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14. ABSTRACT

On September 08, 2013, the Federal Aviation Administration released a study completed by the Flight Deck Automation Working Group. The group identified multiple areas of vulnerability that are having negative effects on aviation safety. One of the areas of concern is degradation of pilot knowledge and skills. In over 60% of the aircraft incident reports reviewed by the working group, errors in manually handling the aircraft were a factor. One of the causes of the handling errors is degradation of pilot stick and rudder skills, which was caused by automation overuse and the lack of manual flight practice. Operational deployments will be the prime time P-8A pilots could suffer from automation dependency. The lack of simulators and pilot training availability in the aircraft could set up pilots to exhibit the effects of automation overuse. Squadrons must take steps to promote the practice and upkeep of manual flying skills to reduce the possibility of pilots' basic flying skills atrophying. The responsibility for continued growth in knowledge and exercise of stick and rudder skills will also fall on the pilots' shoulders. As a professional aviator, a P-8 pilot must hold him or herself to the highest standard and not accept becoming a slave to automation. If both squadrons and pilots take the proper steps, the safe operation of the Navy's newest aircraft will continue.

15. SUBJECT TERMS
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MASTER OF MILITARY STUDIES

TITLE: AUTOMATION DEPENDENCY IN THE P-8A POSEIDON

SUBMITTED IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR THE DEGREE OF
MASTER OF MILITARY STUDIES

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Executive Summary

Title: Automation Dependency in the P-8A Poseidon

Author: LCDR John C. Perkins, United States Navy

Thesis: To ensure P-8A aviators are ready to perform their basic flight fundamentals, the training syllabus and currency requirements must focus on reinforcing the importance of staying connected to the aircraft and using every opportunity to practice manually flying the aircraft.

Discussion: On September 08, 2013, the Federal Aviation Administration released a study completed by the Flight Deck Automation Working Group. The group identified multiple areas of vulnerability that are having negative effects on aviation safety. One of the areas of concern is degradation of pilot knowledge and skills. In over 60% of the aircraft incident reports reviewed by the working group, errors in manually handling the aircraft were a factor. One of the causes of the handling errors is degradation of pilot stick and rudder skills, which was caused by automation overuse and the lack of manual flight practice. An additional concern identified by the Working Group was the reluctance of the pilot to intervene when automation is in control of the aircraft - automation overuse being credited again to the pilot's loss of confidence in his or her stick and rudder skills. The Working Group also identified pilot disconnect from the aircraft as a result automation over reliance as a vulnerability. The disconnect from the aircraft allowed pilots to become unaware of the energy state of the aircraft or unaware of malfunctions, and pilots were not prepared to assume manual control of the plane.

Conclusion: Operational deployments will be the prime time P-8A pilots could suffer from automation dependency. The lack of simulators and pilot training availability in the aircraft could setup pilots to exhibit the effects of automation overuse. Squadrons must take steps to promote the practice and upkeep of manual flying skills to reduce the possibility of pilots' basic flying skills atrophying. The responsibility for continued growth in knowledge and exercise of stick and rudder skills will also fall on the pilots' shoulders. As a professional aviator, a P-8 pilot must hold him or herself to the highest standard and not accept becoming a slave to automation. If both squadrons and pilots take the proper steps, the safe operation of the Navy's newest aircraft will continue.

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History of Unmanned Aircraft

The American Civil War marks one of the first uses of unmanned aerial vehicles, when forces from both the Confederate and Union Armies used unmanned balloons to carry ordinance for release over a designated target,[1] Charles Perley patented a means of controlling the balloon in 1865. Placing the balloon upwind of the target, Perley used various lengths of fuse cord to time the release of the weapon once the balloon had reached its target.[2]

By 1914, Elmer Sperry was working with Glenn Curtiss to develop a gyroscopic system that would allow an aircraft to stabilize itself in level flight without an aviator. The gyroscope device also included a means with which to change the pitch of the aircraft, causing it to dive once reaching a pre-set distance.[3] Four years later, Charles Kettering, working in part with the United States Army, expanded the ability to control unmanned aircraft. He equipped the Kettering Bug with a device that would count the number of propeller revolutions. Once the Bug's propeller reached the predetermined revolution count, the engine would shut down and the Bug would descend to its target.[4]

Additionally, the United States took steps in improving the ability of precision control in unmanned aerial vehicles in World War II. Operation Aphrodite employed the B-17, B-24, and PB4Y-1 as improvised UAVs. The Army used radio-controls to manipulate actuators connected to the aircraft's flight control surfaces. The Army also installed television cameras in the flight station and nose of the aircraft to allow monitoring of flight instruments and a visual reference of

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[1] Jim Garamone. 2002. From the U.S. civil war to Afghanistan: A short history of UAVs. Army Communicator 27 (2) (Summer2002): 63-4, https://search.ebscohost.com/login.aspx?direct=true&db=mth&AN=65827771&site=ehost-live.

[2] Charles Pebley. Improvements in discharging explosive shells from balloons. United States of America Patent US37771. February 1863. http://www.google.com/patents/US37771.

[3] Garamone, A short history of UAVs, 2002, https://search.ebscohost.com/login.aspx?direct=true&db=mth&AN=65827771&site=ehost-live.

