Good Practices for Conducting Maintenance & Condition Inspections of Experimental Aircraft

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About Me

- B.S. and Ph.D. degrees in Molecular Biology (1995, 2001)
  - Pharma/biotech scientist 2001-2012
- Private pilot (2000)
  - Own/maintain experimental Steen Skybolt
- Airframe & Powerplant mechanic (2014)
- Founded Mike's AeroClassics, Inc. (2014)
  - "Tube-and-fabric" aircraft
  - Experimental aircraft
- Independent Rotax Maintenance Technician (2015)
- Member of AOPA, EAA, IAC, VAA, Warbirds of America

Objective

- To understand challenges associated with *maintaining ourselves.*
- Provide methods to ensure maintenance or an inspection is done well.
- Provide guidance around ensuring a safe and uneventful post-maintenance flight.

Challenges of Maintaining Experimental-Amateur Built Aircraft

- Certification and maintenance of E-AB aircraft are managed according to a different regulatory and policy framework than non-E-AB aircraft.
- Unlike type-certificated aircraft, there is no restriction on who may perform maintenance on an E-AB aircraft.
- The experimental nature of amateur-built aircraft is evident in the wide range of powerplants, equipment, and design features found in these aircraft.

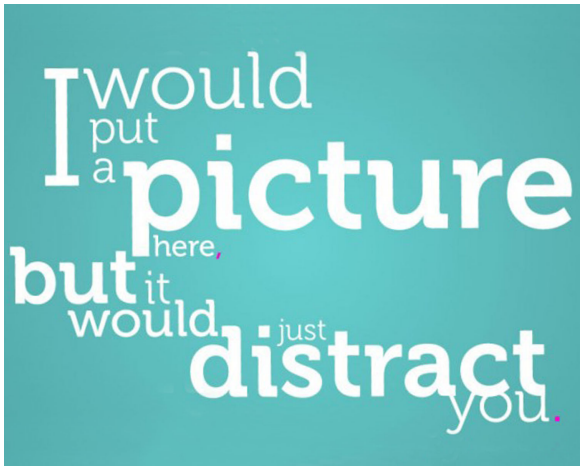
Biggest Challenge: Human Factors

- Aviation safety relies on maintenance *performed by people*.
  - Tools & equipment
  - Technical Data
  - Knowledge & technical skills
- Accidents/incidents can result from maintenance errors
  - Parts installed incorrectly
  - Parts missing (e.g. safety wire/cotter keys, spacers)
  - Tools left in engine compartment
  - Necessary checks were not performed
- Many factors can degrade a person's ability to perform effectively and safely.

AC 43.13-1b, Chapter 13. Human Factors and
http://www.faa.gov/about/initiatives/maintenance_hf/

“The Dirty Dozen”

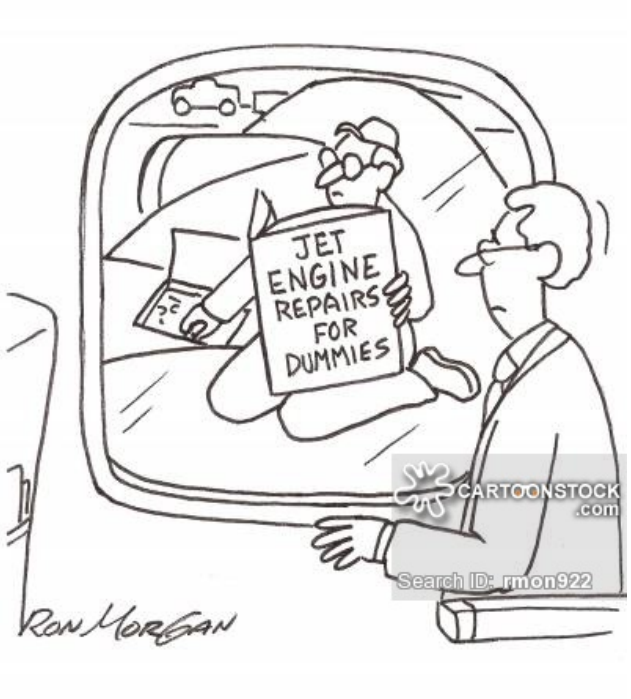
- Lack of communication
- Complacency
- Lack of knowledge
- Distraction
- Lack of teamwork
- Fatigue
- Lack of resources
- Pressure
- Lack of assertiveness
- Stress
- Lack of awareness
- Norms



It is important to know the dirty dozen, how to recognize their symptoms, and most importantly, know how to avoid or contain errors.

