UNDERSTANDING AUTOPILOT MODES

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The issue:

“Typically not understanding the logic a particular mode employs, using an inappropriate mode for the phase of flight, simultaneous manipulation of the controls whilst a mode is engaged, or not using modes that might assist workload and enhance safety.”
Back to basics:

- Ab-Initio training and a fundamental understanding of ‘primary effects of controls’
  - Pitch determines Airspeed primarily, Vertical speed secondarily
  - Collective determines Vertical speed primarily, Airspeed secondarily
- Trimmed, steady state conditions
  - Trim release and trim adjustment not understood:

<table>
<thead>
<tr>
<th>Trim Release - What does it do?</th>
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<td>Hopefully, a simple question. What does the trim release on helicopters actually do?</td>
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- Evident in practice:
  - Former GA pilots flying AS332L in SAS mode
  - Flying the B212 with ‘trim off’
Hi ppruners,

I’ve been having a lot of discussion lately with colleagues as to what is the proper way of using the force trim in our machines. Several ways of doing it have arisen, and it got me worried, since there are very different between themselves.

I know the use of the trim button on the uh-1 helicopter but I just get confused why I heard that I have to "press the trim release and fly the aircraft to a new altitude and then release, the new altitude will then be held."
“As previously mentioned in section 1.18.3.1, it is important that all control pressures be trimmed off, in a steady-state flight, before engaging GA mode. Otherwise, the helicopter may deviate significantly from the desired flight profile. This is due to the fact that the trim actuators may not be able to adequately compensate for changes in aircraft attitude.”
Engaging modes, then interfering with controls
MOVING ON FROM BASICS TO THE AFCS.....HIERARCHY

- Rate Damper - SAS
- Control Augmentation - SCAS
- Attitude Hold - ASE
- Autopilot
- Operational Autopilot
AFCS HIERARCHY LOOP

Autopilot → Servos → Helicopter response

AFCS Outer Loop

AFCS Inner Loop

Fast acting, low authority
Slow acting, high authority
AFCS HIERARCHY – LOOK FAMILIAR?
If within parameters, the CFD will capture the localizer and track it inbound. If not within parameters, the localizer will arm, the pilot should use the heading mode to fly the aircraft to a proper intercept heading and the CFD will automatically capture once within parameters.
UNDERSTANDING THE MODE LOGIC – RFM/FCOM CONTENT

**“ALT” MODE ON THE PITCH AXIS**

<table>
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<tr>
<th>CONDITIONS AND EVENT</th>
<th>DESCRIPTION</th>
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| Conditions which prevent the mode being engaged | - Helicopter has ground logic status  
- Airspeed > 65 knots (if collective pitch parallel actuator is not available)  
- Data display error on the RFDs and NBs |
| Actions or events which engage the mode | - The appearance of the final reference on the attitude scale causes the system to change from the "ALT A" mode to the "ALT" mode  
- As the helicopter nears the ground the system changes from the "VSI" "IAS" "GS" mode to the "ALT" mode (80 ft) |
| Conditions which inform the crew of an excessive deviation | - Difference of 25 m between the attitude of the helicopter and the reference attitude for 2 seconds |
| Conditions which cause disengagement of the mode | - Loss of pressure attitude data for at least 10 seconds  
- Loss of attitude data at least 10 seconds  
- Airspeed < 20 knots for 2 seconds (if the collective pitch axis is not available)  
- Engagement of one of the following modes: "ALT" "VSI" "CRHT" "GA"  
- Capture of the "GS" mode |
| Conditions which change the axis controlling the mode | - Engagement of the "IAS" mode causes the system to change from the pitch axis "ALT" mode to the collective axis "ALT" mode |

**Minimises confusion:**
- “Why isn’t it engaging?”
- “Why is it doing that?”
- “Why has it dropped out?”

**Aids monitoring/avoids surprise:**
- Which axis to monitor
- What to expect with mode changes
- When approaching envelope limits

**“ALT” MODE ON THE COLLECTIVE PITCH**

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<th>CONDITIONS AND EVENT</th>
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| Actions or events which engage the mode | - Airspeed > 60 knots  
- Engagement of the "IAS" mode  
- Loss of the automatic trim on the cyclic pitch axis  
- The appearance of the final reference on the attitude scale causes the system to change from the "ALT A" mode to the "ALT" mode |
| Conditions which cause disengagement of the mode | - Loss of the collective axis parallel actuator or artificial load canceled  
- Loss of a pitch or roll axis servos actuator  
- Loss of the collective pitch lever position detection  
- Engagement of one of the following modes: "ALT A" "VSI" "CRHT" "GA"  
- Capture of the "GS" mode |
| Conditions which change the axis controlling mode | - Change from the collective axis "ALT" mode to the pitch axis "ALT" mode if the airspeed > 65 knots for 5 seconds |
FMA is the “visual conversation’ from the autopilot to the crew – use it!
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- What the autopilot is doing now
- What the autopilot will do next
AUTOPILOT MODES - NOT JUST THE AFCS
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Fly over, or fly by?
OPERATIONAL USE

- SOPs, SOPs, SOPs…
  - Based on ‘Golden Rules of Automation’
  - Based on specifics of the aircraft modes and logic
  - Based on mission profile/operating environment
  - Consistent in their logic
  - Indoctrination in Operator Conversion phase – (dry) simulator hours
- Monitored in operations:
  - LOSA
  - FDM
  - Peers
- Assessed in OPCs (regulator has to buy into the concepts)
Personal responsibility:
- Not spoon fed
- Seek Information
- Question understanding
- Accountable for safety
SUMMARY

- ‘Understanding autopilot modes’ covers a spectrum of concepts:
  - Basic aircraft handling
  - Basic AFCS systems without coupling – inner and outer loop concepts
  - How the OEM determines envelope and operating logic
  - How the OEM describes the AP Modes in RFM/FCOM/FCTM
  - How the OEM displays the operating modes
  - How other systems (e.g. FMS) interact with AP
  - How and when to use modes i.a.w. SOPs
  - Taking personal responsibility for understanding – generally the pilot(s) are the first to the scene of an accident!