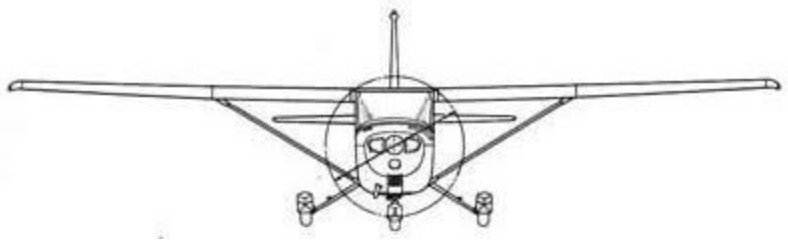
AUTOMATION MANAGEMENT

STANDARD OPERATING PROCEDURES



University *of* Dubuque

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PRACTICAL TEST STANDARDS

The Private Pilot, Instrument Rating, Commercial Pilot, and Certified Flight Instructor practical test standards emphasize automation management as one of the six essential parts of single pilot resource management (SRM). It reads:

> **Objective:** *To determine the applicant can effectively use the automation features of the aircraft, including autopilot and flight management systems, in such a way to manage workload and can remain aware of the current and anticipated modes and status of the automation. The applicant should:*
>
> 1. *Explain how to recognize the current mode of operation of the autopilot/FMS*
> 2. *Explain how to recognize anticipated and unanticipated mode or status changes of the autopilot/FMS*
> 3. *State at any time during the flight the current mode or status and what the next anticipated mode or status will be*
> 4. *Use the autopilot/FMS to reduce workload as appropriate for the phase of flight, during emergency or abnormal operations*
> 5. *Recognize unanticipated mode changes in a timely manner and promptly return the automation to the correct mode*

The Instrument Rating practical test standard also addresses the issue examining automation usage and management during the practical test. Because the University of Dubuque (UD) utilizes a fleet of technically advanced aircraft (TAA's) for the instrument training and each of those aircraft have an integrated autopilot system, the student's knowledge, use and management of the autopilot will be examined during the end-of-course evaluation. The "Aircraft and Equipment Required for the Practical Test" section reads:

> *. . . the applicant is expected to utilize an autopilot and/or flight management system (FMS), if properly installed, during the instrument practical test to assist in the management of the aircraft. The examiner is expected to test the applicant's knowledge of the systems that are installed and operative during the oral and flight portions of the practical test. The applicant will be required to demonstrate the use of the autopilot and/or FMS during one of the non-precision approaches. The applicant is expected to demonstrate satisfactory automation management skills . . .*

The flight director (FD) and autopilot (AP) can be very useful tools for the pilot if the systems are understood and used properly. This section will address FD and AP usage throughout the University of

Dubuque's flight training curriculum. The FMS portion of automation management is discussed in the navigation section of the UD Standard Operating Procedures document.

LEVELS OF AUTOMATION

There are four distinct levels of automation usage, 1—autopilot off without flight guidance (FMS flight plan), 2—autopilot on without flight guidance (FMS flight plan), 3—autopilot off with flight guidance (FMS flight plan), and 4—autopilot on with flight guidance (FMS flight plan).

The first level of automation usage is flight without the use of the autopilot or FMS. At this level, the pilot is manually controlling the aircraft and navigating visually or by reference to raw data, groundbased navigation systems such as a VOR. Level two involves the pilot utilizing the autopilot system to control the aircraft by holding headings and/or altitudes, thus lightening the pilot's workload to allow more attention on navigation, procedures, or other mentally demanding tasks. At the third level of automation usage, the pilot is engaged with manually controlling the aircraft, but the FMS and FD have been programmed to aid him/her with situational awareness and navigation. At this level, a flight plan or procedure would be loaded into the FMS and the FD programmed to direct the pilot along both vertical and lateral navigational tracks with the pilot still physically maneuvering the aircraft. Level four is the most automated level with the FMS providing vertical and lateral navigational guidance, the autopilot being programmed, engaged and maneuvering the aircraft along the provided flight plan and vertical track, and the pilot monitoring the system but not manually maneuvering the aircraft.

