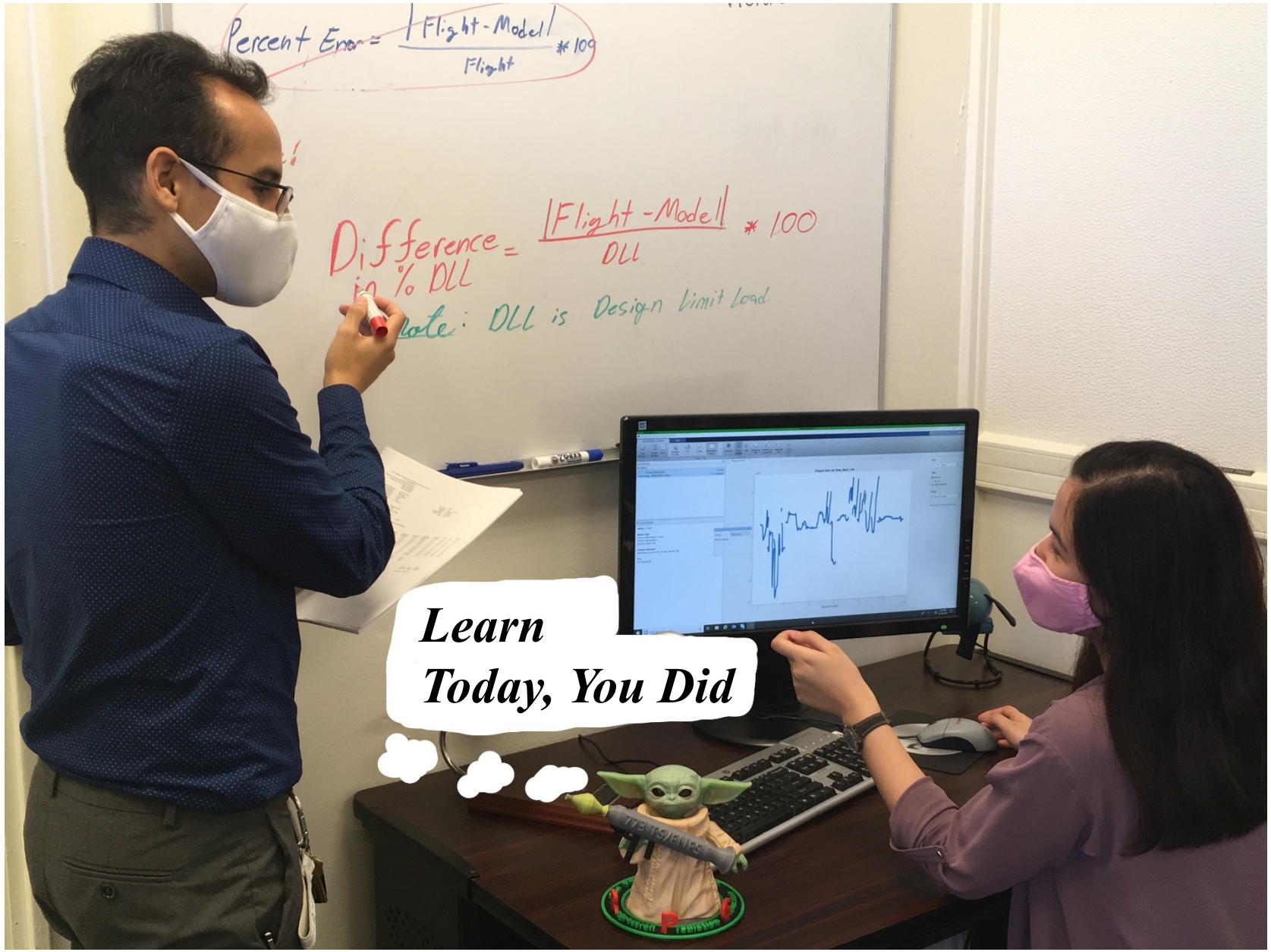
- Can execute control room training with realistic loads on real control room screens.
  - Zero Safety Risk
  - Lower Cost

"It can a
loads in s
resource g
pipelines



- In-house capability to p
  - Real-Time in the Ridley

QUESTIONS


Percent Error = |Flight - Model| / Flight * 100
Difference in % DLL = |Flight - Model| / DLL * 100
Note: DLL is Design Limit Load
Learn
Today, You Did