[4] Garamone, A short history of UAVs, 2002, https://search.ebscohost.com/login.aspx?direct=true&db=mth&AN=65827771&site=ehost-live.

the flight path.[5] Operators in place in an adjacent aircraft would then direct the drone to its intended target.[6]

Jumping forward to 2007, the United States Navy began production of the X-47 unmanned combat air system demonstration program. The most recent variant, the X-47B designed for carrier operations, boasts the most capable avionics suite to date. The flight management system, aided by a precision, vision based, global positioning system (GPS), allows for autonomous capabilities.[7] The management system can operate on a pre-programmed navigation route that requires only a system or mission operator to monitor performance.[8]

The improvements made in unmanned aircraft flight guidance systems continue to alleviate the roles of the naval aviator. A system operator alone can monitor the X-47B. An unmanned aerial vehicle like the X-47B can support a combat mission requiring an aircraft to take-off, transit to a designated target, drop ordinance, and return for landing, with no pilot involved.

Just as guidance systems in unmanned aerial vehicles continue to evolve, so have technologies in manned aircraft. The U.S. Navy has released the P-8A Poseidon to the fleet as its new Anti-Submarine Warfare platform. The P-8's autopilot and guidance system has the capability to perform much like the X-47B. The pilot can engage the autopilot after take-off and once coupled to the guidance system, the autopilot will control the aircraft during most phases of flight. The pilot at this point cannot fall into a role of a system operator. He or she must remain connected to the aircraft so that awareness of airspeed, altitude, and all other conditions of the

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[5] John Degaspari. 2003. "Look, ma, no pilot!" Mechanical Engineering 125 (11) (11): 42, https://search.ebscohost.com/login.aspx?direct=true&db=mth&AN=11272734&site=ehost-live.

[6] Ed Darack. "A Brief History of Unmanned Aircraft, from Bomb-bearing Balloons to Global Hawk." *Air and Space Magazine.* May 2011. http://www.airspacemag.com/photos/a-brief-history-of-unmanned-aircraft-174072843/?no-ist.

[7] Naval Technology. "X-47B Unmanned Combat Air System Carrier (UCAS), United States of America." *Naval Technology Market & Customer Insight.* Accessed November 15, 2014. www.naval-technology.com/projects.

[8] X-47B Unmanned Combat Air System Carrier (UCAS), United States of America.

plane is maintained. The pilot must be ready at all times to take physical control of the aircraft to ensure the safety of the crew and plane. To make certain that confidence in his or her stick and rudder skills and scanning habits do not atrophy, the pilot must take every opportunity to manually fly the aircraft and not fall into the trap of automation dependency. To ensure P-8A aviators are ready to perform their basic flight fundamentals, the training syllabus and currency requirements must focus on reinforcing the importance of staying connected to the aircraft and using every opportunity to manually flying the aircraft.

Automation Dependency Mishaps

Automation in aviation refers to the use of computer systems to manipulate the control surfaces and engines of the aircraft to maintain heading, altitude, airspeed, and the intended flight path. Automation systems remove the pilots need to use stick and rudder skills, or manual flying techniques, to operate the aircraft. There are benefits to using these computer systems: they reduce the workload on the flight station crew and can increase the situational awareness of the pilots beyond aircraft control. However, there are also the possibilities of negative effects of automation. If pilots become too dependent on the systems and use them solely, a degradation in manual piloting skills can occur; a pilot may lose confidence in his or her ability to fly the plane manually. Additionally, the pilot can become disconnected from the aircraft to the point where his or scan of airspeed, altitude, or power settings and recognition of malfunctions becomes impaired. These effects of automation dependence are at the forefront of aviation safety.

Flight Deck Automation Working Group

On September 08, 2013, the Federal Aviation Administration release a study completed by the Flight Deck Automation Working Group. The group identified multiple areas of vulnerability that are having negative effects on aviation safety. One of the areas of concern is degradation of pilot knowledge and skills.[9] In over 60% of the aircraft incident reports reviewed by the working group, errors in manually handling the aircraft were a factor.[10] One of the causes of the handling errors is degradation of pilot stick and rudder skills, which was caused by automation overuse and the lack of manual flight practice.[11] An additional concern identified by the Working Group was the reluctance of the pilot to intervene when automation is in control of the aircraft - automation overuse being credited again to the pilot's loss of confidence in his or her stick and rudder skills. The Working Group also identified pilot disconnect from the aircraft as a result automation overreliance as a vulnerability. The disconnect from the aircraft allowed pilots to become unaware of the energy state of the aircraft or unaware of malfunctions, and pilots were not prepared to assume manual control of the plane.[12] Multiple investigation reports from the National Transportation Safety Board in the past few years identified overreliance of automated equipment as one of the causal factors of the accidents. Three accident investigations completed by the NTSB will be discussed in the next few paragraphs to highlight outcomes of pilots becoming disconnected from the aircraft or a degradation in stick and rudder skills from automation dependency.

Flight 214

On July 06, 2013, Asiana flight 214 was approaching San Francisco International Airport for landing on runway 28L. The Boeing 777 is equipped with an automatic flight control system that allows a computer to control the inputs to the aircraft's flight controls to maintain a selected flight path as well as an auto-throttle system that will control power output of the engines to

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[9] Federal Aviation Administration. 2013. "130908 PARC FltDAWG Final Report Recommendation." November 20. Accessed November 2014. http://www.faa.gov.

[10] Ibid, 31.

[11] Ibid, 33.

[12] Ibid, 36

maintain desired speed. The pilot at the controls of the aircraft during the approach, although new to this specific Boeing model, had accumulated over 9000 flight hours in commercial aircraft during a 19-year career. At the time of the accident, the pilot was completing the 777-qualification process and had accrued 33 hours of flight time and 24 hours of simulator time. One would expect that an aviator with this amount of experience would be fully capable of manually flying an aircraft.

