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# Preliminary Examination of Simulator-Based Training Effectiveness

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# THE EFFECTIVENESS OF MICROSOFT FLIGHT SIMULATOR AS A TRAINING AID FOR PRIVATE PILOT TRAINING AND PROFICIENCY

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The debate regarding the effectiveness of computer-based software for pilot training and proficiency has been ongoing since such software first became available.  While studies on the efficacy of such software have been and continue to be conducted, pilots are in large number utilizing such packages.  A nationwide survey was conducted to determine how the Microsoft Flight Simulator (MFS) software package is being used by pilots for both initial private pilot training and for maintaining proficiency once certificated.  Over 650 survey respondents evaluated the effectiveness of MFS in 14 areas of pilot operations. It was found that over 40% of respondents used the software package during their private training, and that 85% of respondents now use the software package to help maintain their proficiency. These findings indicate that student and private pilots have embraced MFS as a useful training and proficiency aid.

In 1980, the Microsoft Flight Simulator (MFS) software package entered the marketplace, and over the past 30 years there have been ten editions released (Grupping, 2007).  The earliest versions of the software were somewhat rudimentary, as the graphics and processing capabilities of computers of the time were unable to portray flight realistically.  For many years, certificated pilots did not view the software as useful for training or proficiency purposes.  But now, both the software and the capabilities of even inexpensive computers have evolved so a fairly realistic flight experience is provided.  This improvement has led to the use of the MFS package by pilots for both training and proficiency purposes, even though the Federal Aviation Administration (FAA) does not allow time spent using the package to be logged.  There have even been two books published which describe methods for using the MFS package for flight training (Van West & Lane-Cummings, 2007; Williams, 2006).

There have been a tremendous number of studies performed to evaluate the transfer of training and effectiveness of personal computer based basic aviation training devices (BATDs) for instrument flight skills (Federal Aviation Administration, 1999; Dennis & Harris, 1998; Taylor, et al., 2003, Johnson & Steward, 2005).  These studies resulted in Advisory Circular 61-136, which approved the use of BATDs for up to ten hours of initial instrument training, and for use in meeting the recency of experience requirements of  14 CFR 61.57(c)(1) (Federal Aviation Administration, 2008).  However, BATDs require physical controls for the following items: landing gear, wing flaps, cowl flaps, carburetor heat control, mixture, propeller, and throttle controls.  In addition, the following controls must be able to be set without using a keyboard or mouse: master/battery, magnetos, alternators, fuel boost pumps, avionics master, pitot heat, and aircraft lights.  Given these requirements, MFS does not qualify as a BATD.

However, this fact has not stopped instrument pilots from using the MFS package heavily for both training and proficiency purposes. In a 2009 study, it was found that for those pilots who earned their instrument rating after 2000, approximately 80% utilized MFS during instrument training, for a mean of 51 hours (Beckman, 2009).  In the same study, it was found that 61% of study participants utilize the package to maintain instrument proficiency.  In both initial training and proficiency, the areas of basic attitude instrument flight, holding patterns, enroute navigation, instrument approach procedures, and previewing approaches at unfamiliar airports were ranked as skills that could be effectively practiced in MFS.

## Statement of the Problem

Although instrument skills and procedures have long been practiced in simulators or training devices, the use of these training aids for private pilot training has basically been neglected.  However, anecdotal evidence suggests that many student pilots not only use MFS for entertainment purposes, but also as a means to practice skills necessary to obtain their private certificate.  In addition, many certificated pilots use the software package to maintain a level of proficiency when they are not able to fly regularly.  Given that the necessary software and controls can be purchased for around $200, MFS potentially provides an affordable platform for both student and private pilots to enhance and retain their skills. However, if the package is to be used effectively, the skills which are

most appropriate to the package need to be identified, so pilots can best use the package to their advantage. The research questions to be addressed by this study are:

1. How frequently are student pilots using the MFS package for training purposes?
2. How frequently are private pilots using the MFS package for proficiency purposes?
3. What flight skills are rated as most effective to practice with MFS during private pilot training?
4. What flight skills are rated as most effective to practice with MFS to maintain proficiency for private pilots?

## Methodology

The Middle Tennessee State University Institutional Review Board approved the conduct of this human subject research study. A 12 question survey instrument was developed in electronic format using the SurveyMonkey survey generation website. The first questions concerned basic demographics, including indication of the highest certificate held by the respondent, whether they were instrument rated, whether they held a flight instructor certificate, and in what year they earned their private certificate.

