A STUDY FOR IMPROVING SAFETY: BUILDING THE TOOLS TO ENSURE STUDENT SUCCESS

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A STUDY FOR IMPROVING SAFETY:
BUILDING THE TOOLS TO ENSURE STUDENT SUCCESS

by

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__________________

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in

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A STUDY FOR IMPROVING SAFETY:
BUILDING THE TOOLS TO ENSURE STUDENT SUCCESS

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ABSTRACT

The aim of this study is to prove the effectiveness of a cockpit mockup using the model of a Piper Archer III, which is the primary training aircraft at Rocky Mountain College. Through only allowing access to the cockpit mockup to half of the new private pilot students, a comparison can be made to the remaining new private pilot students to conclude if the cockpit mockup is a viable training tool. If the device is determined to be an affective training aid, it would then be recommended to the Rocky Mountain College Aviation Program to include the device in the flight training curriculum. The results found from the study seem to prove that the device can improve checklist completion times, and further studies could include more data to backup the results found.
INTRODUCTION

Safety and efficiency are two paramount elements that are essential in order to meet the demands of all who take part in aviation. With each flight having the potential for great tragedy, it becomes necessary to train the professionals in this industry to the highest of standards. No other industry is faced with as much scrutiny and regulation as the aviation business. In order to ensure the ones commanding the aircraft in the system operate to the high standard imposed on them, pilots must be trained for as many scenarios they may face while flying. To train these individuals to this standard, the learning process in which they encounter cannot be as simple as a lecture and a few visual aids. Due to the complexity of aviation, a more hands-on learning process is required that demands immediate feedback from the students. This creates the need for certain devices that can train these individuals effectively. The economics of owning an airplane doesn’t allow for this plane to be primarily used for the ground training initially required of trainees. This has brought the development of flight simulators which mimic the airplane exactly. However, these simulators are expensive to purchase and operate, and not all flight training schools can afford them. This creates a need for something simpler than the airplane or a simulator. With not all schools having the same financial resources as some large institutions, it also is necessary to have an economical solution to this problem.

Enter the cockpit mockup, or paper tiger, training device. It is a simple, inexpensive alternative that is perfect for beginning pilots to practice certain training aspects, like checklists and to build memories of the location of certain switches or knobs. Not all schools, however, have devices like this for students to train, even though they typically cost less than some textbooks. As mentioned above, it is essential to have hands-on learning experiences to get the
effect students need to memorize certain aviation topics (Jensen). This lack of use of simple cockpit mockup devices is due in part to the lack of knowledge of their importance and potential improvement on training. That becomes the goal of this project. It is essential to show that the benefits of using a cockpit mockup outweigh any drawbacks that the devices may have. The primary goal is to prove that using the cockpit mockup will lead to better memorization of procedures to help translate to actual flight training. Arguably, the most important of these procedures are emergency procedures, or certain checklists that must be memorized and practiced to perfection in the event of an actual emergency in flight. All pilots must be prepared for the worst, and these emergency procedures are the first step in ensuring this preparation (Reason).

In order to improve the recall of emergency procedures among Rocky Mountain College aviation students, a cockpit-specific replica of the Piper Archer III must be readily accessible to them. The replica must be as close to the actual dimensions of the airplane as possible, and must accurately show the location of all the various switches and controls (Cherry). This will aid by serving as a base to practice any emergency procedures, and will also assist in building muscle memory on how to perform the different checklists required. The goal of building this device is to continually aid students in their emergency recall procedures to a point where they can be asked anytime of the day or night about an item on a checklist, and be able to recite it with ease, and with proper hand movements.
BACKGROUND