The Asiana Pilot in Command Qualification process calls for a total of 20 flight legs and 60 hours to complete. The pilot of Flight 214 had completed eight of the required legs that each concluded with a visual approach and landing, aided by an Instrument Landing System (ILS),[13] with the automatic flight control system engage and auto-throttles controlling speed until the aircraft was established on the final approach[14] and below 1000 feet. This coincided with airlines standard operating procedures for its aviators; Asiana recommends that automation be used as much as possible during all phases of flight.[15] While using automation will help reduce pilot fatigue, specifically in high traffic areas such as airports, this practice takes valuable opportunities away from pilots to ensure their stick and rudder skills do not atrophy. Furthermore, Asiana Airlines manual flying training to include pitch control expectations and power control settings to complete a visual approach are not covered in the training syllabus.[16]

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[13] An **instrument landing system** (**ILS**) is a radio beam transmitter that provides a direction for approaching aircraft that tune their receiver to the ILS frequency. It is a ground-based instrument approach system that provides precision lateral and vertical guidance to an aircraft approaching and landing on a runway, using a combination of radio signals and, in many cases, high-intensity lighting arrays to enable a safe landing during instrument meteorological conditions (IMC).

[14] A final approach (also called final leg and final approach leg) is the last leg in an aircraft's approach to landing, when the aircraft is lined up with the runway and descending for landing.

[15] National Transportation Safety Board. Descent Below Visual Glidepath and Impact With Seawall, Asiana Airlines Flight 214. 2013. AAR1401 (NTSB, July 13).

[16] NTSB, AAR1401.

Upon arrival to San Francisco International, the approach controller notified the pilot that the ILS approach to the runway was inoperable. The pilot accepted a vector to the final approach course, approximately 14 miles from the runway and elected to attempt a visual approach. When the aircraft approached five miles from the landing, the plane was above the desired glide path and the pilot made the decision to disconnect the automatic flight control system and continued the approach manually. The pilot's atrophied basic manual flying capabilities caused an unstable approach resulting higher than normal decent rates, airspeed decreasing below minimums, and higher than normal pitch attitude. The pilot was late to respond to the unstable approach and the aircraft arrived short of the runway, striking a seawall and subsequently sliding along the runway, spinning 330 degrees and coming to a stop along the side of the runway.

The National Transportation Safety Board concluded that had the pilot had more manual flight practice and relied less on automation, he would have had better pitch control, airspeed awareness, and would have made the correct power additions to keep the aircraft on a stable approach to landing.[17] Three passengers were fatally injured; an additional forty passengers and nine crewmembers sustained serious injuries because of the accident. The accident destroyed the aircraft.

Flight 8284

Empire Airlines Flight 8284 on approach to Preston Smith International Airport Lubbock Texas is another aircraft incident that can be attributed to automation dependence. The first officer was the pilot at the controls during the initial phase of the approach on 27 January 2009.

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[17] NTSB, AAR1401.

She was a certified commercial pilot in both single and multi-engine aircraft. She has accumulated over 2000 flight hours, 1890 hours as pilot in command.[18]

The pilots were operating a twin turbo prop, short haul regional airline at the time of the incident. The aircraft are configured with an automatic flight control system that allows for the roll, yaw, and pitch of the aircraft to be controlled by its flight computer system. At the time of the approach, the flight station crew entered the ILS for runway 17R into the flight management computer and the computer was directing the aircraft towards the runway.

As the aircraft was descending toward the runway, the crew initiated checklist and began to configure the plain for landing. The first officer, still the pilot at the controls with the autopilot engaged, called for the flaps to be extended by the co-pilot. As the co-pilot moved the flap handle, the flaps on the right wing remained up and as a result, the aircraft began to roll to the right. The autopilot corrected the asymmetric condition, which went unnoticed by the first officer. She did not recognize the malfunction until she observed an increase in airspeed, noting that it should have decreased with the extension of the flaps. Again, because the autopilot was masking the malfunction, the initial diagnosis by both pilots was that neither flaps had extended. This mis-diagnosis became extremely dangerous as the aircraft speed continued to decrease and the plane exhibited pre-stall indications. At this time, the autopilot had automatically disconnected and the first pilot had manual control. From this point on the aircraft remained in an unstable condition, neither of the pilots were able to correct the situation. The aircraft impacted the ground short of the designated point of land and slid to a stop along the right side of the runway.

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[18] National Transportation Safety Board. Crash During Approach to Landing Empire Airlines Flight 8284 Avions de Transport Regional Aerospatiale Alenia *ATR 42-320, N902FX*. 2009. AAR-11-02 (NTSB, January 27).

In a post flight interview, the first pilot indicated that she was not aware that she had actually experienced a flap asymmetry malfunction during the approach. The first pilot's unawareness can be attributed to a dependency on automation, and not verifying changes in configuration. If she had visually checked the position of the flaps and watched for any un-commanded roll of the aircraft, which she should have seen as the autopilot corrected the malfunction with left wing down inputs; the first pilot would have avoided this incident. Because of the accident, one crewmember was seriously injured and the other sustained minor injuries. The impact of the crash destroyed the aircraft.[19]

Balotesti Flight

On March 31, 1995, an airbus A310 was scheduled for departure from Bucharest en-route to Brussels. The pilot at the controls was a fifty-one year old man who graduated from initial flight school in 1968. During his twenty-seven years as a pilot, he accumulated over 8900 hours of flight time in three separate commercial aircraft, 650 of these in the A310 airframe.

The A310 twin-engine jet airliner is a commercial aircraft used for medium to long-range flights.[20] The A310 is outfitted with an auto system, which controls the output of each engine. The output of the engine is selected based on what profile the aircraft is operating, takeoff, climb, cruise, or descent. Once the pilot engages the auto thrust system, the flight management computer will make the required adjustments.[21]

Once cleared onto the runway, the A310 completed uneventful takeoff. The pilot engaged the auto-thrust system, which was controlling engine output in the takeoff mode. The aircraft was starting a left turn crossing 1500 feet when the thrust mode transitioned to the climb

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[19] NTSB, AAR-11-02.