After demographics, the next part of the survey was designed to see whether or not the participant used MFS during their initial private pilot training. If a participant indicated that they did use MFS during their private training, they were asked to rate the effectiveness of the software package for training in each of the following areas: General cockpit familiarization; procedures and checklists; understanding aircraft systems; interpreting flight instruments; visual cues experienced during flight; basic maneuvering flight; slow flight, stalls, and steep turns; ground reference maneuvers; pattern work and landings; VOR set up and usage; GPS set up and usage; cross country navigation; basic attitude instrument flight; instrument and equipment failures; radio procedures and phraseology; previewing unfamiliar airports; and aeronautical decision making. A standard Likert response scale was utilized, with the possible responses: Very Effective, Effective, Neutral, Not Effective, and Very Ineffective. In addition, the option to select Not Practiced was available to participants for each of the listed skills. At the conclusion of this section, participants were asked to estimate the total number of hours they spent using MFS while they were training for their private certificate.

The second section of the survey attempted to evaluate how MFS was used after the participants obtained their private certificate. Thus, the first question asked was whether or not the pilot had used the MFS package to maintain or improve their proficiency level since achieving their private certificate. If this question was answered in the affirmative, the participant was asked to indicate how effective the package was for practicing each of the following skills: Procedures and checklists; aircraft systems operations; basic maneuvering flight; slow flight, stalls, and steep turns; ground reference maneuvers; pattern work and landings; VOR set up and usage; GPS set up and usage; cross country navigation; basic attitude instrument flight; instrument and equipment failures; radio procedures and phraseology; previewing unfamiliar airports; and aeronautical decision making. The same Likert scale as indicated above was utilized for response options for this question. Participants were then asked to estimate the number of hours per month they spend using MFS to practice their flying skills, and whether they typically practiced a specific skill or fly a scenario when using MFS. Finally, participants were provided an open response area in which they could provide any additional comments about their use of the MFS package for private pilot training and proficiency.

The survey was distributed to potential participants by the daily electronic newsletter Aviation eBrief, published by the Aircraft Owners and Pilots Association. The newsletter has a subscriber list of over 415,000 pilots, aircraft owners, and other aviation professionals. Aviation eBrief published a paragraph describing the study, along with an internet link to the survey, in a November 2009 newsletter. All certificated private pilots were encouraged to participate by completing the survey. Over 745 responses were received within one week of the survey announcement, and the survey was closed to respondents at that point.

## Results and Discussion

There were 745 total responses, of which 651 were valid (the respondent held at least a private certificate). Of these, 432 held only a private certificate, while 163 held a commercial certificate, and 56 held an airline transport pilot certificate (ATP). Those that did not hold at least a private certificate were not able to continue with the

survey.  With regards to an instrument rating, 57% of the participants indicated they had this rating, while only 18% of participants indicated having a certified flight instructor (CFI) certificate. The average year in which a private certificate was earned was 1992, with the range being from 1945 to 2009.  Over 44% (281 of 629) of the respondents indicated they used MFS while they were training for their private certificate, although when the participants who had obtained their private certificate after 1980 (the year the MFS package first became available) were examined, the percentage that used it during private training increased to 61% (281 out of 459). When those that received their private certificate since 2000 were examined, it was found that 76% (213 of 282) of these participants used the package during their training.

A large majority of the 281 participants who indicated they used MFS for training responded to the follow on question regarding the effectiveness of the package for learning specific skills. The effectiveness, as perceived by the respondents, of MFS for practicing a variety of skills necessary for the achievement of a private pilot certificate, can be seen in Table 1. It was found that the six skills having a combined Very Effective and Effective rating greater than 75%  included: interpreting flight instruments (97%), VOR set up and usage (91%), basic attitude instrument flight (90%), general cockpit familiarization (81%), cross country navigation (81%), and basic maneuvering flight (76%).  Those skills with the lowest ratings (less than 50% of the responses in the Very Effective or Effective categories) included: ground reference maneuvers (36%), radio procedures/phraseology (42%), and aeronautical decision making (45%). All other skills were rated between 50% and 75% Very Effective or Effective. The last question in the training section of the survey asked how many hours the participant spent using MFS while training for their private certificate. The mean response for this item was 112 hours (SD = 17.62).