The human brain is complex in its nature, which also causes a complex process in order for it to learn effectively. When it comes to learning in aviation, the same holds true, and it takes knowledge of this learning process in order to train a student to learn all of the information required. In the current FAA Aviation Instructor’s Handbook, it describes how there are many factors involved in simply ensuring the student can begin to learn. One of the most important ideas to consider is Maslow’s Hierarchy of Needs. This is a psychological idea which has different tiers or levels of needs that must be met in sequential order before moving to the next higher tier (Aviation Instructor’s Handbook). Noted in this hierarchy of needs are the needs of safety and security. These are essential to move any higher and to allow a student to feel comfortable enough to reach the highest levels of needs: self-esteem and self-actualization, which are achieved through progressing through training (Hoover). Safety and security can be understood as the student feeling comfortable and not worried about accidents, or emergencies so much that they don’t allow any other thing into their brain to learn. However, if a student builds confidence that if faced with an emergency they could handle it, then they can progress through their training in a timely manner, resulting in increased self-esteem (Cirincione). This is also a reason why emergency procedures are required to be studied before the first flight a student has at Rocky Mountain College. However, the students aren’t expected to meet the highest level of learning known as correlation, and defined as associating what has been learned, understood, and applied with previous or subsequent learning (Aviation Instructor’s Handbook). Instead, the students are expected to complete the required monthly test of emergency procedures, which only holds the student to learn at the lowest level, or simply using rote memory (Telfer). In order
to combat this simplistic learning style, it is imperative to have a more effective learning process for the students, which can come through realistic training in a timely manner by using a cockpit mockup as a training tool. This is the goal of the trainer and would symbolize the success of the device if it were to be implemented into the programs training curriculum. An additional reason for including the trainer into the curriculum would be to align the training to match the airline industry’s own training programs. Since it is not economic or realistic to allow airline pilot trainees to have access to study in actual airplanes, they must rely on simulators to show where switches and displays are located in the cockpit. Due to the fact that the simulators that many airlines operate typically cost hundreds to thousands of dollars to run, it then becomes essential to have a simple, inexpensive alternative which can still have the effect required to ensure trainees learn the procedures required. This has resulted in airlines building paper tigers, or cockpit mockups as a cost effective way to provide resources for students to train with (Arban & Doherty).
MATERIALS

The cockpit mockup is relatively cheap and easy to build, compared to a flight simulator or an airplane. Due to its reasonable price and convenience, a cockpit mockup is a great solution to assist in training for all aspects and all types of flight training. For the device built in the test, all the items, except the photograph of the aircraft, were purchased from S Bar S Building Center located at 2032 Old Hardin Road, Billings, MT 59101 and the prices listed reflect purchase prices of the items on June 16th, 2012. The photograph of the aircraft printed in color to scale was printed by FedEx Office located at 821 N. 27th Street, Billings, MT 59102 and the price listed reflects the purchase price of items on July 5th, 2012.

Materials Needed

<table>
<thead>
<tr>
<th>Items:</th>
<th>Price:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 8’X4’ Sheet of Particle Board (any brand)</td>
<td>$14.99</td>
</tr>
<tr>
<td>1 box of ¾ inch, 50 count wood screws (any brand)</td>
<td>$1.99</td>
</tr>
<tr>
<td>4 cans of spray paint (any brand, any color desired)</td>
<td>$15.94</td>
</tr>
<tr>
<td>1 photograph of aircraft intended, printed in color, to scale</td>
<td>$69.99</td>
</tr>
<tr>
<td>1 5’ strip of Velcro with adhesive</td>
<td>$3.25</td>
</tr>
<tr>
<td><strong>Total:</strong></td>
<td><strong>$106.16</strong></td>
</tr>
</tbody>
</table>

Design

The cockpit mockup is designed to simulate is the Piper PA-28-181 Archer III, a single-engine training aircraft that is the primary training aircraft for Rocky Mountain College. The dimensions of the actual aircraft were taken to allow the cockpit mockup to represent the actual cockpit accurately (see Figure 1 below). The device is largely made out of particle board/plywood and fastened together with wood screws. The display of the cockpit is a printed color picture provided by Piper Aircraft Company. The photograph is printed on plastic
cardboard, and attached to the plywood backing using Velcro, thus allowing the photograph to be interchanged if deemed necessary. The overhead panel switches, as well as fuel selector valve are printed on standard white paper, and laminated to ensure durability after repeated use. Both the overhead panel switches and fuel selector valve printouts are attached to the plywood using Velcro for the previously mentioned reasons.

*Figure 1* Design plan using 8 X 4 sheet of plywood with dimensions
METHODS

Due to the variability in learning that is present from person to person, it was necessary to control as many variables in the study as possible. The first step was selecting students that were going to have access to the cockpit mockup. In order to gain a more accurate result, it was decided that the only students to be tested would be private pilot students enrolled at Rocky Mountain College. This decision was made based on the fact that each of the individuals had minimal aviation experience and would offer the true result of whether a person could learn better using the paper tiger. All of these private pilot students started at the same point in their training and complied with the syllabus approved by the Federal Aviation Administration (FAA) under 14 CFR Part 141. At the beginning of the Fall 2012 semester, the program had 18 new private pilot students. The group was split in half, resulting in 9 being allowed access to the cockpit mockup, and 9 being a part of the control group. The candidates were chosen at random using the students enrolled in the AVS 101 Private Pilot Ground School course. The students allowed access to the cockpit mockup were contacted and advised they would be allowed one 30 minute session administered by me. The students were to complete this session before reaching the twelfth lesson of the private pilot course. During this flight lesson, in which they were accompanied by a flight instructor employed by the aviation program, the instructor was given a sheet explaining the procedures in which to collect the data (Figure A1). The test included three specific emergency recall procedures which students are tested on throughout their training. The scenario is presented in a realistic order of events broken down into three parts, beginning with an engine fire in flight, followed by a power loss in flight, and concluding with a power off landing, all of which have associated emergency recall procedures. The time to respond to each
simulated emergency procedures was the quantitative factor determining if using the cockpit mockup was a success. Time was chosen as the determining factor due to the fact that in a real life emergency situation, time is critical and the correct procedures in flight must be followed in order to ensure the safest outcome. After the flight was completed, the flight instructor turned in the form for analysis of the collected data.
RESULTS

