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## Developing a Standardized Checklist Curriculum to Improve Checklist Performance Under Normal Workload Flight Operations

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DEVELOPING A STANDARDIZED CHECKLIST CURRICULUM TO IMPROVE  
CHECKLIST PERFORMANCE UNDER NORMAL WORKLOAD FLIGHT OPERATIONS

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## Introduction

Checklists are a fundamental element to a safe and secure flight environment. Checklists are designed to aid pilots while performing crucial tasks during predetermined flight segments. However, the checklist is of little use if procedures prescribed by the manufacturer are not followed.. Basic skills on how to properly use a checklist need to be trained to proficiency with novice pilots to ensure continuous and proper use.

### *Purpose of Checklists*

There is a lot of information to remember when flying an airplane. Each checklist provides the essential items that need to be included during certain phases of flight. Relying solely on memory is not a good idea because of the possibility of forgetting. If a checklist is used, the error may be brought to the pilot's attention before an undesirable situation occurs.

In 2006, a private pilot departed from an airport in Petal, Mississippi. The aircraft, a Cessna 172N, was configured with 40 degrees of flaps. Shortly after takeoff, the aircraft clipped the tops of trees and crashed. The probable cause as reported by the National Transportation Safety Board was, "The pilot's improper use of flaps, which resulted in an impact with trees during takeoff-initial climb" (Aircraft Owners and Pilots Association Air Safety Foundation [AOPA ASF], 2007). The Cessna 172N Information Manual states, "normal and short field takeoffs are performed with flaps-up" and that "Flap settings greater than 10 degrees are not approved for takeoff" (AOPA ASF, 2007). If the checklist was used properly, the pilot would have discovered the configuration error prior to departure and may have prevented the accident.

### *Checklist Formats*

Checklists were commonly produced in paper form. However, electronic versions of checklists are becoming more popular. Electronic checklists are being implemented in both

transport category and general aviation aircraft. Both forms of checklist have their advantages and disadvantages.

Paper checklists tend to be readily available. A pilot can reach for and secure the checklist and instantly perform the required check. The pilot can also reference the checklist at any time, since a power source is not required. This is a benefit for operations such as preflight inspection. If electrical sources are lost during flight, such as with alternator and battery failures, the paper checklist will still be available for reference.

A disadvantage of the paper checklist is the possibility of losing track of one's place in the checklist. If there is an interruption, the pilot may not continue from the same step prior to the interruption. This may result in an important item being skipped, leading to an abnormal condition or event. If a pilot forgets where they left off, they may need to start the checklist over from the beginning, taking away precious time and attention from other flight duties.

Electronic checklists have a number of benefits. Having a checklist in electronic format means less clutter in the cockpit. Pilots do not have to worry about where to keep the paper checklist when they are not using it. The more organized the cockpit is, the more the pilot can focus on flying the airplane. Another advantage to electronic checklists is the pilot is less likely to forget or skip an item. Users must push a button to verify each checklist item, resulting in some sort of verification such as a color change. If the pilot gets interrupted during the checklist, they know exactly where they left off when they return to it.

The Boeing Company began development on the Boeing Electronic Checklist (ECL) in the late 1980's (Arkell, 2006). The ECL was initially introduced for the Boeing B-777. It is slated to be a part of the B-787 and hopefully the B-747-8. One of the highlights of the ECL is that it prompts the flight crew for use at certain phases of flight. This prompt should prevent

missing important items at critical times. Some ECL are so highly integrated into the aircraft the device will not allow the pilot to proceed to the next checklist item if the ECL senses the previous checklist items as not configured or set properly.

Electronic checklists do have disadvantages. Primarily, if power is lost within the aircraft, the checklist becomes unavailable. Thus, paper checklists still need to be readily accessible. Pilots may also forget to complete a checklist in the absence of visual prompts, such as a physical checklist in lap, to remind them to complete it. Pilots must be sure to remain vigilant to their external flight environment and complete checklists at the appropriate times. There is also the possibility the pilot will waste valuable time if they become lost in the various modes or different levels within computer screens' pages and must search for a specific checklist segment.

In the Cirrus, electronic checklist segments are presented on a computer screen known as a Multi Function Display (MFD). The checklist is one of many pages that can be displayed on the MFD. Other pages include a map, engine instruments, and nearest airports. When a pilot initially references a checklist segment, the first segment item text and response are shaded magenta. A pilot acknowledges an item as complete by pushing a button on the right side of the MFD that will change the shade of the item to green and place a green check mark on the right side of the item. The subsequent item text will then be shaded magenta. Items yet to be addressed are shaded white.

A standard flight in the Cirrus aircraft involves the use of both paper and digital checklists. Paper checklists are used when there is no electrical power available, such as before starting the engine. Digital checklists will be used during the remainder of the flight. Pilots may need to revert to paper checklists in the event of system malfunctions. This can include failure of the Multi-Function Display and complete loss of electrical power.

### *Checklist Completion Methods*

Checklists can be completed in a number of ways. Procedures may vary between aircraft manufacturers and flight departments. Cirrus has designated two methods for its checklists: 1) Do-List, and 2) Flow Pattern. Cirrus describes the do-list method as, “a checklist which is executed in a conventional manner of reading the checklist item and selecting the appropriate condition of the item. Do-lists are used when procedure sequence and/or item condition is critical to completion of the procedure” (CIRRUS Design, 2005, p. 4-6). The flow pattern is similar to the do-list method, except that the flow pattern, “refers to the path through the cockpit the pilot moves along during the execution of the checklist. The items and their conditions are memorized and executed without reference to the written checklist. Following completion of the flow pattern, the checklist is immediately referenced to ensure procedure completion” (CIRRUS Design, 2005, p. 4-6).

Each checklist method has its own advantages. The do-list method assures that items are completed in the proper order. Relying on memory alone allows the possibility for a step to be omitted or completed in the wrong sequence, which may result in an undesired effect or condition. On the other hand, the flow pattern method tends to take less time to accomplish. During critical phases of flight, such as climb and before landing, proper checks can be performed quickly and verified when time permits. Either one of the checklist methods must be used to complete all the checks. Cirrus provides guidance as to which method best suites each checklist. Cirrus makes clear that, “UNDER NO CIRCUMSTANCE SHOULD A NORMAL PROCEDURE BE COMPLETED SOLELY FROM MEMORY!” (CIRRUS Design, 2005, p. 4-6).

### *Salient Stimuli*

Using the checklist is a valuable operational procedure. If used properly, it makes certain the aircraft is properly configured for the appropriate phase of flight. Each checklist must be completed at certain moments in time, which should be standardized from flight to flight. Cirrus provides guidance to these specific points when each checklist should commence. These specific points are salient stimuli, or subtle prompts that remind the pilot to begin a checklist segment. Salient stimuli occur during every flight, so pilots need to know what they are.

The first few checklists segments occur prior to major actions while still on the ground: before starting engine, engine start, before taxi, taxiing, before takeoff, and takeoff. Each of these checklist segments should be completed prior to or during the specific event. Checklists that begin with 'before' in the name should be accomplished prior to the task in the checklist name. The takeoff checklist is grouped into this category. The other checklists occur during their respective operations, i.e. engine start and taxi.

The climb checklist segment has a generalized salient stimulus. Checklist segment commencement occurs at a point in space relative to the ground, which can vary from airport to airport. The climb checklist is started when the aircraft is at 1000' above ground level (AGL). The pilot must make a mental note of the departure airport elevation to properly begin the climb checklist. For example, a pilot departing from Miami International airport (KMIA), which has an elevation of 8', should commence the climb check at 1008' mean sea level (MSL). However, a pilot departing from Telluride Regional airport (KTEX) in Telluride, Colorado, which has an elevation of 9078', should commence the climb check at 10,078' MSL. It is up to the pilot to know the exact point the check should be started. The climb check follows the flow pattern method because there can be a lot of activity happening during the initial climb, such as scanning

for traffic, communicating with air traffic control, monitoring aircraft system parameters, all while flying a specific departure procedure.