[20] Ministry of Transport Civil Aviation Inspectorate, 1995. Accident A310-324 YR-LCC Balotesti. 1995. 31/839/21/09 (Ministry of Transport Civil Aviation Inspectorate, March 31). http://aviation-safety.net/database/record.php?id=19950331-0.

[21] Ministry of Transport Civil Aviation Inspectorate, Accident A310-324.

profile as scheduled.[22] At this time, the thrust control computer started a power reduction on both throttles to match the scheduled power setting. However, at the time of this transition, a malfunction developed in the system. This malfunction caused one of the throttles to continue to reduce power creating an asymmetrical situation. The malfunction went unnoticed by the pilot at the controls partially due to relying on the additional pilot in the flight station to monitor the throttles but, more significantly because of an over-dependency or a false confidence in the auto throttle system. Because the malfunction was never recognized, the aircraft became uncontrollable leading it to crash just after take-off. The pilot could have prevented the accident if the he had continued to verify that the system was operating correctly and did not depend or assume that the automation was performing as advertised. If the pilot engages the automatic thrust systems, he or she has the ability to manually control the throttles. Once the manual input from the pilot is complete, the system will maintain the elected throttle position. If the pilot had had his hand on or near the throttles, he would have recognized this malfunction and manually corrected the power reduction. As a result, the accident took the lives of eleven crewmembers and forty-nine passengers and the impact with the ground destroyed the aircraft.[23]

While there are times the training syllabuses instruct pilots to place full faith in the flight instruments of the aircraft, for example, if the pilot is suffering from the effects of special disorientation, this should not be the case when it comes to automation. All three of the incidents above highlight the effects of automation dependency. They show how quickly an aviator can lose control of their aircraft if he or she places too much trust in automation instead of their basic aviation skills. The Navy has introduced the P-8A Poseidon into the Maritime Patrol Plane community and it is equipped with similar automation systems as described in these

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[22] Ministry of Transport Civil Aviation Inspectorate, Accident A310-324.
[23] Ministry of Transport Civil Aviation Inspectorate, Accident A310-324.

incidents. Pilots and commanders will carry the responsibility of ensuring that the basic flying skills do not atrophy and that an environment or culture is not created that will foster overreliance on automation.

Naval Aviation Training

Primary Flight Training

Where or when are basic flying skills introduced to a future aviator and how are the stick and rudder techniques formed into a skill that should become second nature. This training begins for a future P-8A aviator during primary flight school. The basic skills that the student pilot learns during this course of instruction will translate into each of the aircraft he or she steps into along their training pipeline. When the prospective aviator reaches the level of their fleet aircraft, he or she will be able to apply these basic skills to safely operate the plane no matter what type of equipment is in the aircraft.

Instructors will train prospective P-8 pilots in their first military aircraft, the Beechcraft T-34C "Turbo mentor" during primary flight training. The T-34 is a simple aircraft; it is a single engine, unpressurised plane with no automatic flight controls or automatic thrust systems. The pilot is provided with flight instruments, a stick and rudder for primary flight controls, and trim wheels for secondary controls. Additionally, the pilot has manual control over the power levers, flaps, and landing gear systems.[24] The student pilot completes all take-offs, transits, approaches, and landings by manually flying the aircraft.

Figure 1: Cockpit T-34C Turbo mentor

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[24] Chief of Naval Air Training. "Work Book, Aircraft Systems Familiarization, T-34C." *CNATRA Instruction P-307*. Corpus Christi, Texas, June 23, 2003.

Instructors will teach the future pilot how to develop an effective scan pattern prior to stepping into the aircraft before performing the first flights. The design of the instruction of the pilot's scan is to discipline their eyes to move from inside the flight station to outside the aircraft in an efficient and timely manner. This is important for two reasons; a pilot needs a visual scan outside the aircraft for traffic and navigational purpose and then inside for the instrument panel for indications of power setting, flight instruments, and malfunction identification. A pilot cannot become fixed or stop their scan or they could run a risk of missing important information. The goal of an effective scan is to know what to look for, when to look, and how to respond correctly to what you have seen.[25] The pilot must avoid becoming complacent once experienced is gained in the aircraft and continue to exercise this tool.

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[25] Chief of Naval Air Training. "Flight Training Instruction, Primary Contact, T-34C." *CNATRA Instruction P-330.* Corpus Christi, Texas, June 24, 2003.

Another fundamental developed in primary flight school is the concept of Power Attitude Trim.[26] This is another tool a future P-8 pilot will use during the training curriculum and throughout his or her flying career. This is a continuous process throughout flight and applies to small corrections as well as larger maneuvers. For example, if the pilot wants to initiate a climb, he or she will manually add power, increase the attitude of the nose, and then trim the plane for the new flight condition.[27] The student pilot will use his or her scanning technique to ensure the correct power setting has been selected and the appropriate airspeed is maintained throughout the maneuver. The pilot will manually initiate the same power attitude trim principle once the aircraft approaches the designated altitude. The student pilot will reduce power, the nose attitude will decrease, and he or she will trim the aircraft for the new flight condition. Again, the student pilot must continue to scan his or her instrument to ensure the inputs to all the flight controls are producing the desired or anticipated flight condition.

