Flight Testing & Checklists

Phil Baldwin
2/16/2018
To Do List

1) Make to do list ✓
2) Check off first thing on to do list ✓
3) Realize you’ve already accomplished 2 things ✓
4) Reward yourself with nap (in progress)
Topics

• Safety
• Operating Limitations
• Regulations
• Briefing
• Pre-Flight Checklist
• In-Flight Checklist
• Post-Flight Checklist
• Debriefing
Safety

• Maintain safety for EVERYONE involved
  • Pilot
  • Ground crew
  • Spectators
  • Bystanders

• Set up safety procedures and follow them

• No one person is in charge of safety during testing: everyone must be aware of what is happening

• “Swiss cheese” model
  • Several seemingly small events lead to major loss
Safety

Safety

• Maintain situational awareness
  • Other people may be flying with you
  • An extra set of eyes is always helpful

• **AMA Safety Code**

• **Flight Test Safety’s Best Practices**

• Absolutely must maintain sufficient clearance from manned aircraft
  • For UAS: FAA-mandated maximum of 400 ft AGL
  • Example: at the local AMA field, 400’ AGL puts only 300 feet in between our aircraft and aircraft on glideslope for RW 23 at KLAF
    • If the manned aircraft is 1° below glideslope, that clearance is down to about 100 feet
Safety
Operating Limitations

• Intrinsically related to the safety of the operation
• Often driven by weather or other physical factors
  • Cloud ceiling
  • Temperature limits
    • Can be an aircraft or a pilot limitation
  • Wind speed/direction
  • Visibility
  • Battery voltage
  • Did you bring a tool kit?
• Develop a GO/NO-GO decision tree for testing based on your operating limitations
Regulations

• Federal
  • [FAR Part 107](#)

• State or local legislation

• Community-Based Organization
  • [Academy of Model Aeronautics](#)
    • Provides insurance and other services

• Local club
  • Often have their own safety rules for specific sites

• Land owner
Procedures

• Step-by-step of each segment of testing, from beginning to end
  • One action per step, e.g.
    1. Ensure prop arc clear
    2. Insert safety plug
    3. Verify correct ESC tone output (verify # battery cells)
    INSTEAD OF
    1. Power up propulsion system
  • Checklist format is nice

• If you have one person create procedures, have another verify and offer corrections/improvements

• Likewise, have a second person verify all checklist items during test execution
Procedures

• Pre-flight procedures ensure you will be ready to fly at the field
  • There will be snow on the ground (in Indiana anyway…) at some point

• Procedures for flight are broken down by maneuver
  • Traditionally called “cards” as the pilot would have them on a kneeboard in the aircraft
  • For UAS flight testing:
    • All or most data acquired on-board
    • Have a teammate tell the pilot what maneuvers are to be flown and with what parameters
      • Airspeed tolerances, altitude tolerances, power settings, etc.
      • Live data on the ground makes this easy
    • Once autopilot control gains are known, may be able to automate some tests
  • Pilot input is valuable to assessing the performance
Briefing
Briefing

• Discuss with team what will happen during flight
• Build list of extra items to take that are not already on a “Things to take flying” checklist
• Assign jobs
  • Video
  • Hand-written notes
  • Spotter
  • Etc.
• Walk through checklists
Example Checklist

• Small GA aircraft
• IC engine – not all steps applicable
• Notice breakdown of steps
  • Line-by-line
  • Single item per line
• Generally verbalize “Preflight checklist complete” after completing that section
  • “Before start checklist complete”... etc.
Pre-Flight Checklists

Why do they exist?

• Get team and aircraft ready to fly
• Make sure nothing is missing...
• Ensure systems functioning nominally
Pre-Flight Checklists

• Before leaving base (Armstrong Hall, etc.)
  • Take flight box
  • Take plane

• Upon arrival at flight field
  • Unload components

• Before powering up
  • Visual inspection
  • Control surfaces

• Powering up
  • Plug in battery
Pre-Flight Checklists

Exercise:
• As teams, create a first draft for your team’s pre-flight checklist (only pre-flight right now)
  • Google docs is fine
  • Be specific!
• 5 minutes to work, then quick 1-minute presentation from each team
• Discussion and thoughts from other teams/coaches

Timer
In-Flight Checklists

Why do they exist?

- Perform the tasks you want to perform in the way you want them performed
- Remove guess work in a fast-paced phases of flight
  - “Do I flip the switch now? I thought I was supposed to do X first”
- Ensure some performance value is being met
  - E.g. every 5 minutes, check battery voltage/% capacity remaining
- Make sure aircraft is in the correct configuration...
In-Flight Checklists

Example of a missed checklist item...
In-Flight Checklists

• Climb out – Manual Mode
• Climb out – Auto Mode
• Cruise – Manual Mode
• Cruise – Auto Mode
• Before Landing – Manual Mode
• Before Landing – Auto Mode
In-Flight Checklists

Exercise:

• As teams, create a first draft for your team’s in-flight checklist (only in-flight right now)
  • Google docs is fine (new tab from earlier one works well)
  • Be specific!

• 5 minutes to work, then quick 1-minute presentation from each team
• Discussion and thoughts from other teams/coaches

Timer
Post-Flight Checklists

Why do they exist?

• Ensure safety of team
• Ensure safety of spectators
• Prepare aircraft for disassembly/transport/another flight
Post-Flight Checklists

• Disarm System
• Safe System
• Remove battery
• Download logs
• Secure components
Post-Flight Checklists

Exercise:
- As teams, create a first draft for your team’s in-flight checklist (only post-flight right now)
  - Google docs is fine (new tab from earlier one works well)
  - Be specific!
- 5 minutes to work, then quick 1-minute presentation from each team
- Discussion and thoughts from other teams/coaches

Timer
Debriefing

• Wrap-up of what went well
  • And what did not
• Assign next tasks (hopefully not repairs)
One more example checklist

**Emergency Procedures**

- Not much to be done for a lot of in-flight emergencies for R/C aircraft
  - But regaining control from an erroneous autopilot is possible!
- Crash debris recovery procedures should be put in place
  - LiPo batteries need monitored
  - Motors may still spin
Mission Planner’s Pre-Flight Feature
Mission Planner’s Pre-Flight Feature

• Very customizable – add any parameter and trigger level
  • Battery voltage
  • % capacity remaining
  • Geofence
  • Etc.

• Add items that are not inherently part of the Pixhawk

• Add as many lines as you want
Questions?