Cruise and descent checklists are initiated at the beginning of the cruise or descent portion of flight, respectively. Both checklists are designated as flow pattern checks. The flow pattern works well because the checklist items require different MFD pages to be referenced, such as the engine page. Thus, the checklist is unable to be viewed while the items are to be completed.

Before Landing checks ensure the aircraft is configured properly for landing. During an Instrument Flight Rules (IFR) flight, this is to occur at least 2 nautical miles prior to the final approach fix. During a Visual Flight Rules (VFR) flight, the Before Landing checks are performed on the downwind leg. This way the pilot can focus attention on flying the approach and not configuring the aircraft during the last moments before landing.

The After Landing and Shutdown checklists clean up the aircraft from the landing phase and prepare it for the next flight. The After Landing check is performed once the aircraft is clear of the active runway. Pertinent items are performed, such as flap retraction and making sure only required exterior lighting is operating. Airports with a high traffic density require aircraft to promptly clear the runway environment, allowing subsequent aircraft to land. To reduce time spent in the runway environment, the After Landing check is a flow pattern. Cirrus has determined that items during the shutdown check are so important they must be completed in their exact order, making the check a do-list.

### *Teaching Methods*

Western Michigan University's (WMU's) College of Aviation claims to ensure, "graduates possess the skills and abilities required by employers" (WMU College of Aviation,

n.d.). Graduates will go on to fly for a variety of aviation companies. Many of those companies will be operating under Federal Aviation Regulations (FAR) Part 135 and Part 121 rules. FAR §135.83 briefly states that a pilot shall use a cockpit checklist that contains procedures for before starting engines, before takeoff, cruise, before landing, after landing, and stopping engines (FAA, 2008, p. 353). FAR §121.315 requires approved cockpit check procedures be readily usable and shall be followed before starting engines, taking off, or landing. It also states, “The procedures must be designed so that a flight crewmember will not need to rely upon his memory for items to be checked” (FAA, 2008, p. 162). If students are familiar with properly using checklists, they will have an easier time transitioning to procedures enforced by companies and even the government.

The Federal Aviation Administration (FAA) produces many documents with important information for pilots. The first chapter of the “Airplane Flying Handbook”, titled Introduction to Flight Training, provides guidance about checklist usage. Checklists are described as, “an aid to the memory and helps to ensure that critical items necessary for the safe operation of aircraft are not overlooked or forgotten” (FAA, 2004a, p. 1-6).. Humans are prone to forgetting, which is why the physical checklist should be referenced no matter how well the pilots thinks they know and understand the checklist by memory.

Instructors are responsible for engraining proper checklist usage in their students’ memory. If the instructor teaches proper checklist usage beginning with the first flight, the student will continue to build on a solid foundation. This principle is known as primacy. Primacy is, “the state of being first, often creates a strong, almost unshakable, impression” (FAA, 1999, p. 1-5). In other words, what the student is first told will have the most impact. This is important to remember because if an action is introduced incorrectly, the student may have a difficult time

changing improper or bad habits. Also, the more a person performs an action, the better they remember it. If an instructor requires a student to perform checklist segments properly during every flight, the student will become accustomed to it. This is known as the principle of exercise (FAA, 1999, p.1-5).

The FAA produces a Practical Test Standards (PTS) booklet for each pilot certificate and rating. The introduction to all PTS contains special emphasis areas, one of which is proper checklist usage. Special emphasis areas are, “essential to flight safety and will be evaluated during the (entire) practical test” (FAA, 2003a, 2003b, 2003c, 2004b, 2007). Checklists will be evaluated throughout the practical test keeping safety in mind. If completing a checklist would compromise safety, the checklist shall be completed as soon as conditions permit (FAA, 2003a, 2003b, 2003c, 2004b, 2007).

The WMU Flight Operations Manual (FOM) dictates how checklists shall be used during all training flights. Broadly stated in WMU91.171, “pilots shall use appropriate checklist for all normal operations” (WMU COA, 2008). The next section of WMU91.171 states, “If at any time the flow of a checklist is interrupted and the pilot can not be certain as to where he/she left off, the pilot should return to the beginning of that section and complete the entire checklist” (WMU COA, 2008). Students and instructors alike need to be aware of these general rules since it is not specifically addressed in the detailed lesson plans for each flight.

The WMU Training Course Outline (TCO) provides line items on which each flight lesson is graded. A line item is a specific flight task, maneuver, or condition that is evaluated. Each line item is assigned a completion standard, which range from Level D to Level 4. When an instructor is demonstrating an item, it is considered Level D. When the student performs an item, it is evaluated from Level 0 to Level 4. Level 0 represents unsatisfactory performance. If the

instructor provides a demonstration and the student begins to show an understanding of the demonstration, Level 1 performance has been achieved. A Level 2 standard means the student understands a concept and can safely perform it requiring only occasional instructor assistance. Level 3 is considered proficient to PTS, or what the FAA has deemed as acceptable limitations. The highest performance standard, Level 4, means a student has achieved mastery of the lesson consistently at or above PTS. Attached in Appendix A is a detailed description of each completion standard from the TCO.

Appendix A also includes each line item that specifically addresses checklist usage from the private pilot course and the instrument rating course. Only 7 of the 12 Cirrus checklist segments for normal flight conditions are specifically graded in the private pilot course. The 7 checklist segments are spread throughout the first 5 flight lessons. Since all checklist segments are encountered during a standard training flight, complete usage should be addressed during the initial flight at least to Level D.

There is no clear conclusion to checklist usage in the private pilot course. Most checklist items are given a final completion standard of Level 1. Only the line item “Taxi and Checks” in Lesson 5 increases the completion standard to Level 2. After Lesson 6, the next time in-flight checklists are graded is Lesson 36, the final flight in the course before the private pilot check ride. During Lesson 36, checklist usage must be at PTS standards, Level 3, even though the student has not specifically been required to be at such a proficient level up to this point.

The instrument rating course puts more focus on checklist usage. Although each checklist segment is not graded individually, they are encompassed within the category “checklist use.” Twenty-four of the 36 instrument lessons require the student to demonstrate Level 3 proficiency of checklist use. One anomaly exists in which checklist use criteria drop to Level 2 for one

lesson after being at Level 3 criteria for a consistent number of lessons. Subsequent lessons are set at Level 3 completion standards. The final three lessons in the instrument rating course do not specifically mention checklist use. However, there is a line item labeled “Cockpit Checks.” It must be assumed that cockpit checks incorporate checklist usage, such as is designated for FAR Part 121 operations.

Two studies by William Rantz evaluated student checklist usage (Rantz, Dichinson, Sinclair & Van Houten, in press; Rantz, 2009). Both studies took place in a simulated flight environment with instrument rated pilots. The first study had pilots utilize paper checklists derived from a Cessna 172 aircraft. Participants were graded on how many checklist items were completed correctly. Initial sessions in baseline showed that, “Overall average checklist items were completed correctly 53% of the time” (Rantz, Dichinson, Sinclair & Van Houten, in press). Participants were then provided with a graphic representation of their performance showing how many checklist items were completed correctly, incorrectly, or omitted. Performance then jumped to greater than 98% proper completion for the remainder of the study.

A follow up study conducted by Rantz had a similar premise. Graphic feedback was once again provided after baseline, however paper checklists were being compared to digital checklists in the Cirrus SR-20 aircraft. In baseline, paper checklists were only completed 38% correctly and digital checklists were only completed 39% correctly. During the feedback intervention, paper checklists were completed 90% correctly and digital checklists were completed 89% correctly (2009). When feedback was withheld from the participants, “Improvement maintained at near perfect levels for participants during the reversal phase with 100% paper checklist items correct and 99% digital items checklist items correct” (2009, p.70).