The student pilot will take the principles of scan and power attitude trim to the aircraft and use them to master basic air work. The Naval Flight Training instruction defines basic air work as, "demonstrated technique and mastery of the power and flight controls to obtain the desired attitude, heading, airspeed, and altitude consistently through a range of maneuvers."[28] The student pilot will have the opportunity to refine this skill during every flight. The student pilot will be required to demonstrate and perform a number of maneuvers to prove that he or she is capable of manually controlling the aircraft safely from the initial take-off through the final landing. Maneuvers such as constant angle of back turns,[29] level speed changes,[30] and basic

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[26] Trim is used for trimming and balancing the airplane in flight and to reduce the force required of the pilot in actuating the primary flight control surfaces. These tabs are small airfoils attached to, or recessed into, the trailing edge of the primary control surfaces.

[27] Flight Training Instruction Primary Contact T-34C, 2003.

[28] Flight Training Instruction Primary Contact T-34C, 2003.

[29] Constant Angle of Back Turns - turning the aircraft using a constant angle of bank to an assigned heading while maintaining altitude and airspeed.

transitions[31] will allow the student pilot to gain confidence in the ability to be in control of the aircraft manually, without assistance from an automated system. Additionally, the student pilot will put his or her stick and rudder skills and scan to the test during the approach and landing phases of the training flights. This is arguably the most critical phase of flight; the aircraft will go through multiple configuration changes; descending and decelerating until touchdown on the runway. The student pilot will constantly be adjusting power and attitude while trimming the aircraft during each configuration change to maintain the appropriate airspeeds and descent rates to arrive on the final approach course as required to complete the landing process.

The student pilot will exercise these skills on every flight. This syllabus design is not only to better the pilot's stick and rudder skills but also to keep those skills current. Less time between flights will also allow the student pilot's scan to stay sharp so recognition of trends or possible malfunction, and making early corrections to them will come second nature. The requirement for break in training warmup events identifies the importance of the regular exercising of these manual flying skills. The warmup event is a non-syllabus event that is scheduled to compensate for breaks in the training of student pilots. The training syllabus bases the number of warmup events off the number of days between training flights.[32] The diagram below from the Primary Training Instruction displays the criteria for the scheduling of warmup events.

Figure 2: Warmup Criteria during Primary Flight Training

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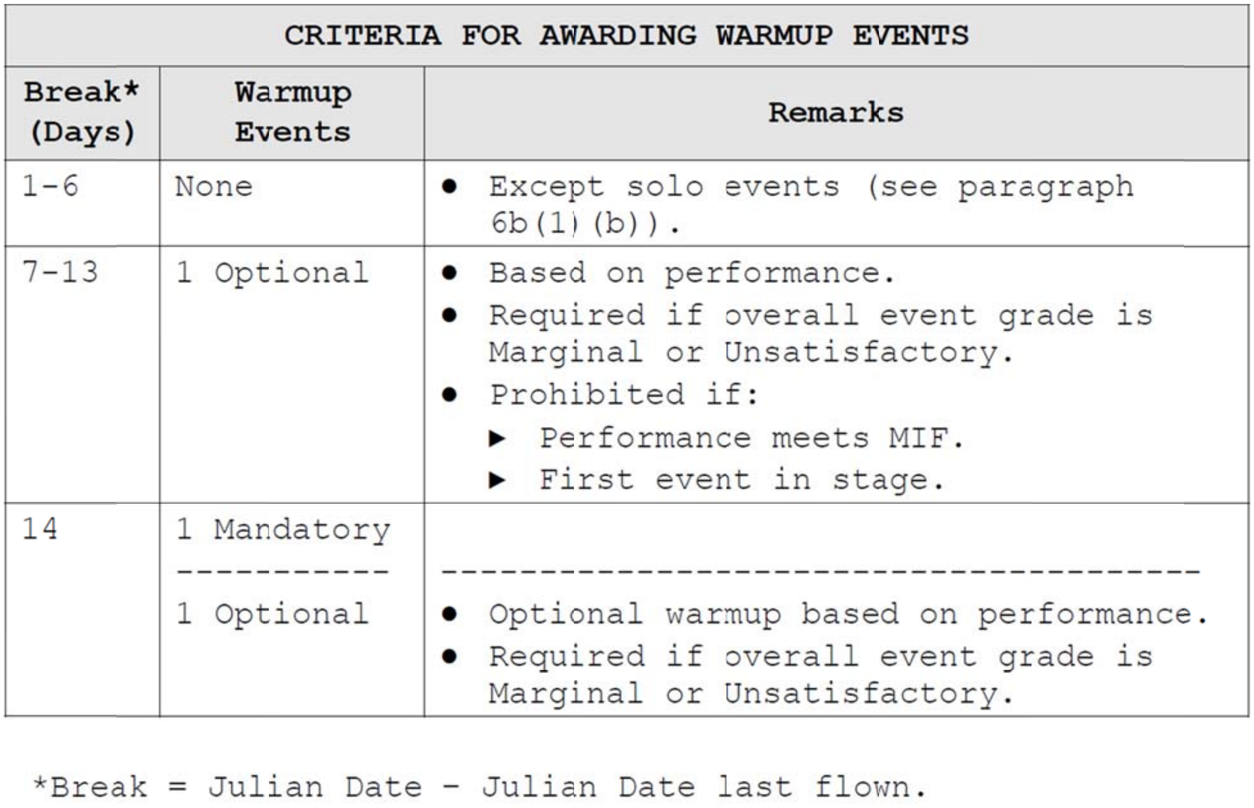
[30] Level speed changes (LSC) are taught to familiarize you with the various trim adjustments required with changes in airspeed, power setting, and aircraft configuration.

[31] The basic transitions are used to enter a climb or descent from normal or fast cruise and to level off in normal or fast cruise from a climb or descent.