Table 1. *Perception of the Effectiveness of MFS for Specific Skills in Private Pilot Training*

| Skill | Very Effective | Effective | Neutral | Not Effective | Very Ineffective | Not Practiced | n |
|---|---|---|---|---|---|---|---|
| General Cockpit Familiarization | 32% | 49% | 11% | 5% | 1% | 3% | 261 |
| Procedures and Checklists | 19% | 35% | 26% | 8% | 3% | 9% | 262 |
| Understanding Aircraft Systems | 13% | 38% | 29% | 11% | 2% | 8% | 261 |
| Interpreting Flight Instruments | 59% | 38% | 3% | 0% | 0% | 1% | 263 |
| Visual Cues in Flight | 14% | 37% | 34% | 10% | 5% | 2% | 262 |
| Basic Maneuvering Flight | 27% | 48% | 14% | 7% | 2% | 2% | 262 |
| Slow Flight, Stalls, Steep Turns | 16% | 38% | 25% | 11% | 6% | 4% | 263 |
| Ground Reference Maneuvers | 11% | 25% | 29% | 19% | 8% | 9% | 262 |
| Pattern Work/Landings | 25% | 36% | 20% | 12% | 6% | 2% | 263 |
| VOR Set Up and Usage | 71% | 20% | 5% | 0% | 0% | 4% | 262 |
| GPS Set Up and Usage | 42% | 26% | 12% | 3% | 0% | 16% | 262 |
| Cross Country Navigation | 45% | 36% | 11% | 4% | 0% | 5% | 262 |
| Basic Attitude Instrument Flight | 52% | 38% | 6% | 2% | 0% | 2% | 262 |
| Instrument/Equipment Failures | 28% | 32% | 17% | 5% | 0% | 19% | 263 |
| Radio Procedures/Phraseology | 13% | 29% | 28% | 12% | 5% | 13% | 260 |
| Previewing Unfamiliar Airports | 37% | 38% | 11% | 6% | 1% | 7% | 262 |
| Aeronautical Decision Making | 13% | 32% | 31% | 9% | 2% | 11% | 261 |

The next section of the survey dealt with the use of MFS for proficiency purposes after achieving a private pilot certificate.  Over 85% (n=519) of the survey respondents indicated using the package since earning their certificate. Once again, participants were asked to rank the effectiveness of the package for various skills, but this time with regards to maintaining proficiency.  The results may be seen in Table 2.

Table 2. *Perception of the Effectiveness of MFS for Retaining Proficiency in Private Pilot Skills*

| Skill | Very Effective | Effective | Neutral | Not Effective | Very Ineffective | Not Practiced | n |
|---|---|---|---|---|---|---|---|
| Procedures and Checklists | 18% | 36% | 24% | 5% | 3% | 13% | 478 |
| Aircraft Systems Operation | 14% | 41% | 27% | 6% | 1% | 10% | 477 |
| Basic Maneuvering Flight | 23% | 43% | 21% | 4% | 2% | 6% | 477 |
| Slow Flight, Stalls, Steep Turns | 16% | 30% | 26% | 11% | 3% | 15% | 477 |
| Ground Reference Maneuvers | 9% | 25% | 30% | 14% | 5% | 17% | 476 |
| Pattern Work/Landings | 21% | 35% | 23% | 10% | 3% | 8% | 479 |
| VOR Set Up and Usage | 62% | 29% | 5% | 1% | 0% | 3% | 479 |
| GPS Set Up and Usage | 46% | 32% | 11% | 2% | 1% | 9% | 478 |
| Cross Country Navigation | 47% | 35% | 9% | 2% | 1% | 5% | 475 |
| Basic Attitude Instrument Flight | 61% | 31% | 5% | 1% | 1% | 2% | 479 |
| Instrument/Equipment Failures | 33% | 36% | 13% | 3% | 1% | 15% | 477 |
| Radio Procedures/Phraseology | 13% | 28% | 28% | 12% | 5% | 14% | 476 |
| Previewing Unfamiliar Airports | 40% | 36% | 11% | 4% | 1% | 7% | 481 |
| Aeronautical Decision Making | 18% | 36% | 27% | 5% | 2% | 12% | 474 |

It was found that five skills had a combined Very Effective and Effective rating greater than 75%: basic attitude instrument flight (92%), VOR set up and usage (91%), cross country navigation (82%), GPS set up and usage (78%), and previewing unfamiliar airports (76%). Those skills with the lowest ratings (less than 50% of the responses in the Very Effective or Effective categories) included: ground reference maneuvers (34%), radio procedures/phraseology (41%), and slow flight, stalls, and steep turns (46%). All other skills were rated between 50% and 75% Very Effective or Effective. Participants were then asked to estimate the hours per month that they spend using the MFS package to practice their flight skills, and the mean response was 9.6 hours (SD = .759). Finally, participants were asked to indicate whether they typically practice a specific skill or a scenario (i.e., particular flight segment) when using the MFS package. The result was 60% indicating that they practice a scenario, and 40% indicating that they practice a specific skill.