Where Rantz's study focused on student completion of checklists, this current study incorporated flight instructor's knowledge of checklists. The Pilots Operating Handbook for an aircraft should describe the proper way to use a checklist. A thorough curriculum also provides the instructor with a detailed description of what the school determines to be important areas of focus. At a minimum, training may only be as good as the completion requirements set forth in the curriculum.

## Method

Participants in the study were made up of a combination of 11 faculty and staff flight instructors at Western Michigan University's College of Aviation. These are all the people involved with making certain students are properly prepared for safe flight. Some participants provide more than primary instruction. They also administer progress and stage checks to students other than their own. Progress and stage check flights are comparable to taking a mid-term and final exam, respectively.

The participants need not have any current students in the instrument rating course, but need to be qualified to teach instrument students if necessary. Participants must have possessed an instrument flight instructor certificate and provided flight instruction in the Cirrus SR-20. The fact that the instructor is certified to instruct students in their instrument rating means the instructor should have sufficient knowledge of the checklists and when they need to be accomplished.

Data was collected by means of a 4 page, paper questionnaire. The first page sought participants' opinions of checklists and how participants dealt with students and checklists. The remaining three pages tested participant knowledge of the Cirrus SR-20 checklists, including: 1) whether a checklist is a do-list or flow check, 2) when the appropriate time is during flight, specifically on an ILS approach, to conduct each checklist, and 3) the appropriate items and corresponding responses for specific checklists. Only 8 of the 12 normal checklist segments were included in the questionnaire, beginning with the Before Takeoff checklist and continuing through the Shutdown checklist. The 8 checklist segments were chosen because they are flow pattern method checks and supposed to be memorized. The remaining 4 segments are do-list method checks and do not need to be performed by memory.

Participants were given a questionnaire to complete in their own free time. An example of a properly completed questionnaire is in Appendix B. Each participant was read a recruitment script. A copy of the recruitment script can be found in Appendix C. Participants were instructed to complete the questionnaire solely by memory. No outside references were to be used, such as the physical checklist. Participants were allowed to complete the questionnaire on their own time in their own location primarily because of participants' time commitments. The questionnaire was completely anonymous, as described in the Anonymous Survey Consent Form found in Appendix D. This way, performance statistics could not be traced back to participants. Many instructors seemed eager to participate in the study.

During the grading process, 1 point was given if an item was checked off or responded to correctly. For the detailed checklist items and responses, totals were tallied for both sections. In other words, if the participant provided the correct item but an incorrect response, they would still get 1 point for the item. If a specific item or response contained multiple parts and only a portion of the item or response was provided, half a point was given.

In an effort to compare checklist knowledge between two groups, checklist use data was collected from student participants at the conclusion of the Rantz study (2009). These data of student participants were collected using the same questionnaire as this study to collect data from the instructor pilots. It is important to note that the students in the Rantz study had recent experience with the Cirrus checklist and knew their checklist performance was being observed and tested during the end of the study.

## Results

### *Checklist Completion Methods*

Figure 1 presents the percentage of participants that identified a checklist method correctly. The Before Landing Checklist had the most correct responses with 100% of participants identifying it as a flow check. The After Landing checklist had the most incorrect responses with only 36.36% of participants correctly identifying it as a flow check. Many incorrect responses were also provided for the Normal Takeoff checklist, with only 45.45% of the responses correctly identified as a do-list.

No participants correctly answered 100% of the checklist methods. Four of the participants correctly answered 7 of the 8 checklists (P3, P7, P9, and P11). One participant, P5, answered only 3 of the 8 checklists correctly. Overall, 69.32% of the checklists items were properly identified.

### *Salient Stimuli*

Figure 2 presents the percentage of participants to correctly identify the salient stimuli to commence a checklist. There was less of a spread in identifying stimuli than identifying checklist methods. The Before Takeoff, Before Landing, After Landing, and Shutdown checklists all had 100.00% proper completion. At only 70.00% proper completion, the Descent checklist was the lowest overall in scoring. Five participants properly identified 100% of the 8 stimuli that are used to commence a checklist (P1, P6, P8, P10, and P11). The fewest items correctly answered was by P3 with 5.5. The partial point was given for identifying the salient stimuli of the Climb checklist as “above 1000’ (feet).” This could be interpreted in different ways, such as at 1000’ MSL, at 1000’ AGL, or at any altitude above 1000’ MSL or AGL. One participant, P2, did not complete

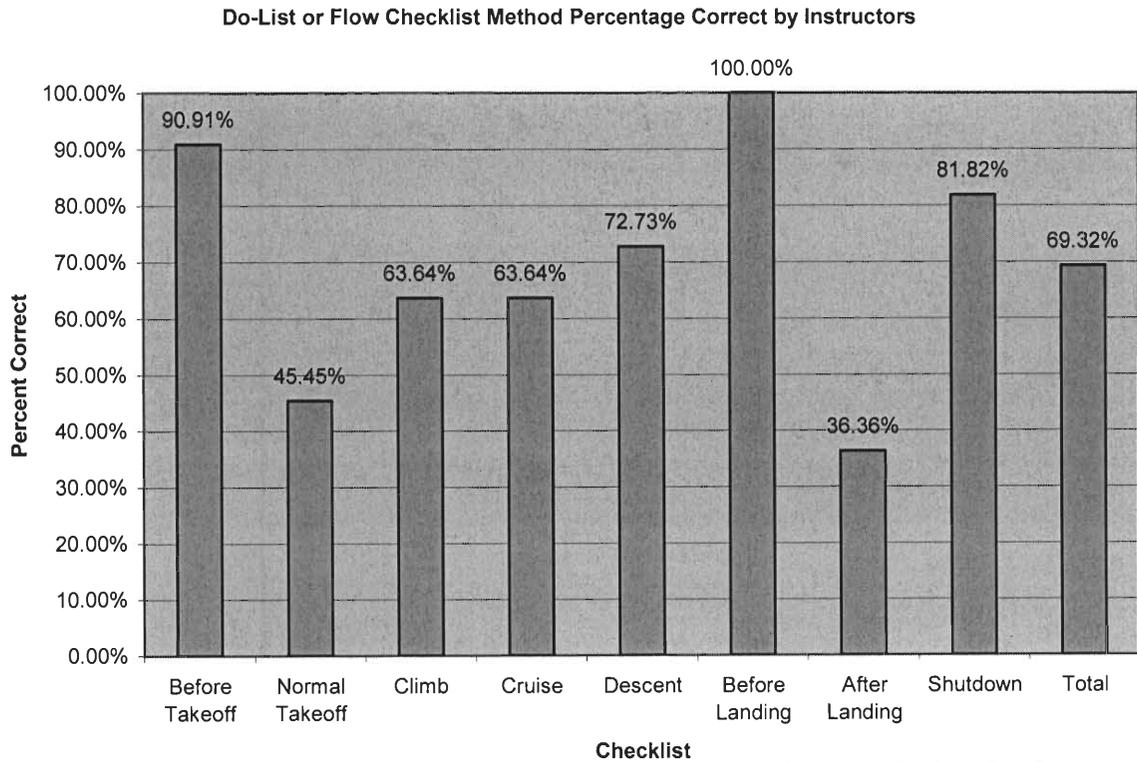


Figure 1. Percentage of participants to correctly identify a checklists' method as Do-List or Flow.