Each of the four levels of automation provide different benefits depending on the phase of flight and pilot's experience, knowledge and level of proficiency. Because of this fact, emphasis will be placed on different levels of automation at different stages in training at the University of Dubuque. The levels of automation appropriate to each stage of UD's curriculum are:

Private:

Stage 1—Level 1—autopilot off without flight guidance: Stage 1 of the Private Pilot training course is dedicated to providing the student pilot with the knowledge and skill to perform his/her first solo flight in an airplane. The focus during this stage of training is on the student's ability to control the aircraft during all phases of flight including normal and emergency operations. During the Stage 1 evaluation, the check instructor will not allow the student to use the AP, but will require that the entire flight be manually hand flown.

Stage 2—Level 2—autopilot on without flight guidance: Stage 2 of the Private Pilot training course is dedicated to developing the student's ability to further master his/her control of the aircraft and navigate along cross-country routes utilizing various forms of navigation. Although a flight plan

may be programmed during the cross-country flights, emphasis is on the student's ability to navigate, not the aircraft's ability to track a pre-programmed FMS flight plan. During the Stage 2 evaluation, the check instructor will allow the use of the FD and AP during portions of the crosscountry scenario, but will require the student to demonstrate his/her ability to manually fly the aircraft during the majority of the flight assessment.

Stage 3—Level 2—autopilot on without flight guidance: Stage 3 of the Private Pilot training course is dedicated to developing the student's mastery of the aircraft during normal and emergency operations. Stage 3 includes the student's first solo cross-country. Although the student may program a FMS flight plan for situational awareness, the cross-country requirement of the Private Pilot Practical Test Standards includes the ability of the student to demonstrate proficiency in pilotage/dead reckoning and radio navigation. Emphasis during this stage is still on the student's ability to navigate, visually determine the aircraft's position, and maintain control of the aircraft—all automation level 2 tasks. During the Private Pilot end-of-course evaluation, the check instructor will allow the use of the FD and AP during portions of the crosscountry scenario, but will require the student to demonstrate proficiency in manually flying the aircraft during normal and emergency operations.

Instrument:

Stage 1—Level 3—autopilot off with flight guidance: Stage 1 of the Instrument Rating course is dedicated to developing the student's knowledge, understanding, and application of instrument navigation skills and techniques. During this stage, the student will learn how to execute different types of instrument procedures including holds, arcs and approaches. The use of the FMS is specifically addressed in the navigation section of the UD Standard Operating Procedures document. The use of the FD and FMS procedures are encouraged whenever possible, but the student must develop proficiency in executing instrument procedures at the appropriate level of automation (level 1 through 3) as required by the phase of flight or status of the aircraft's flight instruments/displays. During the Stage 1 evaluation, the check instructor will allow the use of the FD—whenever the FD is available depending on the flight scenario—throughout the assessment. Autopilot usage will be limited to the enroute and arrival portions and must be disengaged after crossing the intermediate fix on an approach.

Stage 2—Level 4—autopilot on with flight guidance: Stage 2 of the Instrument Rating course results in the student's mastery of all instrument procedures. The Instrument Practical Test Standards requires the instrument applicant to demonstrate approach proficiency while using the aircraft's automation at level 4. During this stage, students will learn FD takeoffs, the use of automation throughout all phases of flight, and autopilot coupled instrument approaches. During the Instrument Rating end-of-course evaluation, the check instructor will allow the use of the FD

and AP for the enroute and arrival phase, and will require use of the AP on one of the nonprecision approaches. The remainder of the procedures will be hand flown by the applicant using an appropriate level of automation (1 through 3) at his/her discretion.

Commercial:

Stage 1—Levels 1-4: Stage 1 of the Commercial Pilot course is dedicated to the mastery of both visual and instrument cross-country procedures. Throughout this stage of training, the student should utilize the aircraft's automation at the appropriate level for the flight or phase of flight to manage workload appropriately. The stage 1 evaluation is based on visual procedures and emergency operations, therefore a thorough review of level 1 and 2 should be conducted prior to the stage exam. During the Stage 1 evaluation, the check instructor will allow the use of the FD and AP during portions of the cross-country scenario, but will require the student do demonstrate proficiency in manually flying the aircraft during normal and emergency operations.