Human Factors: Personal Minimums Checklist – Before the maintenance task

- BEFORE doing the work, ask yourself:
  - Do I have the knowledge to perform the task?
  - Do I have the technical data?
  - Have I performed the task previously?
  - Do I have the proper tools and equipment?
  - Have I had the proper training?
  - Am I mentally prepared?
  - Am I physically prepared?
  - Have I taken the proper safety precautions?
  - Do I have the resources (time, parts, money) available to perform the task?
  - Have I researched the FARs to ensure compliance?



Human Factors: Personal Minimums Checklist – After the maintenance task

- AFTER doing the work, ask yourself:
  - Did I perform the task to the best of my abilities?
  - Was the task performed to be equal to the original?
  - Was the task performed in accordance with appropriate data?
  - Did I use all the methods, techniques and practices acceptable to industry?
  - Did I perform the task without pressures, stress and distractions?
  - Did I reinspect my work, or have someone else inspect my work, before returning to service?
  - Did I make the proper record entries for the work performed?
  - Did I perform the operational checks after the work was completed?
  - Am I willing to sign on the bottom line for the work performed?
  - Am I willing to fly in the aircraft once it is approved for the return to service?

Condition Inspections for E-AB

What is a Condition Inspection?

- A condition inspection is the equivalent of an "annual inspection" of a type certificated aircraft.
- The **operating limitations** on your homebuilt will include the following (or something similar):

  "No person shall operate this aircraft unless within the preceding 12 calendar (usually) months it has had a **condition inspection performed in accordance with the scope and detail of Appendix D to part 43**, or other FAA-approved programs, and found to be in a condition for safe operation."
- Condition inspections shall be recorded in the aircraft maintenance records showing the following (or a similarly worded) statement: **"I certify that this aircraft has been inspected on (insert date) in accordance with the scope and detail of appendix D to part 43 and found to be in a condition for safe operation."** The entry will include the aircraft total time in service, and the name, signature, certificate number, and type of certificate held by the person performing the inspection.

Who can perform a Condition Inspection?

- The inspection can be performed by any licensed A&P mechanic, an FAA Approved Repair Station, or by the builder of the airplane provided the builder obtains a "Repairman's Certificate" from the FAA.
- Unlike an annual for a type certificated aircraft, the A&P mechanic does NOT have to have his/her "Inspection Authorization."

Use an Inspection Checklist

- Each person performing a condition inspection shall use a checklist while performing the inspection
  - May be the person's own design
  - One provided by the manufacturer
  - One obtained from another source
  - Must include the scope and detail of the items in Appendix D of Part 43
- Ensures nothing is missed during inspection
- Keeps you organized

Inspection Checklist Example

E. WING GROUP			INSP.	O.K
	1.	REMOVE INSPECTION PLATES AND FAIRINGS		
	2.	CHECK SURFACE AND TIPS FOR DAMAGE		
	3.	CHECK AILERON HINGES, PUSHRODS FOR OPERATION		
	4.	CHECK AILERON TRAVEL IS WITHIN LIMITS RT UP_____RT N_____LT UP_____LT DN_____		
	5.	CHECK FLAP CONDITION AND HINGES		
	6.	CHECK FLAP OPERATION AND MECHANISM		
	7.	CHECK FLAP ALIGNMENT		
	8.	CHECK WING ATTACH BOLTS		
	9.	CHECK HEATED PITOT OF SECURITY, HOSE SECURITY, AND OPERATION		
	10	CHECK WINGTIPS FOR DAMAGE AND SECURITY		
	11	CHECK OPERATION OF LANDING LIGHTS		
	12	CHECK OPERATION OF STROBE LIGHTS		
	13	CHECK OPERATION OF POSITION LIGHTS		
	14	RE-INSTALL INSPECTION PANELS AND FAIRINGS		