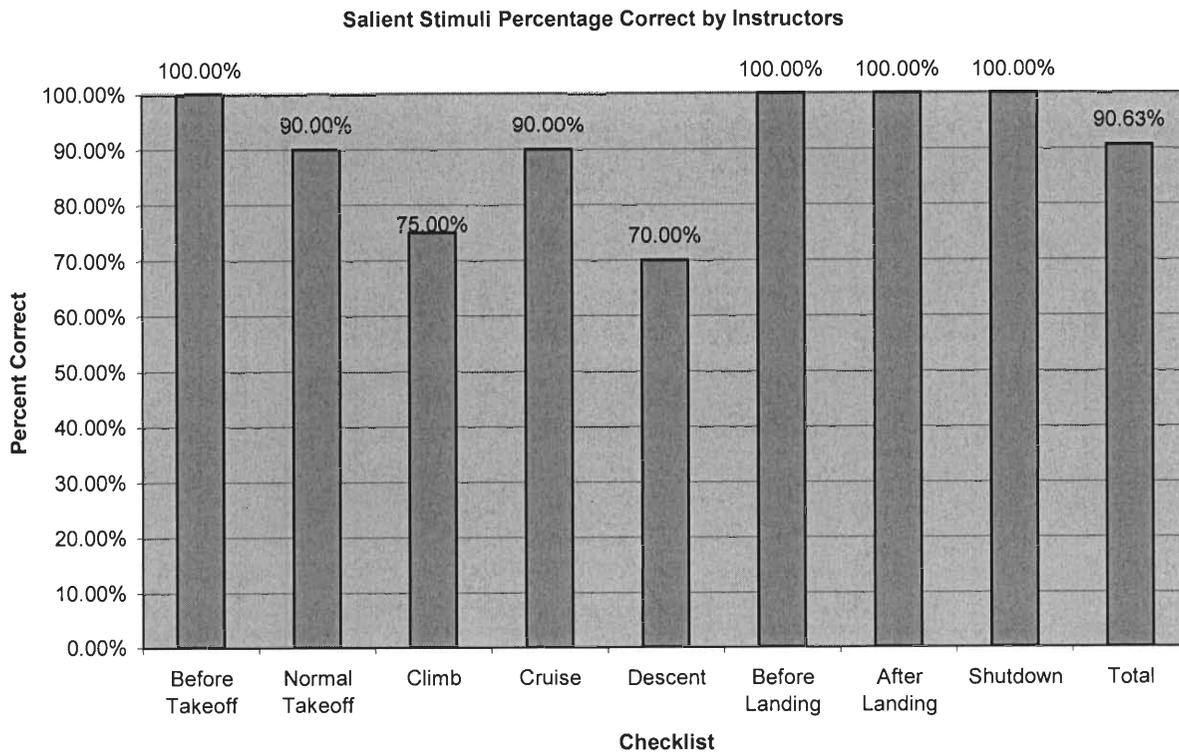


Figure 2. Percentage of participants to correctly identify the salient stimuli to commence a checklist.

this section because they did not understand the question. Data from this participant's section was not incorporated in the results.

### *Checklist Segment Items and Responses*

Participants' results revealed that checklist items are known better than the responses that go along with each item. Figure 3 presents a comparison of the 58 flow pattern checklist items and responses correctly answered by instructors. Average results for checklist items were 68.50% correct. Participants ranged from a minimum of 33 items (56.90%) correct to a maximum of 47 items (81.03%) correct. Average results for checklist item responses were 61.83% correct. Participants ranged from a minimum of 29 responses (50.00%) correct to a maximum of 45.5 responses (78.45%) correct.

Student participants from the Rantz study (2009) yielded slightly higher results for the checklist items and their appropriate responses, as seen in Figure 4. Average results for checklist items were 80.03% correct. Participants ranged from a minimum of 39.5 items (68.10%) correct to a maximum of 56.5 items (97.41%) correct. Average results for checklist item responses were 73.42% correct. Participants ranged from a minimum of 33 responses (56.90%) correct to a maximum of 56.5 responses (97.41%) correct.

### *Checklist Importance*

Participants were asked their opinion about how important checklist usage is during flight. Responses ranged from 7 to 10 on a scale from 1 to 10. A 1 represented low importance and 10 represented high importance. The average perceived importance of checklists was 9.09. Participants were then asked the amount of emphasis they actually placed on checklists during training lessons. Responses once again ranged from 7 to 10 on a scale from 1 to 10. In this case,

Comparison of Flow Pattern Checklist Items and Checklist Responses Correct by Instructors

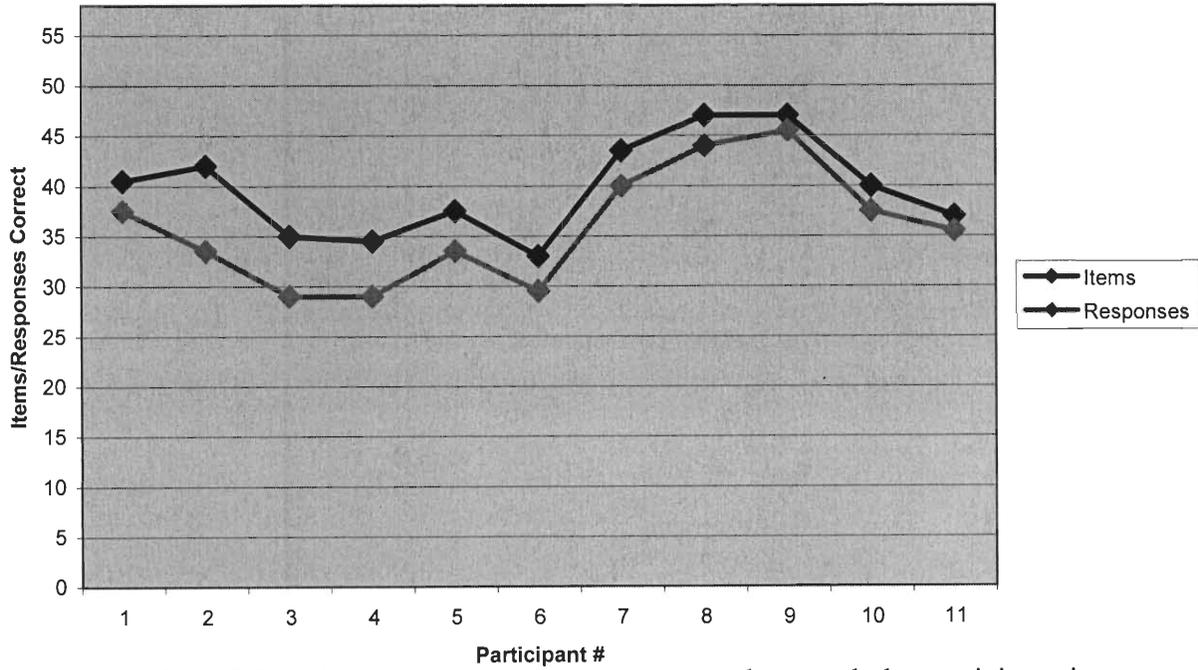


Figure 3. Number of checklist items and responses answered correctly by participant instructors.

Comparison of Flow Pattern Checklist Items and Checklist Responses Correct by Students