Stage 2—Levels 1-4: Stage 2 of the Commercial Pilot course results in the student's achievement of his/her high performance and complex aircraft operating endorsements. The aircraft utilized in this stage will also be used on the end-of-course evaluation. The student should learn the AP systems and know how to utilize it appropriately. During the Stage 2 evaluation, the check instructor will require the student to hand fly the vast majority of the flight, but may direct the student to utilize the FD/AP at the check instructor's discretion.

Stage 3—Levels 1-4: Stage 3 of the Commercial Pilot course introduces multiple commercial maneuvers in preparation for the practical test. Throughout this stage, the student will develop mastery of the aircraft during visual maneuvers. The Commercial Pilot practical test does require the assessment of the applicant's cross-country planning and flying skills. During the end-of-course evaluation, the check instructor will allow the use of the FD and AP during portions of the crosscountry scenario, but will require the student to demonstrate proficiency in manually flying the aircraft during normal and emergency operations.

Multi-Engine:

Stage 1—Level 1: Stage 1 of the Multi-Engine Rating course is dedicated to the student's mastering of visual maneuvers in a multi-engine airplane during normal and single-engine operations. Since the focus in this stage is on the student's ability to manually control the aircraft, the use of the aircraft's automation will not be emphasized. During the Stage 1 evaluation, the check instructor will not allow the use of the AP.

Stage 2—Levels 1-4: Stage 2 of the Multi-Engine Rating course is dedicated to the student's mastering of instrument maneuvers in a multi-engine airplane during normal and single-engine operations. Since the focus of this stage is on the student's ability to operate in the IFR environment, the

automation may be used at the appropriate level for the flight or phase of flight to manage workload as necessary. During the Multi-Engine Rating end-of-course evaluation, the check instructor will allow the applicant to utilize the aircraft's automation at the appropriate level to manage workload. However, the vast majority of the assessment will be hand flown to demonstrate the applicant's proficiency in multi-engine aircraft operations.

LIMITATIONS

The following limitations—or Pilot Operating Handbook/Aircraft Flight Manual limitations, whichever is more restrictive—apply to all UD aircraft autopilot usage:

Minimum Altitudes:

- During all operations below 1500 ft AGL, the pilot flying shall keep one hand on the control wheel even when the autopilot is engaged.

MINIMUM ALTITUDE FOR AUTOPILOT ENGAGEMENT	
Phase of Flight	***Minimum Altitude***
Takeoff	**800 ft AGL**
Go-Around / Missed Approach	**800 ft AGL** *(positive rate of climb must be established, obstacle clearance requirements met, AND above 800 AGL)*
Approach	*(must be disengaged no lower than)* **200 ft above TDZE**

Disengagement:

1. The autopilot must be disengaged whenever it is not performing as desired or anticipated
2. The autopilot must be disengaged for landing
3. The autopilot must be disengaged for the execution of a missed approach procedure
    - The autopilot may be re-engaged after the minimum altitude requirements have been met

FLIGHT DIRECTOR

The major components of the flight director (FD) system consist of the attitude indicator, horizontal situation indicator, mode selector, and flight director computer. It is important to note that a FD in use does not infer the aircraft is being manipulated by the autopilot (coupled), but is providing steering commands that the pilot (or autopilot, if coupled) follows.

The FD is displayed on the Primary Flight Display (PFD) in the form of a chevron-shaped set of command bars. The FD computer receives information from various instruments concerning the position of the aircraft in relation to the desired modes that have been selected. The command bars then display pitch and bank information for the pilot to follow to achieve the desired performance and track. To use the FD, the pilot places the delta shaped attitude indicator into the command bars so that they are lined up on both sides.