Discrepancy Log (”Squawk List”)

- List of items that were found during the inspection, or by owner/operator, that need attention
  - Rough running within a certain range of RPM
  - Static interference of radio during Tx/Rx
  - Reported altitude is different from altimeter setting
  - Small crack starting to form at cowl fastener
  - Desire to add or modify equipment (e.g. replace exhaust system)
- Discrepancy Log can be appended to Inspection Checklist
- Include detail about the issue and how it was resolved:
  - Date found, how repaired, and by whom (owner, AMT, repair station)

AC 20-106, Aircraft Inspection for the General Aviation Aircraft Owner

- The Habit of Inspection
  - Begin by performing Preflight Inspections
  - Work up to Detailed Inspections
  - Use Manufacturer's Recommendations as a guide
  - Develop a system and use an **inspection checklist**
  - Once adopted, do not deviate from the procedure
- If defects are noted or suspected, have a detailed assessment done by someone with knowledge of your particular experimental aircraft, or a certificated mechanic.

Maintenance & Inspection Do's and Don'ts

DO…

- have proper tools.*
- use checklist/procedure & stick to it.
- remove all inspection plates & cowlings
- clean all items to be inspected.
- check all moving parts for proper lubrication & locking devices for security.
- inspect for proper safetying techniques, and resafety a part you have unsafetied BEFORE inspecting the next item.
- seek assistance when in doubt.
- the job right the first time.

DON'T…

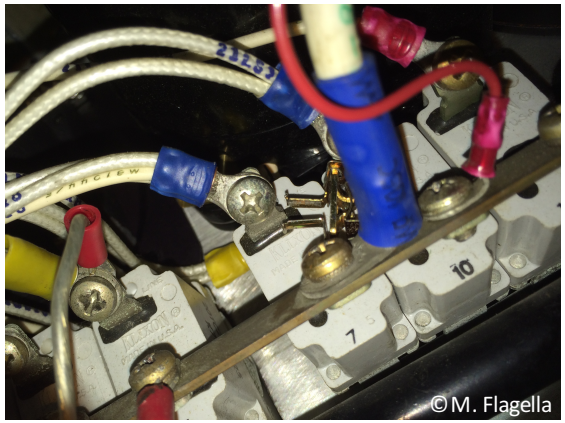
- be hurried – take time to properly inspect each item.
- move the prop unless mags are "OFF" or ignition system is otherwise rendered inoperative.
- presume an item is safe until it has been checked.
- perform any complex inspection or maintenance operation unless you are properly trained and/or supervised.
- take the attitude "It can't happen to me."

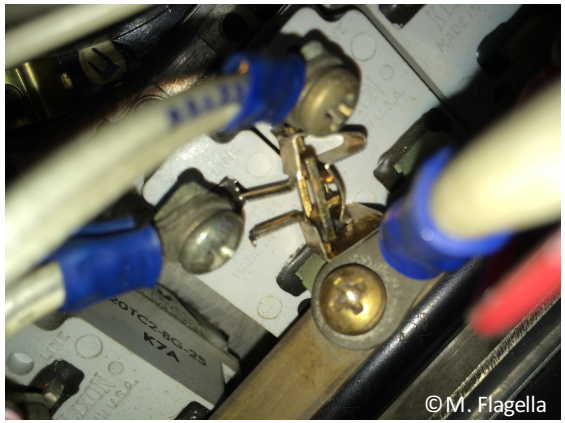
Maintenance Case Study

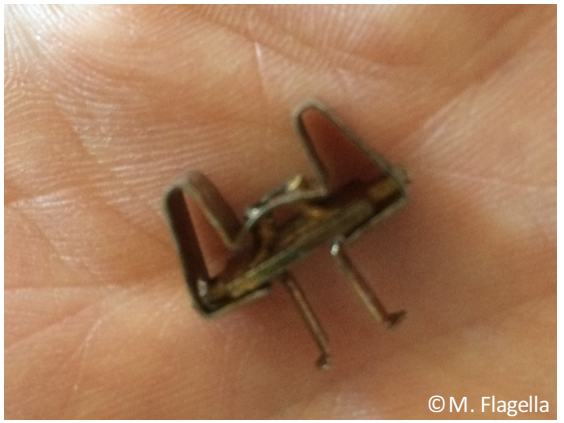
"When I turn on my plane's Master Switch, the Nav lights come on!"