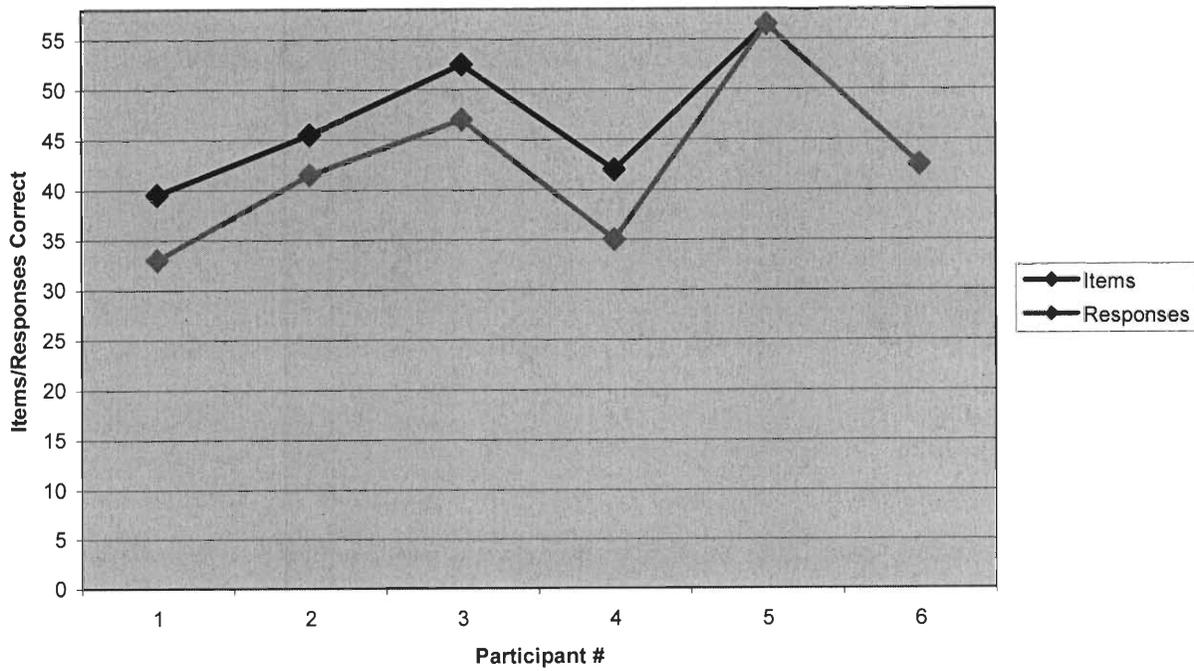


Figure 4. Number of checklist items and responses answered correctly by participant students.

1 represented low emphasis and 10 represented high emphasis. The average emphasis placed on checklists during training flights was 8.91.

All participants indicated that they tracked student completion of checklists. Nine of the participants said they track completion solely by memory. Only 2 of the participants said they record student progress on paper. All participants also indicated that they notify the student of their error. The broad generalization indicates that instructors give the student ample time to rectify the situation before mentioning the issue. Many instructors also provide prompts to the student that a situation needs to be addressed instead of blatantly stating a checklist has not been completed. Appendix E contains all the written responses from participants.

## Discussion

### *Checklist Completion Methods*

The flight instructor is responsible for teaching students the proper way to use aircraft checklists. There seems to be low performance in instructor understanding of when to use the Do list and when to use the Flow list method of checking. This could be a concern regarding the original learning source and frequent repetitive testing of instructor knowledge regarding checklist use. No assumptions can be made to the instructor's actual checklist performance as no observations were conducted having the instructor use the checklist.

Each checklist is assigned either a Do List or a Flow Pattern completion method for a specific reason. Otherwise, there would not be different methods required to complete checklist segments. It is not known whether improper method completion compromises flight safety. Unless there is a legitimate reason for changing the completion method though, pilots should follow the direction provided by the aircraft manufacturer.

### *Salient Stimuli*

Since the checklist is designed to assist the pilot in making sure the aircraft is properly configured, it should be completed at the right time. Participants did fairly well identifying the salient stimuli for commencing a checklist with 82% correct completion. Still, instructors should be completely knowledgeable of the salient stimuli. Checklist segments completed at the proper time will reduce the overall pilot workload. If a segment is completed at an improper time, the pilot may become overburdened with other flight tasks.

### *Checklist Segment Items and Responses*

Results of the comparison of checklist items and responses prove that instructors and students alike do not have all of the flow checks memorized. Many participants grouped multiple

items under a single term, such as the navigation lights, landing light, and pitot heat under “load the system.” The grouped term demonstrates there is an understanding that the electrical system does need to be tested, but allows the chance of important items being left out. Thus, it can be assumed that the flow pattern checklists are not being taught or completed properly.

Many participants did not receive credit for checklist segment responses because of terminology. For instance, the proper response for the item “Doors” is “Latched.” Multiple participants used the term “closed” instead. Technically the door could be closed but not properly latched. Having an improper understanding of the item response

### *Checklist Importance*

Although instructors indicated checklist importance averages a rating of 9.09, checklist emphasis was reported at 8.91. This shows instructors recognize the importance checklists play in the cockpit, but they do not emphasize checklists to the same level. Checklist emphasis should have a rating equal to or greater than checklist importance. Instructors explained that checklists were important to maintain safety and also to complete necessary items or tasks. Some instructors explained emphasis varies depending on the type of flight training. Theoretically, checklists should have the same amount of importance and emphasis no matter the training.

### *Improvements*

Pilots cannot change their checklist behaviors unless errors are brought to their attention. Western Michigan University’s College of Aviation needs to initiate changes in its flight training curriculum to improve 1) knowledge of proper checklist segment Do List or Flow Pattern completion methods, 2) recognition and initiation of checklist segments’ respective salient stimuli and 3) understanding of checklist segment items and appropriate responses, Several

simple improvements may help increase safety and performance of flight instructors, their students and the industry as a whole.

The private pilot and instrument rating curriculums need to be modified to place a complete emphasis on checklists. Currently, only 7 of 12 checklist segments are graded over 9 of the 36 (or more) lessons in the private pilot course. Every flight course should grade all of the checklist segments. The segments can be addressed as line items or grouped together as a whole just like the instrument rating course does with a line item called “Checklist Use.” Another option would be to encompass checklist grading with other special emphasis areas found in the PTS since the FAA has deemed them pertinent to safe flight.

All checklists should be addressed and demonstrated during the first flight to stress their importance since they will be encountered. Subsequent flights need to gradually intensify checklist completion requirements. Eventually, students should be required to achieve a Level 3 standard for checklist use prior to private pilot course completion.

The instrument rating course currently does a good job evaluating checklist usage. Only one lesson does not address checklist use. A majority of the lessons require students to use checklists to PTS. One minor flaw in the curriculum occurs in Lesson 79 where the completion standard drops to Level 2 for “Checklist Use” after being at Level 3 for the previous 18 lessons.

Definitions should be provided for line item terms that encompass multiple items, such as “Checklist Use” and “Cockpit Checks.” These terms can combine checklist segment completion methods, prompts, items and responses into one category and does not make grading cumbersome for the instructor. Solid definitions will make sure that instructors are grading students uniformly. If a student has a different instructor for a lesson, expectations should not

change. Instructors should also know the specific checklist items and criteria level used to grade the student as outlined in the syllabus.

Students are primarily tested during flight but are also tested on the ground. WMU presolo quizzes are computer based evaluations of a student's knowledge. One quiz is based entirely on the Cirrus SR-20. Normal checklist procedures are currently not included in the quizzing process. Testing proper checklist segment completion methods, salient stimuli, and checklist segment items and responses may help improve students' performance. A standardized quiz can be used throughout flight training to reinforce proper checklist usage. Students can take this quiz during the presolo phase and again prior to any progress or stage check. Quizzes should be developed for different training courses since there are minute differences between instrument and visual flight checklists. A customized quiz would be needed for each aircraft type as well. For example, the checklist for a Cirrus SR-20 looks much different from the Piper Seminole.

Students are not the only ones who should be routinely quizzed. Instructors' knowledge needs to be checked as well. An instructor should first be quizzed during initial standards training before being allowed to instruct in the aircraft. Recurrent training also needs to occur and could happen in different ways. One way would be during the monthly quiz WMU flight instructors are required to complete. One month could focus on methods and salient stimuli while other months would focus on specific items and responses for checklist segments. A second option would be to have checklists tested during the yearly Part 141 check. When an instructor passes on knowledge to students, only a portion is retained. The college must make sure that instructors are conducting their training to the highest standard so students receive the best training possible.

Currently at WMU, there is no standard for recording student progress during flight. A majority of the participants indicated that they used memory alone to track checklist usage. With so many activities happening during a flight lesson, the instructor may not remember all of the student's deficient items and actions. There is a likelihood that the student will not receive appropriate or full feedback during debrief. Few participants indicated they write notes on paper during the flight lesson.