[32] Chief of Naval Air Training. "Primary Multi-Service Pilot Training System." *CNATRA Instruction 1995.140D.* Corpus Christi, TX, May 8, 2009.



CRITERIA FOR AWARDING WARMUP EVENTS

Break* (Days)	Warmup Events	Remarks
1-6	None	● Except solo events (see paragraph 6b(1)(b)).
7-13	1 Optional	● Based on performance. ● Required if overall event grade is Marginal or Unsatisfactory. ● Prohibited if: ▶ Performance meets MIF. ▶ First event in stage.
14	1 Mandatory ----------- 1 Optional	 --------------------------------------- ● Optional warmup based on performance. ● Required if overall event grade is Marginal or Unsatisfactory.

*Break = Julian Date - Julian Date last flown.

The establishment of a warmup process shows that there is concern for the performance of a student pilot if there is an extended period of time out of the aircraft. There is an expectation that the student pilots stick and rudder skills and scan, if not exercised on a regular basis will cause a reduction in the ability to operate the aircraft safely. While students in the primary training syllabus are not introduced to automatic flight management systems in the T-34C, they should be introduced to the similar effects that automation dependency can have on their manual flying skills.

Advanced Multi-Engine Training

Once the prospective P-8A pilot graduates from primary flight training, he or she will move on to training in the T-44C Pegasus. The T-44C is a Beechcraft, twin-engine, pressurized, fixed-wing aircraft. The primary mission of the T-44C is the training of student aviators in a multi-engine aircraft to gain proficiency in multi-engine flight in preparation for his or her fleet aircraft.[33] Like the T-34, the pilot has the ability to manually control the primary and secondary flight controls and additionally the syllabus will introduce the student pilot to the functions of a flight management system and flight guidance system.

Figure 3: Flight Station of the T-44C Pegasus

The flight management system (FMS) is composed of a control display unit (CDU) and a FMS computer. The system allows the student pilot to tune communication and navigational aids and program or modify flight plans.[34] The flight guidance system (FGS) is composed of two flight guidance computers, a flight guidance panel, and four servos.[35] The system provides the student pilot with autopilot, flight directors, and electronic trim. The FGS operates in multiple modes

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[33] Chief of Naval Air Training. "Multi-Engine Flight Training Instruction, T-44C." *CNATRA Instruction P-561*. Corpus Christi, TX, September 12, 2014.

[34] Chief of Naval Air Training. "Student Handout Booklet, T-44C Systems Course." *CNATRA Instruction P-564*. Corpus Christi, TX, June 12, 2011.

[35] CNATRA Instruction, P-564.

that provide input to the autopilot to maintain heading, altitude, flight plans, and final approach courses and glideslopes.[36]

The student pilots' first training events in the plane will not start with operating the flight guidance system, but rather training will resemble the training received in the T-34, physically flying the aircraft. The student will use the same scanning and power attitude trim techniques introduced in primary training and apply them to maneuvers in the T-44. Training flights will start with level speed changes, turn patterns, and slow flight maneuvers to gain confidence in manually operating the new aircraft. Additionally, the training syllabus will introduce the student pilot to operating the aircraft with the loss of an engine and ditching scenarios. All of the situations presented to the student pilot allow for the development of stick and rudder skills to manually control the aircraft regardless of flight regime. Just like primary training, this curriculum recognizes that extended breaks in training for a student pilot may drive the scheduling of a warmup flight.

Figure 4: Warmup Criteria during Advanced Flight Training

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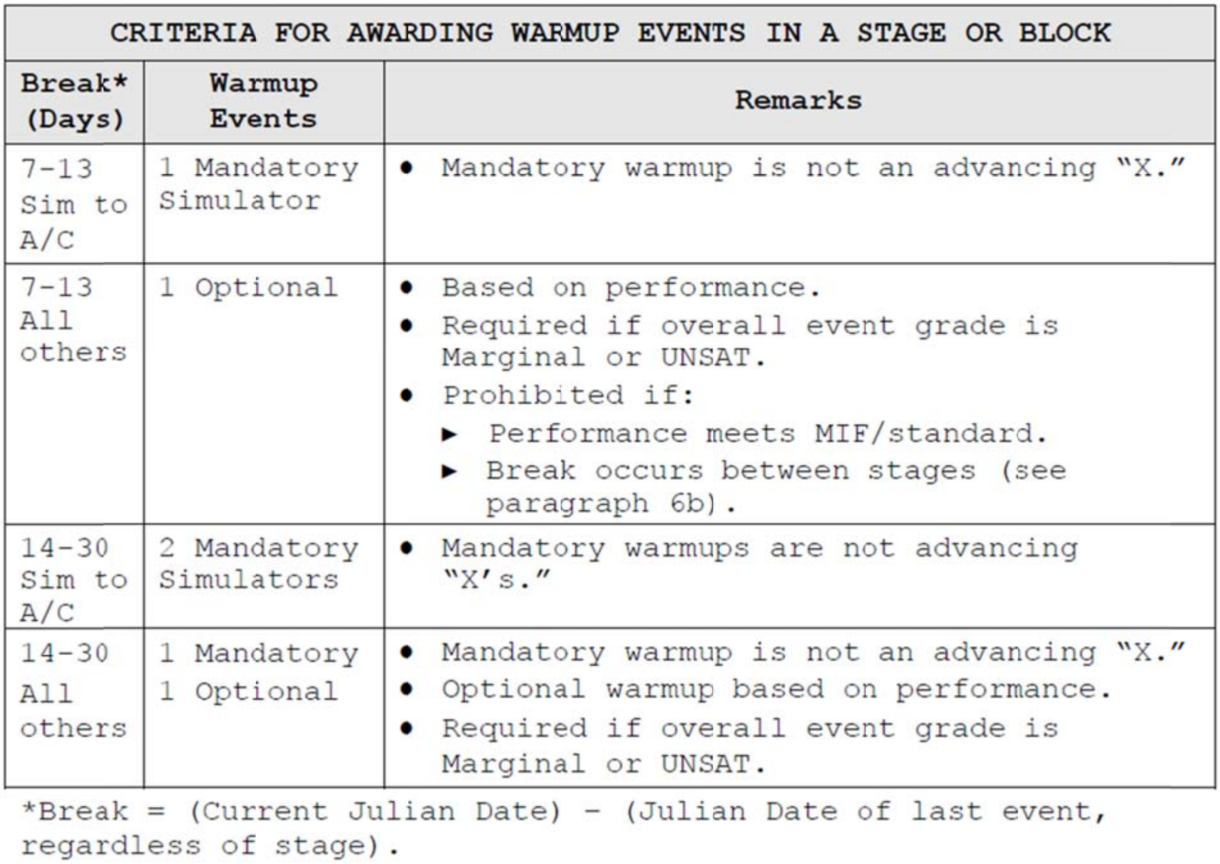
[36] CNATRA Instruction, P-564.