Maintenance Case Study

"When I turn on my plane's Master Switch, the Nav lights come on!"







Owner had recently had the altimeter replaced. A technician likely dropped the instrument nut and did not retrieve it after maintenance, causing a short circuit across the Nav light switch from main bus bar.

This is an example of Foreign Object Debris ("FOD") and a potential fire hazard.

Foreign Object Debris ("FOD")

"FOD is any object located in an inappropriate location in the airport environment that has the capacity to injure airport or air carrier personnel and damage aircraft."

Air France Flight 4590 (2000)

FOD has the potential to damage aircraft during critical phases of flight:

- Cutting aircraft tires
- Become lodged into flight mechanisms
- Shorting out electrical system

FAA AC 150/5210-24 "Foreign Object Debris Management"

FOD Taxonomy

- FOD composed of any material and be any color and size
- FOD typically from OTHER aircraft
- Typical FOD comprised of:
  - Aircraft and engine fasteners (e.g. nuts, bolts, washers, safety wire)
  - Aircraft parts (e.g. fuel caps, oil sticks, access panels)
  - Mechanics' tools and rags
  - Flight line items (pens, luggage zippers & wheels, soda cans, water bottles)
  - Natural materials (leaves, wildlife)

FOD Management

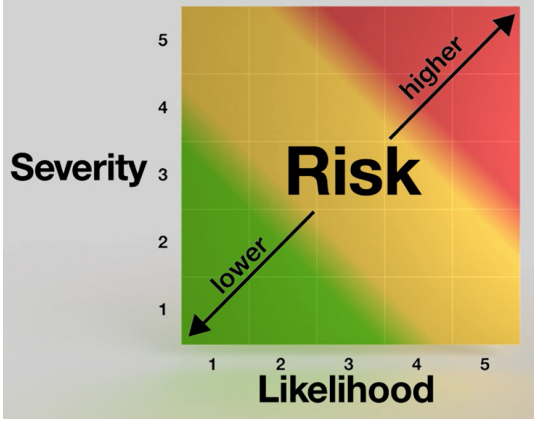
- Aircraft Maintenance:
  - Account for and dispose of nuts, bolts, washers, safety wire, etc.
  - Account for hand tools used in repair jobs
- Aids to control FOD:
  - Checklists
  - Cut-out tool tray liners
  - Use spill-proof bags, magnetic trays and toolboxes.

Carelessness and overconfidence are more dangerous than deliberately accepted risk.

-Wilbur Wright, 1901

AC 90-109 – Airmen transition to Experimental or Unfamiliar Airplanes

- Hazard Identification
  - Identify specific safety hazard(s)
    - Example: Stall/spin during base-final turn
- Risk Assessment
  - Determine the severity of the hazard(s)
    - Example: Potentially fatal
  - Determine the likelihood that the hazard will occur
    - Example: Minimal likelihood



- Risk Mitigation – actions that minimize or understand risk
  - Obtain specific training
  - Use specific safety equipment
  - Review designer's operational information & your flight plan
- These are considerations common to all airplanes

AC 90-89B - Amateur-Built Aircraft and Ultralight Flight Testing Handbook

- Assist amateur builders in developing aircraft flight plans.
- Guidance for flight testing after modifying an experimental aircraft
  - Level of modification (look to FAR 21.93 for general guidance)
    - Major Change that affects "weight, balance, structural strength, reliability, operational characteristics or other characteristics affecting the airworthiness of the product."
  - Flight testing in some form is advisable
    - Reveal any malfunctions or unintended consequences of modification
    - Allow the pilot to become familiar with the (new/altered) operation of the aircraft
    - Example: ensure a new instrument is properly working and that you know how to use it.

Conclusions

For your post-maintenance flight to be safe and uneventful:

- You are mentally and physically ready to perform maintenance or inspection,
- You have the right tools & information,
- You understand the task(s) to be performed,
- You will follow good maintenance practices, and
- You have a plan and will follow it.

Thanks and safe flying!

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