A system needs to be adopted that requires instructors to physically record events during flight, specifically how and when a checklist was completed. This way the instructor can provide a more thorough debrief. Instructors could make notes on printed versions of individual grade sheets. A general grading sheet could also be developed with common line items encountered during most flights, such as checklists.

New technologies may help instructors track checklist usage in more detail while providing the student with a better indication of their performance. An electronic device could transcribe data into a graphical format quickly. Providing students with a visual indication of their performance may help improve future student performance, as demonstrated in the Rantz studies. Future research could focus on different methods of providing feedback to the student. An ideal device would allow the instructor to download information recorded in flight directly into the student's permanent records.

It seems prudent to consistently and firmly reinforce checklist use from the beginning of a pilot's flight training. It is unknown to what extent primacy influences the accuracy level and duration of checklist performance over a pilot's career. Given the inconsistent methods of early checklist instruction and assessment, any improvement to the bottom line in safety of flight training operations should be considered.

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Appendix A  
WMU Curriculum Checklist Procedures

## *WMU Curriculum Checklist Procedures*

### *Frasca Cirrus FTD Use Policy (Version 1: 12/12/06)*

#### **Use of Checklist**

3. Use of all other checklist per phase of flight is required, starting with **BEFORE STARTING ENGINE**.

### *Flight Operations Manual (01/03/2008)*

#### **WMU91.171 Checklists**

- A. When operating WMU aircraft, pilots shall use appropriate checklist for all normal operations. For emergency operations, memory drills should be accomplished as required and followed up with a physical checklist when time permits.
- B. If at any time the flow of a checklist is interrupted and the pilot can not be certain as to where he/she left off, the pilot should return to the beginning of that section and complete the entire checklist.

### *Training Course Outline (Revision 9 – July 2007)*

#### **COMPLETION STANDARDS FOR WMU PROFESSIONAL FLIGHT PROGRAM**

Each flight lesson should include a post flight debrief that critiques the students performance. The critique should be in relationship to specified tasks and minimum completion standards stated for each task. Western (non-141 requirement) requires the student to receive an overall grade for each flight. This letter grade should be a Western grade relative to the student's preparation and performance as compared to the required completion standards of the lesson and attempts required. Solo flights should be graded as either Satisfactory / Unsatisfactory. Additionally, each critique sheet indicates tasks and the associated levels of completion standards. When evaluating each task and completing the critique sheet in the student record folder, the following criteria (on the next page) shall be used for evaluating task standards:

#### **Level D – Instructor Demonstration Only**

**Knowledge** – Instructor teaches the element of the lesson.

**Performance** – Student watches instructor.

#### **Level 0 – Unsatisfactory Performance**

**Knowledge** – Student lacks an understanding or is experiencing difficulty with the concepts, skills, or procedures for accomplishing the basic elements or maneuvers. The student achieves less than 60% on written or oral tests.

**Performance** – Instructor intervention is required. Student is unable to accomplish the elements of the maneuver or is unsafe while performing them even after re-teaching. Such minimal performance is a bar to further progress.

#### **Level 1 – Instructor Demonstration – Student Performance**

**Knowledge** – Student begins to understand concepts, skills, or procedures for accomplishing the basic elements or maneuvers. The student can achieve at least 60% on written or oral tests.

**Performance** – Student accomplishes elements or maneuvers by way of instructor direction, teaching, or re-teaching, and with occasional instructor intervention.

### **Level 2 – Understanding with Occasional Instructor Assistance**

**Knowledge** – Student demonstrates a 70% mastery of referenced material on written or oral tests, usually applies concepts, skills, or procedures for accomplishing the basic elements or maneuvers.

**Performance** – The student understands and safely demonstrates elements and maneuvers consistently to within double the standards found in the appropriate PTS with occasional instructor assistance. The student only needs additional practice to meet PTS standards.

### **Level 3 – PTS Standard**

**Knowledge** – Student consistently demonstrates a minimum 80% mastery of referenced material on written or oral tests; explanation of the elements and objectives of maneuvers; voluntarily evaluates and critiques his/her personal performance.

**Performance** – Student consistently applies concepts and skills to accomplish lesson elements and maneuvers to standards as referenced by the current PTS with minimal assistance and no instructor intervention. The student critiques and evaluates personal performance.

### **Level 4 – Associating Knowledge to new Situations – Mastery of the Lesson**

**Knowledge** – Student consistently demonstrates exceptional performance in both written and oral testing above and beyond PTS. Student consistently demonstrates a minimum 90% mastery of referenced material on written or oral tests, explanation of the elements and the objectives of maneuvers.

**Performance** - Student consistently correlates concepts and skills, and demonstrates exceptional performance above and beyond PTS. The student demonstrates attitude, ethics, and communication skills essential for professional flight crew interaction.

### **Level S - Satisfactory Completion of Element**

\*Parenthetical numbers indicate completion standard level.\*

#### **Private Pilot**

- Lesson 1: Preflight Procedures, Cockpit Inspection Including Certificates and Documents (1)  
 Checks Before Starting (1)  
 Checks After Starting (D)  
 Power Checks (Run-Up) (1)
- Lesson 2: Preflight Procedures (1)  
 Checks Before Starting (1)  
 Taxi Checks (D)

- Lesson 3: Taxi Checks (1)
- Lesson 4: Taxi Checks (1)  
Airfield Approach (Arrival), Checks (1)
- Lesson 5: Taxi and Checks (2)  
Climb Checks (1)  
Arrival Checks (1)  
Pre-Landing Checks (1)
- Lesson 6: Traffic Pattern and Landing Checks Demo (D)
- Lesson 7-11: NONE
- Lesson 11A: As assigned by Flight Instructor
- Lesson 12: NONE
- Lesson 12A: As assigned by Flight Instructor
- Lesson 13A: As assigned by Flight Instructor
- Lesson 13S: NONE
- Lesson 14-16: NONE
- Lesson 16A: As assigned by Flight Instructor
- Lesson 17: NONE
- Lesson 17A: As assigned by Flight Instructor
- Lesson 18-19: Preflight Procedures (2)
- Lesson 20-32: NONE
- Lesson 32A: As assigned by Flight Instructor
- Lesson 33: As assigned by Flight Instructor
- Lesson 34: NONE
- Lesson 35A: As assigned by Flight Instructor
- Lesson 36: PTS Tasks

### Instrument Rating

- Lesson 51: Taxi Checks (D)
- Lesson 52: Checklist Use (1)
- Lesson 53: Cockpit Preparation and External Checks (1)  
Checklist Use (2)  
Instrument and Taxi Checks (1)
- Lesson 54: Checklist Use (2)  
Instrument and Taxi Checks (1)
- Lesson 55: Checklist Use (3)  
Instrument and Taxi Checks (2)
- Lesson 56: Checklist Use and Instrument Checks (2)
- Lesson 57: Checklist Use and Taxi Checks (2)
- Lesson 58: Checklist Use and Instrument Checks (S)
- Lesson 59: Checklist Use and Taxi Checks (3)
- Lesson 60: NONE
- Lesson 61: Checklist Use (Including Taxi Checks) (3)
- Lesson 62-64: Checklist Use and Instrument Checks (3)
- Lesson 65: Checklist Use and Instrument Checks (3)  
Memorization of Checks and Flows At Segments On The Approach (1)
- Lesson 66: Checklist Use, Navigation Checks, and Instrument Checks (3)  
Memorization of Checks and Flows At Segments On The Approach (1)
- Lesson 67-68: Checklist Use, Navigation Checks, and Instrument Checks (3)  
Memorization of Checks and Flows At Segments On The Approach (2)
- Lesson 69: Checklist Use and Instrument Checks (3)  
Memorization of Checks and Flows At Segments On The Approach (2)
- Lesson 70: Checklist Use, Navigation Checks, and Instrument Checks (3)  
Memorization of Checks and Flows At Segments On The Approach (2)