CRITERIA FOR AWARDING WARMUP EVENTS IN A STAGE OR BLOCK		
Break* (Days)	**Warmup Events**	**Remarks**
7-13 Sim to A/C	1 Mandatory Simulator	• Mandatory warmup is not an advancing "X."
7-13 All others	1 Optional	• Based on performance. • Required if overall event grade is Marginal or UNSAT. • Prohibited if: ▶ Performance meets MIF/standard. ▶ Break occurs between stages (see paragraph 6b).
14-30 Sim to A/C	2 Mandatory Simulators	• Mandatory warmups are not advancing "X's."
14-30 All others	1 Mandatory 1 Optional	• Mandatory warmup is not an advancing "X." • Optional warmup based on performance. • Required if overall event grade is Marginal or UNSAT.

*Break = (Current Julian Date) – (Julian Date of last event, regardless of stage).

Again, just as in the primary training syllabus, the Naval Training Command expects that a student pilots physical flying skills may be degraded if he or she does not exercise those skills due to time out of the aircraft.

Naval Training Command should also consider another situation that could allow a student pilot to meet the criteria for a warmup event. Once the student pilot has mastered the stick and rudder skills in the T-44, the syllabus shifts to instrument navigation. In this stage, flights will focus on procedures for operating in an instrument environment.[37] The student pilots will also have the opportunity to use the flight guidance system in combination with the autopilot. The T-44C training instruction authorizes the autopilot to be engaged after reaching 400 feet above ground level on departure and must be disengaged by 150 feet during the

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[37] CNATRA Instruction, P-561.

approach to landing.[38] If student pilot uses automation in the T-44 to its max extent during this phase of flying, he or she could suffer the effects of automation dependency, which could mimic the effects of not being in the aircraft at all. This would be the perfect opportunity for the training command to introduce student pilots to known issues created from automation overreliance. This introduction could set the foundation for responsible automation use once he or she reaches the P-8A.

Fleet Replacement Squadron and Squadron Level Training

Once complete with training in the T-44C, a newly-winged aviator transitions to the P-8A Poseidon. A pilot will spend time at the Fleet Replacement Squadron, VP-30, prior to reporting to his or her operational squadron. The syllabus will focus on learning to perform preflight, normal, degraded, and post-flight procedures in the P-8.[39] The pilot will apply the stick and rudder skills and scanning techniques gained during primary and advanced training to learn to manually fly the P-8 during syllabus flights. Like the T-44C, the P-8A is fitted with an Autopilot Flight Director System (AFDS) that allows the Flight Management System to control the path of the aircraft. The P-8 NATOPS authorizes the use of autopilot once the aircraft is 400 feet above ground level and the pilot must disconnect prior to 50 feet above ground level.[40] Additionally, the P-8A has an Auto-throttle System that can provide automatic thrust control from the initial take-off through landing. NATOPS recommends using auto-throttles for all take-off evolutions.[41] When upgrading and while on mission flights, pilots will be provided with more opportunities to use automation systems in the P-8. While at the FRS and at the operation

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[38] CNATRA Instruction, P-564.

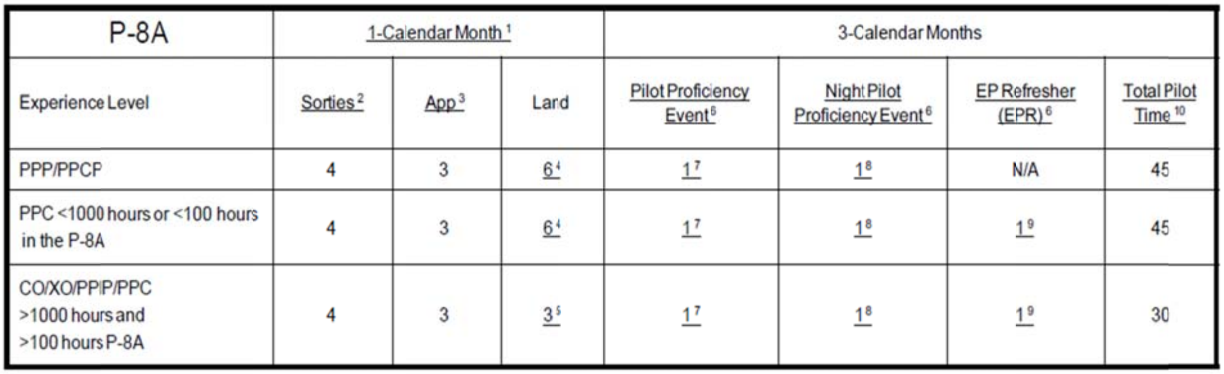
[39] Patrol Squadron Thirty. "P-8A CAT I VP Pilot Syllabus." *Course Identification Number D-2A-1122*. Naval Air Station Jacksonville, FL, August 2014.