Finally, there was an open-ended qualitative question, which asked for any additional thoughts the participant had regarding the usefulness of MFS for private pilot training and proficiency. An astonishing 61% of the respondents (396 of 651) took the time to make comments regarding the package. Equally interesting, of those that responded, less than 2% had a negative comment to make regarding the use of MFS. Examples of common positive sentiments include:

• Great tool to hone your skills and keep up to date. Especially great for G1000 and other GPS procedures.
• As a private pilot, I find Microsoft Flight Simulator to be particularly effective as a tool for "pre-flying" to unfamiliar places to get the airport layout and to get the lay of the land along the route and in the airport environment.
• Excellent tool. Good to use to introduce concepts which then saves time in the cockpit.
• I got my private pilot license in 40.1 hours and passed my FAA written exam with 100% correct. I fully credit MFS for the familiarity with systems and instruments, as well as ATC phraseology.
• I use MFS to maintain basic skills, as where I live there is no general aviation light aircraft. I can get to actually fly 2-3 times a year in light airplanes. MFS is an invaluable aid in maintaining proficiency.

Again, there were very few negative comments to analyze, but the few that were present are represented by the following examples:

• Needs better visual cues for ground reference work. Turns about a point are difficult since side glances are not really effective in gauging position.

• I did not have rudder pedals, so I was weak with them.
• Can lead to bad habits such as "head inside cockpit." Need to have a clear understanding of what it is, and is not, good at to best utilize it.

## Conclusions

Despite the fact that time spent using MFS cannot be credited toward a private certificate, it is clear that the package is being utilized by large numbers of student pilots. For those that received their private certificate after 1980, 61% reported using the package during training, while for those that received their private certificate after 2000, 76% reported using MFS during training. For those that used the package during training, the mean total time spent on MFS was 112 hours. The most useful training skills, as perceived by the participants, were interpreting flight instruments, VOR set up and usage, basic attitude instrument flight, general cockpit familiarization, cross country navigation, and basic maneuvering flight. The first three of these are very flight instrument and navigation instrument dependent, so it seems logical that these skills can be developed through use of a software package. The use of MFS for general cockpit familiarization also seems clear, since becoming familiar with the location of various instruments, switches, and buttons has long been done via methods such as studying a cockpit picture or diagram. Cross country navigation seems a bit less self-evident, but again, navigation instruments are often in use. While visual cues may not be as good as desired, the ability to fully practice VOR and GPS navigation, with at least some visual cues present, is a benefit. Finally, the high rank of basic maneuvering flight was a bit surprising, since again, the visual cues in the package are a bit limited. In addition, the control forces experienced in flight are quite different than those experienced in the software package. However, the ability to practice procedures repetitively while away from the airport was identified by many participants as a valuable aspect of MFS.

The 85% of participants utilizing MFS after achieving their private certificate, with a mean usage of 9.6 hours per month, is an even greater percentage than those that use the package during training. Basic attitude instrument flight, VOR set up and usage, cross country navigation, GPS set up and usage, and previewing unfamiliar airports were perceived as the most effective skills to practice with MFS. These first four skills were also indicated as highly effective in initial training as well, and the additional area of previewing unfamiliar airports has long been seen as a valuable tool by instrument pilots (Beckman, 2009). Given the difficulties of finding and entering the traffic pattern under visual flight rules at unfamiliar fields, it seems natural that the ability to examine the terrain and runway layout of a new airport would be useful to a private pilot as well.

Of the 209 participants who held their commercial or ATP certificate, 117 (56%) also held a CFI certificate. While only a small percentage of these CFIs (22%) used MFS during their initial training (perhaps because their training was conducted before the software package became as capable as it is currently), a much greater percentage (78%) of these CFIs now use the package for proficiency. Given this high rate of usage by CFIs it is likely that student pilot use of the package will continue to remain strong. This being the case, it is important for both students and instructors to know what aspects of flight training can best be assisted by MFS, and this study has attempted to bring those skills to light. In many respects, for both training and proficiency purposes MFS has replaced conventional "arm chair flying," where pilots visualized procedures and maneuvers in their head prior to flight, as a method of developing and retaining essential flight skills. Given the high cost of flight time, any cost savings or safety advantage pilots may achieve through the use of a ground training device should be encouraged, and it appears that private pilots are making wide use of MFS for this purpose.

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