- Lesson 71: Checklist Use, Navigation Checks, and Instrument Checks (3)  
 Memorization of Checks and Flows At Segments On The Approach (2)  
 Memorization of Checks and Flows At Segments On The Approach (1)
- Lesson 72-73: Checklist Use, Navigation Checks, and Instrument Checks (3)  
 Memorization of Checks and Flows At Segments On The Approach (2)
- Lesson 74: Checklist Use, Navigation Checks, and Instrument Checks (3)
- Lesson 75: Checklist Use, Navigation Checks, and Instrument Checks (3)  
 Memorization of Checks and Flows At Segments On The Approach (2)
- Lesson 76: Checklist Use, Navigation Checks, and Instrument Checks (S)
- Lesson 77-78: Checklist Use, Navigation Checks, and Instrument Checks (3)
- Lesson 79: Checklist Use, Navigation Checks, and Instrument Checks (2)
- Lesson 80: Checklist Use, Navigation Checks, and Instrument Checks (3)
- Lesson 81: Cockpit Checks (2)
- Lesson 82: Checklist Use and Instrument Checks (S)
- Lesson 83: Cockpit Checks (2)
- Lesson 84-86: Cockpit Checks (3)

Checklist	Addressed in Private Pilot Course?	Addressed in Instrument Rating Course?
Before Starting Engine	✓	
Engine Start		
Before Taxi	✓	
Taxiing	✓	✓
Before Takeoff	✓	
Takeoff		
Climb	✓	
Cruise		
Descent	✓	
Before Landing	✓	
After Landing		
Shutdown		

Appendix B  
Instructor Pilot Questionnaire Answer Key

## Instructor Pilot Questionnaire - KEY

On a scale from 1 to 10, with 1 meaning low importance and 10 meaning high importance, how important is checklist usage during flight? Explain.

1      2      3      4      5      6      7      8      9      10

On a scale from 1 to 10, with 1 meaning low emphasis and 10 being high emphasis, how much emphasis do you place on student checklist usage during all training flights? Explain.

1      2      3      4      5      6      7      8      9      10

Do you track student completion of checklists?      **YES**      **NO**

If **YES**, what method do you use? (Memory, write on paper, etc.)

If **NO**, why not?

If a student misses a checklist, do you bring this to the student's attention?      **YES**      **NO**

If **YES**, when do you notify the student of the mistake?

If **YES**, how do you notify the student of the mistake?

If **NO**, why not?

Please fill out the following section from *your memory*. Please do not ask anyone or look at the POH for any advice. We would like to understand the extent of your memory concerning checklist function and performance in your flying. If you can not remember an item or segment, please leave the space blank.

- 1) Please indicate which of the following checklists are do-lists and which are flow checks.

Checklist	DO-LIST or FLOW	
Before Takeoff	Do <input type="checkbox"/>	Flow <input checked="" type="checkbox"/>
Normal Takeoff	Do <input checked="" type="checkbox"/>	Flow <input type="checkbox"/>
Climb	Do <input type="checkbox"/>	Flow <input checked="" type="checkbox"/>
Cruise	Do <input type="checkbox"/>	Flow <input checked="" type="checkbox"/>
Descent	Do <input type="checkbox"/>	Flow <input checked="" type="checkbox"/>
Before Landing	Do <input type="checkbox"/>	Flow <input checked="" type="checkbox"/>
After Landing	Do <input type="checkbox"/>	Flow <input checked="" type="checkbox"/>
Shutdown	Do <input checked="" type="checkbox"/>	Flow <input type="checkbox"/>

- 2) During a closed pattern and while receiving radar vectors for an ILS approach, please indicate the appropriate time during the flight to conduct each checklist.

Checklist	Time During Flight
Before Takeoff	At end of runway/in run-up area, prior to takeoff.
Normal Takeoff	Prior to takeoff.
Climb	1000' AGL
Cruise	Reaching desired or assigned cruise altitude.
Descent	Top of descent into the destination.
Before Landing	2 NM Prior to FAF / 1 Dot Above Glideslope
After Landing	After clearing the active runway.
Shutdown	Ready to shutdown.

- 3) Please list, in the appropriate order, the items and responses of each checklist. (i.e. for the item "Seat Belts & Shoulder Harness", the response may be "Secure")

Before Takeoff Checklist ITEMS		Before Takeoff Checklist RESPONSES
1	Doors	LATCHED
2	CAPS Handle	Verify Pin Removed
3	Seat Belts and Shoulder Harness	SECURE
4	Fuel Quantity	CONFIRM
5	Fuel Selector	FULLEST TANK
6	Fuel Pump	ON
7	Flaps	SET 50% & CHECK
8	Transponder	SET
9	Autopilot	CHECK
10	Navigation Radios/GPS	SET for Takeoff
11	Cabin Heat/Defrost	AS REQUIRED
12	Brakes	HOLD
13	Power Lever	1700 RPM
14	Alternator	CHECK
15	Pitot Heat	ON
16	Navigation Lights	ON
17	Landing Light	ON
18	Annunciator Lights	CHECK
19	Voltage	CHECK
20	Pitot Heat	AS REQUIRED
21	Navigation Lights	AS REQUIRED
22	Landing Light	AS REQUIRED
23	Magnetos	CHECK Left and Right
24	Ignition Switch	R, note RPM, then BOTH
25	Ignition Switch	L, note RPM, then BOTH
26	Engine Parameters	CHECK
27	Power Lever	1000 RPM
28	Flight Instruments, HSI, and Altimeter	CHECK & SET
29	Flight Controls	FREE & CORRECT
30	Trim	SET Takeoff
31	Autopilot	DISCONNECT

Normal Takeoff Checklist ITEMS		Normal Takeoff Checklist RESPONSES
1	Power Lever	FULL FORWARD
2	Engine Instruments	CHECK
3	Brakes	RELEASE (Steer with Rudder Only)
4	Elevator Control	ROTATE Smoothly at 65-70 KIAS
5	At 85 KIAS, Flaps	UP

<b>Climb Checklist ITEMS</b>		<b>Climb Checklist RESPONSES</b>
1	Climb Power	SET
2	Flaps	Verify UP
3	Mixture	FULL RICH
4	Engine Parameters	CHECK
5	Fuel Pump	OFF

<b>Cruise Checklist ITEMS</b>		<b>Cruise Checklist RESPONSES</b>
1	Fuel Pump	OFF
2	Cruise Power	SET
3	Mixture	LEAN as required
4	Engine Parameters	MONITOR
5	Fuel Flow and Balance	MONITOR

<b>Descent Checklist ITEMS</b>		<b>Descent Checklist RESPONSES</b>
1	Altimeter	SET
2	Cabin Heat/Defrost	AS REQUIRED
3	Landing Light	ON
4	Fuel System	CHECK
5	Mixture	AS REQUIRED
6	Brake Pressure	CHECK

<b>Before Landing Checklist ITEMS</b>		<b>Before Landing Checklist RESPONSES</b>
1	Seat Belt and Shoulder Harness	SECURE
2	Fuel Pump	BOOST
3	Mixture	FULL RICH
4	Flaps	AS REQUIRED
5	Autopilot	AS REQUIRED

<b>After Landing Checklist ITEMS</b>		<b>After Landing Checklist RESPONSES</b>
1	Power Lever	1000 RPM
2	Fuel Pump	OFF
3	Flaps	UP
4	Transponder	STBY
5	Lights	AS REQUIRED
6	Pitot Heat	OFF

Appendix C  
Recruitment Script

## Recruitment Script

Hi. I'm Jared Neterer. I am an undergraduate student and part-time flight instructor in the College of Aviation at Western Michigan University. I am conducting a research study for my Honors College thesis project. I am looking for WMU instrument flight instructors who currently provide flight instruction in the Cirrus SR-20 and are available to complete a written survey. The purpose of the study is to determine how effective current checklist areas are being taught at WMU, and provide suggestions on ways to improve checklist usage. This will be done by analyzing how well instructors themselves know the Cirrus SR-20 checklists and their proper usage.