The results of the flight tests were recorded on the sheet distributed to the flight instructors of the aviation program, which is displayed in Figure A1. On this sheet, the instructors were told to record the time it took each student to complete the checklist. These times were compiled and organized into Table 1 as follows:

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Time to complete checklist for students allowed use of the cockpit mockup (in seconds):</th>
<th>Average Time:</th>
<th>Time to complete checklist for students not allowed use of the cockpit mockup (in seconds):</th>
<th>Average Time:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>30</td>
<td>21</td>
<td>42.25</td>
<td>44.25</td>
</tr>
<tr>
<td>B</td>
<td>19</td>
<td>30</td>
<td>21</td>
<td>44.25</td>
</tr>
<tr>
<td>C</td>
<td>30</td>
<td>30</td>
<td>42.25</td>
<td>44.25</td>
</tr>
<tr>
<td>D</td>
<td>90</td>
<td>105</td>
<td>44.25</td>
<td>44.25</td>
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<tr>
<td>E</td>
<td>21</td>
<td>30</td>
<td>44.25</td>
<td>44.25</td>
</tr>
<tr>
<td>F</td>
<td>30</td>
<td>105</td>
<td>44.25</td>
<td>44.25</td>
</tr>
<tr>
<td>G</td>
<td>105</td>
<td>21</td>
<td>44.25</td>
<td>44.25</td>
</tr>
<tr>
<td>H</td>
<td>21</td>
<td>105</td>
<td>44.25</td>
<td>44.25</td>
</tr>
<tr>
<td>Part I:</td>
<td>30</td>
<td>54</td>
<td>84</td>
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<td>Part II:</td>
<td>40</td>
<td>45</td>
<td>45</td>
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<td>Part III:</td>
<td>15</td>
<td>20</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>Total Time:</td>
<td>85</td>
<td>54</td>
<td>84</td>
<td>84</td>
</tr>
</tbody>
</table>

It was intended to collect twice as many samples, however, some flight instructors forgot to perform the test during the scheduled flight, and any data collected during any other lesson than the one specified was not included. The times input into the table are broken down to display an individual student’s performance, as well as average times for each part of the scenario for all of the students. These average times were used to determine an average total time, which is the main set of data used in the test. As shown by Table 1.1, the results from using the cockpit mockup account for a 41.17 second average time difference overall. To put a real-life instance to this time, take for example the flight referred to as the “Miracle on the
Hudson," in which a large commercial airliner lost power to both engines and had to make an emergency landing in the Hudson River in New York. The captain was faced with an urgent situation in which he had to make a decision, and make it fast. Due to the lack of altitude the airplane had, the captain was forced to decide quickly on what the best outcome would be. From the moment of engine power loss to the decision to land the airplane in the water spanned 1 minute, 52 seconds, which was followed 1 minute later with touchdown in the river (Eisen & Savel, 2009). This shows that no time can be spared when faced with an urgent emergency. Seconds count, and when faced with extremely stressful situations, it is not acceptable for a professional pilot to not complete checklists in a timely manner as the lives of all aboard the aircraft hang in the balance. Therefore, if it is possible to improve the time to complete checklists by over 40 seconds by using a cockpit mockup training aid, the benefits speak for themselves (Beaudin-Seiler). This difference in time will increase the overall safety of each pilot if this decrease in response time is consistent for all who use such a device for learning.
ANALYSIS

Results from testing show a 41.17 second average decrease in time needed to complete the required checklists. Also, for each part in the scenario, there was a noted decrease in completion time: Part I of the scenario showed a 2 second decrease, Part II of the scenario showed a 23 second decrease, and Part III showed a 4.5 second decrease. This small sample of data displays how affective the paper tiger can be and its relevance in decreasing the time required to complete checklists. The goal of the test was to note a time decrease if using the paper tiger, which the data shows, thus supporting the hypothesis. Based on this evidence, the viability of the paper tiger is significant to allow further testing in other areas of flight training, such as during commercial pilot training. In the future it would be relevant to test the viability of using the paper tiger in all stages of flight training, including Certificated Flight Instructor (CFI) applicants who would be considered the most highly trained and knowledgeable individuals in the aviation program. This would help display the relevance of the paper tiger for all phases of the flight training process.