The AP is driven by the FD and therefore is controlled and programmed with the same mode selector panel. It is not possible to engage the AP without the FD, it is, however possible to utilize the FD without having the AP engaged. To prevent the aircraft from entering an unanticipated or potentially dangerous attitude or situation, it is the University of Dubuque's policy to always turn on and program the FD prior to engaging the AP. Only after the FD has been appropriately programmed and the pilot is satisfied with the FD indications, may the AP be engaged.

Altitude Preselect:

The altitude preselect bug should be used for all operations to aid in situational awareness and for the benefit of the aural altitude deviation alerter. The altitude bug will be set prior to selecting any FD pitch mode. The altitude bug will also be used for step-down altitudes while on non-precision approaches.

Once the FD has captured a selected altitude, it will maintain that altitude regardless of the bug setting until a new vertical mode is selected. This allows the FD to provide guidance for the pilot to maintain his/her current altitude while setting the altitude preselect for the next step-down altitude, or maintaining the MDA while setting the altitude preselect for the missed approach altitude.

For instrument approaches, the altitude preselect will be set to the missed approach altitude after capturing the glide slope / path on a precision approach, and after the FD has captured the MDA on a non-precision approach.

Lateral Mode Changes:

There are several things that a pilot can do that will cause the FD to revert to ROL mode. The most common of these is making CDI changes while in NAV mode. When the NAV mode is selected, the FD provides guidance to the pilot to intercept or maintain the navigation source that is displayed on the HSI. If the CDI is switched to a different navigation source while the FD is still in NAV mode, the FD will

automatically revert to ROL mode and maintain whatever angle of bank the aircraft was in at the moment the CDI was switched. For example:

- The FD has been in NAV (GPS) mode while enroute to the destination airport and to the initial approach fix on a VOR or LOC approach. After the aircraft has turned toward the runway during the approach, the pilot switches the CDI from GPS to the VOR or LOC while still in NAV (GPS) mode. The FD receives its information from the HSI and was told to follow the GPS needle. When the pilot switched the CDI source on the HSI, the FD no longer has the GPS guidance that the pilot told it to follow. This conflict between what is displayed on the HSI and what the FD was told to follow causes the FD computer to automatically go to ROL mode because the desired navigational information is no longer available.

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Pitch Modes:

GA—(Go-Around) sets the command bars to a 7 degree nose pitch up attitude. Should be used on FD takeoffs and missed approaches.

PIT—(Pitch) maintains the present pitch attitude when selected or can be set using the nose up/down keys or CWS/sync switch. Should not be used during normal operations.

FLC—(Flight Level Change) maintains the selected climb/descent speed. If FLC is used for a climb, the FD will give guidance to climb at the selected speed, but it will not command a descent to attain that speed. If FLC is used for a descent, the FD will give guidance to descend at the selected speed, but will not command a climb to attain that speed. This is the preferred mode while making large altitude changes during climbs as it maintains an indicated climb speed, prevents an inadvertent stall, and will not allow the aircraft to descend to achieve an indicated airspeed.

VS—(Vertical Speed) maintains the selected vertical speed in feet per minute. This is the preferred mode for non-VNAV descents and small altitude changes while climbing

VPTH—(Vertical Path) when armed will intercept and track a preprogrammed vertical navigation descent. A VNAV profile must be built in the flight plan in order to use this function. This is the preferred method of descent whenever a VNAV profile has been programmed and the pilot has discretion during the descent, typically while operating under VFR.

ALTS—(Altitude Selected) arms whenever a different vertical mode is active and the aircraft is not presently at the altitude set by the altitude preselect bug. This mode is not an individually

selectable pitch mode, but rather indicates that the FD/AP should level at the preselected altitude. Once the FD/AP captures the preselected altitude, this becomes the active pitch mode and will provide pitch guidance to maintain that altitude

ALT—(Altitude Hold) maintains the present altitude when the mode was selected. The only way to change the altitude is to utilize the CWS/sync switch. This mode should not be used in normal operations.

Roll Modes:

GA—(Go-Around) sets the command bars to maintain a wings-level bank attitude. This is a transition mode that should only be used during go-arounds/missed approaches to aid the pilot in maintaining a level bank until reaching a safe altitude to select HDG or NAV mode.