[40] Chief of Naval Operations. "Naval Air Training and Operating Procedures Standardization (NATOPS) Flight Manual Navy Model P-8A Aircraft," NATOPS, A1-P8AAA-NFM-000. October 11, 2011.

[41] NATOPS, A1-P8AAA-NFM-000.

squadron, pilot proficiency continues to be a top priority. The Wing Training Manual goes into detail on what a pilot must complete during the calendar month to remain proficient in his or her stick and rudder skill in order to safely operate the aircraft.

Figure 5: P-8A Pilot Proficiency Requirement, Monthly and Three Month



P-8A	1-Calendar Month[1]			3-Calendar Months			
Experience Level	Sorties[2]	App[3]	Land	Pilot Proficiency Event[5]	Night Pilot Proficiency Event[6]	EP Refresher (EPR)[6]	Total Pilot Time[10]
PPP/PPCP	4	3	6[4]	1[7]	1[8]	N/A	45
PPC <1000 hours or <100 hours in the P-8A	4	3	6[4]	1[7]	1[8]	1[9]	45
CO/XO/PPP/PPC >1000 hours and >100 hours P-8A	4	3	3[5]	1[7]	1[8]	1[9]	30

Along with the required landing and approach minimums, a P-8 pilot must meet three calendar month minimums for hours and events.[42] If the pilot does not maintain proficiency minimums, the training manual will restrict what duties he or she may be assigned and what steps must be taken to regain proficiency. However, neither the wing training manual, NATOPS, nor command instructions address another critical vulnerability that can have the same effects on a pilot as being removed from the aircraft; the effects of automation dependency.

Conclusion

On January 04, 2013, the Federal Aviation Administration released a Safety Alert for Operators (SAFO) addressing an increase in manual handling errors. The SAFO presented recommendations for promoting manual flight operations to help reduce the errors caused by

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[42] Commander Patrol and Reconnaissance Group. "VP Wing Training Manual (P-8A)." *COMPATRECONGRUINST 3500.32*. Norfolk, VA, December 18, 2012.

continuous use of auto flight systems.[43] While the training instructions and wing training manuals for Maritime Patrol Plane pilots address the issue of pilot proficiency retention when it comes to breaks in training or days out of the aircraft, controls are not in place for loss in proficiency due to automation dependency. The evidence provided by the Flightdeck Automation Working Group and from the National Transportation Safety Board highlight that degradation in pilot manual handling skills and pilot disconnect when operating aircraft with automation systems can become a problem. This problem is not likely to emerge while a P-8A squadron is operating from its home station. The opportunity for training flights to be scheduled and the availability of simulators should prevent automation overuse effects from being generated. However, pilots will be vulnerable to these effects while on deployment. When the squadron deploys for an extended period, it leaves behind the simulators that absorb the majority of pilot training flights. The training flights completed in the actual aircraft also become less available, meaning less time and opportunities for P-8 pilots to exercise their stick and rudder skills. Missions flown while on deployment will usually consist of one takeoff and one landing to be split between three pilots. The crew will spend multiple hours at altitude and the capabilities of the flight guidance system in conjunction with the autopilot can claim all of the credit for this flight time. This amount of automation usage creates a perfect storm to set pilots on a course for automation dependency. Electronic systems will always be subject to failure; the aircraft will always present pilots with malfunctions no matter how new or sophisticated the equipment. Pilots cannot afford to hesitate in taking physical control of the P-8 in a critical situation due to a loss in their confidence; permitting automation to continue to control the

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[43] Federal Aviation Administration. "Manual Flight Operations SAFO 13002." Safety Alerts for Operators. January 4, 2013. Accessed December 15, 2014. http://www.faa.gov/other_visit/aviation_industry/airline_operators/airline_safety/safo.

aircraft can allow certain situations to snowball and end in a disaster. Pilots cannot become so disconnected from the aircraft while flying and using automation that malfunctions or the condition of the aircraft goes unnoticed.

Avoiding Automation Dependency in the P-8A

To make sure P-8 pilots do not suffer from the effects of automation dependency, squadrons need to establish control measures to promote manual flying of the P-8 when the opportunities are present. Manual flying requirements should emphasize that while on missions; all pilots should take the opportunity on every flight to turn off the autopilot and manually complete altitude transitions during cruise and while on station. Additionally, in conjunction with the Wing Training Manuals pilot proficiency requirements, it should be mandatory for pilots to complete a portion of the minimum approaches and landings without the assistance of automation. Pilot training meetings should address this standard during monthly meetings for reinforcement. The responsibility for continued growth in knowledge and exercise of stick and rudder skills also falls on the pilots' shoulders. As a professional aviator, a P-8 pilot must hold him or herself to the highest standard and not accept becoming a slave to automation. Pilots need to remain confident in their manual flying skills so they will always default to them in a critical situation. By integrating this approach as a standard operating procedure, P-8A squadrons and the pilots operating the Navy's newest aircraft in the fleet can take positive steps towards avoiding the negative effects of automation. P-8A pilots will be ready at all times to disengage automation, take manual control of the aircraft, and continue to operate their aircraft safely.

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