Possible Errors

While it was intended to get the most accurate data possible, not all variables were able to be controlled throughout the entire process of testing and data collection. The variability in learning from person to person used in the test was continually a factor in getting a completely accurate result. While the data was collected at the same point in training for each student, the students did not progress through the training at the exact same rate, therefore causing the data collection to span in a time frame of approximately two weeks. Also, if done again, the 30 minute sessions would be done at the same time in training as well, for example all of the
training lessons would be completed as a preflight briefing on lesson six. Otherwise, for one individual the session could be done on lesson four, while for another, it could be completed on lesson 11, thus having a difference in training that could contribute to the session being more or less effective. This is an extreme example, and the 30 minute sessions occurred for all students between lesson three and eight of their training during this test, which for the previously explained reasons causes some variability in the accuracy of data. Another error in the test is the sample size received after the test was completed. While it was intended to collect twice as much data, the controls over data collection were not possible to keep under the scrutiny of designated individuals, but rather the student’s own instructor whose top priority is to ensure safety and completion of the flight, and not to administer the experiment. This control was not possible to enforce strictly due to the economics and low priority of the test when compared to completing the actual flight safely. For an accurate test, the scenario would have to become its own lesson in itself, which would require FAA approval, which is not necessary for a one-time test for data collection.

**Recommendations**

From the data received, many conclusions can be drawn, as well as open up more questions that can be brought up in the future. Also, for the success of the project to be fully realized, its future would need to be implemented into a written curriculum. The recommendations for future study of this tool are as follows:

1. **Conduct testing using a larger sample size.**

   The sample size used to collect information doesn’t give a completely accurate representation of the actual student pilot population at Rocky Mountain College. It
would be advised to conduct the test using a much larger number of participants if possible in order to allow the data to be statistically significant.

2. **Perform testing on different sample groups, such as commercial pilot applicants and certificated flight instructor applicants.**

   The test was conducted on one type of training population out of the seven possible stages of certificates and ratings offered at the college. The result would give a larger variety of examples of the viability of the device in all stages of learning.

3. **Implement the cockpit mockup training device into the syllabus for Private Pilot students.**

   By requiring students and instructors to meet at the device for a scheduled lesson, it would enforce the proper use of the device as a training aid to improve memory and muscle memory. At the beginning of each course of training, the syllabus is written to allow for multiple ground briefings between the instructor and the student, and a meeting at the cockpit mockup could easily be added to those lessons.

4. **Include the cockpit mockup in ground school courses as a training aid.**

   During each ground school course, the cockpit mockup can be used to display a realistic representation of the airplane. The cockpit mockup is located in the same building as all ground school classes, therefore making it easy to use in these courses.
APPENDIX A:
Forms and Diagrams Used
Figure A1 Form distributed to the flight instructors for data collection

Please read before the flight!!

To be completed during PVT S1 L12

This is a test of your student’s knowledge and ability to recall emergency procedures. The information will be used for a Senior Honors Project. The purpose of this test is simply to collect data for the project. Please fill out this form completely and honestly, as it will help yield more accurate data results. If you have any questions, please call Jason Tobin at (406)-391-1280, or email at jsmbn@gmail.com. Again, it is imperative that you follow the instructions as closely as possible to ensure the data is accurate.

Student Name: ____________________________________________

Instructor Name: ____________________________________________

Date: __________________________

Before starting the scenario and each of its parts, be sure to have some sort of time keeping device. The time it takes to complete the procedure as well as the student’s preparedness will be used in the data collection process. The time starts when you announce the scenario, and runs until the student completes the last checklist item.

Scenario Part 1: Your student is flying solo in the practice area. During the flight, the student begins to smell something burning. The next thing they know, a fire breaks out under the cowlings. After the correct procedure for this emergency is completed, record the time.

Time: __________

Scenario Part 2: After dealing with and putting out the engine fire, the student is now faced with a power loss in flight. After the correct procedure for this emergency is completed, record the time.

Time: __________

Scenario Part 3: After following the correct procedure, the power to the engine does not return. The student is now faced with an off field landing situation. After the correct procedure for this emergency is completed, record the time.

Time: __________

Instructor comments on student performance: ____________________________
__________________________________________
Figure A2 3D image for cockpit mockup without dimensions
APPENDIX B:
Images Used
Image B1 Image used to display the cockpit of the Piper Archer III

Image B2 Image used to display fuel selector valve of the Piper Archer III
Image B3 Image used to display overhead switch panel of the Piper Archer III.

Image B4 Post-cut image of plywood in the dimensions specified
Image B5 Image of completed cockpit mockup after assembly

Image B6 Image of cockpit mockup in its location of testing
BIBLIOGRAPHY