ROL—(Roll) maintains the present angle of bank when the mode was selected. The only way to change the indicated angle of bank is to hold the desired bank attitude and press the CWS/sync switch. This mode should not be used during normal operations.

HDG—(Heading) provides guidance to maintain or reach the heading selected with the heading bug. This mode is to be utilized whenever assigned heading are to be flown

NAV—(Navigation) is displayed on the FMA as the name of the navigational aid that is displayed on the HSI: VOR, GPS, LOC, BC, etc. This mode provides guidance on capturing and maintaining the selected CDI course. This mode is to be utilized whenever tracking a navigational aid is required.

NOTE: *See "CDI Change" for procedures to switch between NAV modes while inflight.*

APR—(Approach) is displayed on the FMA as the name of the navigational aid and the type of vertical track that are displayed on the PFD: LOC or GPS and GS or GP. This is the preferred mode when executing precision approaches.

BC—(Back Course) provides guidance on capturing and maintaining the reciprocal CDI course (tail of the needle). This mode is to be utilized whenever tracking inbound on a LOC/BC approach or outbound on a localizer course.

CDI Change:

1 > Sync the heading bug to the current aircraft heading by pressing the HDG knob

2 > Select HDG mode on the FD control panel

3 > Select the appropriate CDI source

4 > Set the appropriate CDI course

5 > Adjust the heading bug to ensure that the aircraft will intercept the selected CDI course

6 > Select NAV (or APR / BC as appropriate) mode on the FD control panel

7 > Verify the Flight Mode Annunciator (FMA) matches the desired settings and performance

Flight Level Change (FLC): *(Preferred method for large altitude changes during climb)*

1 > Set the altitude preselect to the planned / cleared altitude

2 > Set climb power

3 > Select FLC mode once a climb speed has been established

4 > Set the speed bug to the desired speed using the nose up and down keys or the sync switch

5 > Verify the Flight Mode Annunciator (FMA) matches the desired settings and performance

Vertical Speed (VS): *(Preferred method for non-VNAV descents and small altitude changes during climb)*

1 > Set the altitude preselect to the planned / cleared altitude

2 > Select VS mode

3 > Set VS using the nose up and down keys or the sync switch

4 > Adjust power to maintain desired airspeed

5 > Verify the FMA matched the desired settings and performance

CALLOUTS

CONDITION	*CALLOUT*
Flight Director (FD) On	**Flight Director On, (ROL) and (PIT) Active** *(state the active roll and pitch modes)*
Autopilot (AP) On	**Autopilot On, (ROL) and (PIT) Active** *(state the active roll and pitch modes)*
Autopilot (AP) Off	**Autopilot Off** *(does not apply when selecting the GA button during a goaround or missed approach)*
Altitude Set	**(Altitude) Set** *(state the bugged altitude)*
Altitude Captured	**Alts Cap**
Heading Bug Set	**(HDG) Set** *(state the bugged heading)*
Roll Mode Armed	**(ROL) Armed** *(state the selected mode: HDG, VOR, GPS, LOC, BC)*
Roll Mode Active	**(ROL) Captured** *(state the active mode: HDG, VOR, GPS, LOC, BC)*
Pitch Mode Armed	**(PIT) Armed** *(state the selected mode: VPTH, GS, GP)*
Pitch Mode Active	**(PIT) Active / Captured** *(state the active mode: VS, FLC or the captured: VPTH, GS, GP)*
Approach Mode Armed	**(APR) Armed** *(state the selected mode: LOC & GS, GPS & GP)*
Control Wheel Steering (CWS) Active	**Control Wheel Steering In Use**

Notes:

When using the go-around button during a missed approach or a go-around, the autopilot will disconnect. The profile/procedure includes a callout that annunciates that a go-around is being executed. The go-around procedure requires that the autopilot be disconnect, therefore the "Go-Around" callout infers "Autopilot Off"

The callouts listed above are unique to operating the aircraft automation system and are in addition to the normal callouts for all operations.