The study consists of one questionnaire which will take one (1) 20-minute session to complete. To be eligible to participate, you must be a current WMU CFII and not have participated in Professor Rantz's doctoral study (Project Number 08-04-42), which focused on student usage of checklists.

You may withdraw from this research at any time. Your participation is completely voluntary. Your willingness to participate in the study or your withdrawal from the study will not affect your employment in any way.

Thank you for your time.

Appendix D  
Anonymous Survey Consent Form

Western Michigan University  
Department of Aviation

Developing a Standardized Checklist Curriculum Utilizing Graphic Feedback to Reinforce  
Salient Stimuli Recognition In Simulated Flight

Student Investigator: Jared K. Neterer  
Thesis Advisor: William Rantz

You are being invited to participate in a research study designed to determine how effective checklists are currently being taught in the aviation flight science program at Western Michigan University. The study is being conducted by Jared Neterer who is both a student and part-time flight instructor in the College of Aviation at Western Michigan University. Jared Neterer is conducting this study for his Lee Honors College thesis. Professor Rantz is his thesis chair.

This questionnaire is comprised of 7 sections of short answer and fill in the blank question and will take approximately 20 minutes to complete. Your replies will be completely anonymous, so do not put your name anywhere on the form. You may choose to not answer any question and simply leave it blank. If you choose to not participate in this questionnaire, you may either return the blank questionnaire or you may discard it. Returning the survey indicates your consent for use of the answers you supply. If you have any questions about this study, you can call Jared Neterer at 269-903-1273. You may also call Jared Neterer's thesis chair, Professor Rantz, at 269-492-2881. In addition, you may also contact the Chair, Human Subjects Institutional Review Board (387-8293), or the Vice President for Research (387-8298), if questions or problems arise during the course of the study.

This consent document has been approved for use for one year by the Human Subjects Institutional Review Board (HSIRB) as indicated by the stamped date and signature of the board chair in the upper right corner. Do not participate in this study if the stamped date is older than one year.

Appendix E  
Instructor Pilot Questionnaire Written Responses

### Instructor Pilot Questionnaire Written Responses

On a scale from 1 to 10, with 1 meaning low importance and 10 meaning high importance, how important is checklist usage during flight? Explain.

- It depends on the phase of flight. (7)
- Very important to get airplane configured right but not more important than flying the airplane. (8)
- Checklists are there for a reason; safety. (10)
- Due to the large number of tasks that need to be completed by the pilot on every flight the workload can become overwhelming especially for example during a descent or before landing. Checklists help mitigate some of the stress/workload & also ensure important items are not overlooked. (10)
- They are all flows and students should know them in the flow. (10)
- Checklists are made to ensure the flight crew is getting all of the necessary tasks completed at the correct time. (10)
- It may not seem very important to students but as people get into more complex and advanced aircraft the checklist ensures that all necessary items are done ie systems set properly. (10)

On a scale from 1 to 10, with 1 meaning low emphasis and 10 being high emphasis, how much emphasis do you place on student checklist usage during all training flights? Explain.

- Depends – Early Training – Heavy emphasis to establish norms. Remedial training – Focus more on tasks. (7)
- High Importance. (9)
- Someone needs to teach new pilots how to stay safe and properly operate the aircraft. (10)
- If there is a checklist available for any portion of a given flight I teach my student to use them so that nothing is overlooked. I do explain however, that there are times during certain circumstances that it isn't feasible to use a check list. For example, during an emergency situation where there is no time, then they need to fly the airplane first, do the checklist from memory & time permitting consult the checklist. (9)
- Memorization of these allows better training to occur. Students are not focused on checklists but actually flying & learning. (10)
- A lot has to depend on the student's level of training. A commercial student will be required to complete all checklists at the correct time, while a pre-private student will be given a little extra time. (8)
- High importance but sometimes fail to monitor. (8)
- Airline and corporate training centers emphasize checklists greatly & since these students are training to be professionals I want them to be in the right mindset about checklists from the beginning. (10)

**Do you track student completion of checklists? YES NO**

**If YES, what method do you use? (Memory, write on paper, etc.)**

- Memory – 4
- Memory, only track for current flight
- Memory, sometimes this method is not as thorough
- Generally by memory
- I track the student's checklist usage by memory. If they haven't used a checklist & it is clear to me they have forgotten I will prompt them to do so, but keep no written record.
- I use my memory and always confirm w/th student whether the checklist is done or not. ie climbing through 1,000 AGL if I don't remember them doing the climb checks I ask.
- Notes on paper
- Notes on paper then entries in student records.

**If NO, why not?**

- None

**If a student misses a checklist, do you bring this to the student's attention? YES NO**

**If YES, when do you notify the student of the mistake?**

- As soon as I realize they aren't going to do it.
- If able – prior to a high workload situation.
- Around 30 seconds after I think the checklist should have been completed.
- Within a couple of minutes of the time they should have performed their checklist. Length of time depends on phase of flight.
- Once it is clear to me that they will consult the checklist on their own.
- After I have given him/her enough time to be late.
- Varies by checklist and student.
- In flight – shortly after it should have been done. Post flight – during a debrief.
- Depending on the student's lesson, private or commercial, usually between 30-60 seconds of when the checklist should have been completed.
- I try to prompt them in a way that they notice and become progressively more obvious. This usually occurs after the student has had ample time to recognize their error.
- Depending where we are in-flight I'll remind them before they get too busy or when it is getting close to the next checklist.

**If YES, how do you notify the student of the mistake?**

- Tell them to do checklist
- Oral communication
- Ask if they forgot something
- A couple of different ways. Question them as to what they forgot. If it's a repetitive mistake sometimes I just tell them the checklist they keep forgetting, or sometimes if

they keep forgetting pre-landings checklist, I just make them go around until they remember.

- I will usually brief the student on whatever he/she is doing at that moment & try to bring it to their attention in the form of a question. Ex: During climb out after takeoff I might say “We are climbing out at 96 kts up to 4500 ft on a 180° heading. Is there anything else we could do now that we are established in our climb.” After the first time they hear the word “climb” and almost always by the second time they realized that they have forgotten to use the climb checklist.
- “What are you forgetting?” or “Are you forgetting anything?”
- Ask question about something the checklis(t) covers, change to the checklist page. Just ask if they’ve missed anything.
- “Have we completed the \_\_\_\_ checklist?” Post flight – review the reminder given.
- Generally just ask a simple question. “What are we suppose to do at 1000’ AGL?”
- Usually I ask if there is anything else we could be doing right now or by saying did we get everything done.

**If *NO*, why not?**

- None

Appendix F  
HSIRB Research Approval Letter

Date: March 12, 2009

To: William Rantz, Principal Investigator  
Jared Neterer, Student Investigator

From: Amy Naugle, Ph.D., Chair

Re: HSIRB Project Number: 09-02-32

This letter will serve as confirmation that your research project entitled “Developing a Standard Checklist Curriculum Utilizing Graphic Feedback to Reinforce Salient Stimuli Recognition in Simulated Flight” has been **approved** under the **exempt** category of review by the Human Subjects Institutional Review Board. The conditions and duration of this approval are specified in the Policies of Western Michigan University. You may now begin to implement the research as described in the application.

Please note that you may **only** conduct this research exactly in the form it was approved. You must seek specific board approval for any changes in this project. You must also seek reapproval if the project extends beyond the termination date noted below. In addition if there are any unanticipated adverse reactions or unanticipated events associated with the conduct of this research, you should immediately suspend the project and contact the Chair of the HSIRB for consultation.

The Board wishes you success in the pursuit of your research goals.

Approval Termination: March 12, 2010