



Summer 2017 Pathways Internship Overview

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**Naval Air Systems Command
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➤ **Main Project**

- T-6 Trainer Aircraft Landing Analysis

➤ **Other Projects**

- NATOPS Flight Manual Charts Digitization
- T-6 Trainer Aircraft Data Export / Analysis
- Fighter Aircraft Launch Simulation Data





T-6 Trainer Aircraft Landing Distance: Background

➤ T-6 Trainer Aircraft Landing

- Observed real-life landing distances > Training simulation landing distances

➤ Initial Analysis by NAVAIR team

- Tried to match NATOPS gliding distance charts by modifying drag polars
- Found that NATOPS charts were based off higher drag values than observed in T-6 Trainers
- Ran field performance models but results unavailable





T-6 Trainer Aircraft Landing Distance: Analysis

➤ Initial field performance models

- First model had constant landing gear delta for each flaps configuration
- Second model had varying landing gear deltas for each flaps configuration
 - To determine effect of landing gear drag on landing distance

➤ My field performance models

- Updated both models to include propulsion data from Jan. 2017 aircraft manufacturer report





T-6 Trainer Aircraft Landing Distance: Analysis

- **Used field performance tool to simulate landing/braking for various conditions**
- **General plan**
 - Run field performance tool for all permutations of power setting, temperature, altitude, weight, etc. to determine conditions used to generate NATOPS charts





T-6 Trainer Aircraft Landing Distance: Analysis

- **Digitized NATOPS landing distance charts**
- **Wrote Matlab scripts**
 - Calculate NATOPS landing distance from digitized charts
 - For quickly calculating distances rather than hand-reading charts
 - Create time history plots of landing distance, acceleration, thrust, etc. from field performance software output files
 - To compare data from varying conditions
 - Extract and manipulate field performance braking time history data from field performance software's output files, calculate parameters of interest for analysis (average friction coefficient, NATOPS landing distance, total stopping distance, deceleration rate, etc.), and print to Excel workbook





T-6 Trainer Aircraft Landing Distance: Analysis

- **Deceleration values given in manufacturer's report were average over stopping distance rather than discrete time series**
 - field performance tool unable to implement such a deceleration function
- **Worked backward to determine values of friction coefficient that resulted in NATOPS landing distances and deceleration rates in report**
- **Friction coefficient manipulation unable to match both landing distance and deceleration rate**





T-6 Trainer Aircraft Landing Distance: Analysis

➤ Implemented differential friction coefficient table

- Rolling friction coefficient is 0.025 before abort
- After brakes are applied (at a high airspeed), braking friction coefficient is increased from a low value at a constant rate until a certain lower airspeed is reached, after which it is held constant
- Tried multiple versions of braking coefficient function

Time (sec)	Airspeed (kts)	Friction Coefficient
0	0	0.025
0	200	0.025
1.9999	0	0.025
1.9999	200	0.025
2	0	0.3
2	40	0.2
2	80	0.1
2	200	0.1
200	0	0.3
200	40	0.3
200	80	0.1
200	200	0.1





T-6 Aircraft Landing Distance: Future Analysis

- **Vary friction coefficient differential table to match more closely with NATOPS**
 - Introduce quadratic, exponential, etc. variation of friction coefficient with time and/or airspeed
- **Examine effect of touchdown speed on landing distances**





T-6 Trainer Aircraft Data Export / Analysis

- Digitized flight performance charts and tables
- Converted descent data into NxN lookup table format
- Digitized airspeed conversion plots
- Retrieved fuel, distance, and time data for wide range of conditions





Fighter Aircraft Launch Simulation Data

- For potential future project to develop more efficient fighter pilot instrument display during catapult launch
- Calculated aircraft energy state parameters of interest for launch trajectory analysis, generated plots of variables of interest

