HOME FLIGHT SIMULATION
AND ITS IMPACT ON AVIATION TRAINING

A study of 1,000+ pilots and air traffic controllers.

Produced by

FLIGHT
SIMULATION
ASSOCIATION

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INTRODUCTION

As the organizer of the annual FlightSimExpo convention and a membership association with over 10,000 flight simulation hobbyists, Flight Simulation Association has heard countless stories from certificated pilots and air traffic controllers describing how flight simulation was an invaluable resource during training.

This anecdotal feedback isn't surprising: for years, non-certified and enthusiast flight simulators have allowed passionate aviators to master radio communications, practice checklist discipline, learn glass cockpit avionics, and more…all from the comfort of home. Although flight simulation doesn't always accurately replicate the 'hands and feet' feel of flying an aircraft, many of the procedural aspects of flight training do translate directly.

This reality prompts the question:

> **Do non-certified simulators, used in the home environment, offer a quantifiable training benefit?**

In 2023, Flight Simulation Association conducted a survey of more than 1,000 certificated pilots who had experience with home flight simulation. The purpose was to quantify the value of home flight simulation as a training aid, specifically for pilots who used home flight simulation while training for their Private Pilot Certificate. The survey found that home flight simulation provides a measurable reduction in the number of hours required for pilots to receive their initial certification.

Although previous research has been done regarding the use and benefits of home flight simulation, to our knowledge, this is the first survey that has attempted to quantify its impact.

The survey also evaluated flight simulation's benefits for air traffic controller training. Current FAA air traffic controllers with previous experience in Online Air Traffic Control were asked about their Air Traffic Skills Assessment (ATSA) results, FAA Academy class rank, and subsequent career progression. The controllers were also asked if they felt their virtual controlling experience provided an advantage during formal air traffic control training.

RESULTS BY THE NUMBERS

5.5

The average number of hours a pilot saves in flight training by using home flight simulation.

89%

The percentage of respondents who 'Agreed' or 'Strongly Agreed' that home flight simulation is beneficial for flight training.

$1000+

The amount a pilot could save in flight training cost by using home flight simulation[1].

Out of 14 FAA air traffic controllers with previous experience in Online Air Traffic Control…

13

*Applied to the FAA because their flight simulation experience led them to **discover a potential career** in air traffic control.*

80%

*Graduated from the FAA Academy **ranked first in their class.***

100%

***Checked out successfully** at their first facility.*

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[1] Assuming a $200/hour cost for aircraft rental, fuel, and instruction, a 5.5 hour reduction in flight training equates to $1100 in savings.

KEY CONCEPTS
Home Flight Simulation

Home flight simulation generally refers to using:

1 *A commercially- or freely-available flight simulator platform such as Microsoft Flight Simulator, X-Plane, or Infinite Flight;*

2 *In combination with a plug-and-play flight controls such as a yoke or joystick, on a desktop, laptop, mobile device, or gaming platform;*

3 *For the purposes of aviation training and/or as a hobby.*

Home flight simulation is used without the presence of an instructor and without the intention of adding hours to a pilot's logbook. Its primary objectives are familiarity, proficiency, and currency—not formal training.

> " *I spent about one-third the cost to get my license compared to my fellow ground school students who didn't use a home flight simulator. Back then, instructors told us to buy a cockpit poster and "fly the kitchen sink". I was fortunate to have a home flight simulator that did that even better. My checklists and flows were easy every time I went for a real flight.* "

Although some of the software or platforms used in home flight simulation may also be used in certified and non-certified Basic Aviation Training Devices (BATDs), this survey does not contemplate certified devices (i.e., those that can be used to log training hours), nor are such devices considered by Flight Simulation Association to represent "home flight simulation".

Home flight simulation on display at the annual FlightSimExpo convention.

Online Air Traffic Control

Online Air Traffic Control refers to networks that allow virtual pilots and air traffic controllers to connect their flight simulators in a way that closely reflects the real air traffic system. Similar to how 'multiplayer' modes work in existing online games, flight simulation pilots allow their aircraft to appear in others' simulators, and also see other pilots' aircraft within their own simulator. Additionally, humans playing the role of 'virtual air traffic controllers' use simulated radar screens and voice headsets to issue radio transmissions to pilots within their virtual airspace.

> *Training to become a virtual controller helped when discussing airspace requirements, FARs, and proper radio phraseology. Knowing what controllers might say back helped prepare me for the dialog that would occur each flight.*

How It Works

Once connected to the network, pilots can see and interact with all of the other members who are connected. Pilots are also visible to air traffic controllers, who communicate with aircraft just as they do in real life.

1. *"N33B, turn left heading two one zero."*

2. *"Southwest 395, runway four left, cleared for takeoff."*

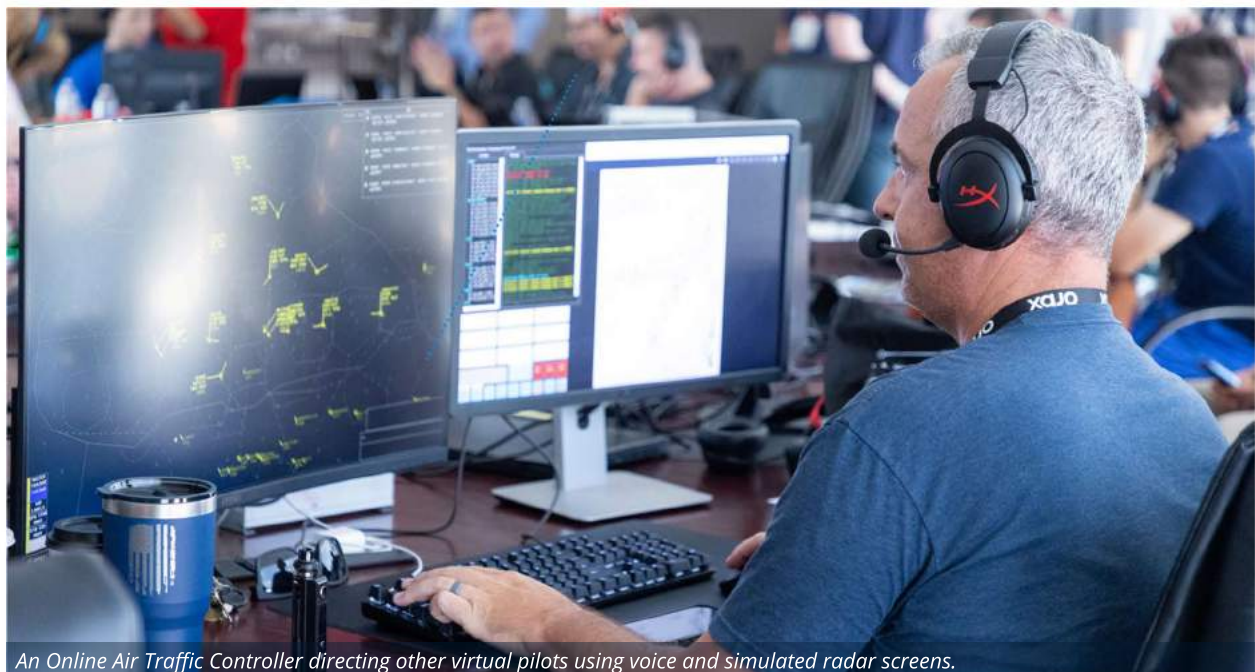**Virtual Controller**

Server

Virtual Pilot 1

"Turn left heading two one zero, N33B."

Virtual Pilot 2

"Runway four left, cleared for takeoff, Southwest 395."

An Online Air Traffic Controller directing other virtual pilots using voice and simulated radar screens.

RESULTS PART I: PILOT TRAINING

Flight Simulation's Impact on Flight Training Hours

The survey collected data for pilots obtaining their certificates as early as 1950. However, to assess flight simulation's impact, results were reduced to those who received their Private Pilot License within the last 10 years (since 2013), considered by Flight Simulation Association to be the start of the 'modern' flight simulator era. Before this date, simulator fidelity and accessory devices for practicing online air traffic control, glass cockpit avionics, and other concepts were less advanced, meaning the technology was less impactful as a training aid.

Survey analysis found that pilots who use home flight simulation with Online Air Traffic Control while training for their Private Pilot Certificate earn it with **5.5 training hours fewer** than those who don't.

On average, survey respondents who used home flight simulation with Online Air Traffic Control during flight training obtained their Private Pilot Certificate at 55.5 flight training hours, **18.5 hours less than the national average** of 75 hours, according to the FAA[1].

Assuming a flight training cost of $200/hour, including aircraft rental, fuel, and instructor time, the 5.5 hour reduction equates to a savings of over $1000. Therefore, the software and flight control hardware required to achieve a reasonable home training setup pays for itself.

Perceived Benefit

The survey also examined whether pilots could perceive a benefit from the use of home flight simulation technology. Respondents were asked to identify the impact they *thought* flight simulation had, and those responses were compared to reality.

The results show that pilots' perceptions are accurate: those who felt flight simulation reduced their flight training earned their certificate at a lower number of hours than those who didn't.

> "
> *I have been teaching Civil Air Patrol cadets to fly for over a decade. During that time, the most outstanding student I ever encountered . . . had several thousand hours of home flight simulator experience, but no airplane flying time. He was able to solo after only 7 hours of training with no difficulty. That cadet is now an airline pilot.*
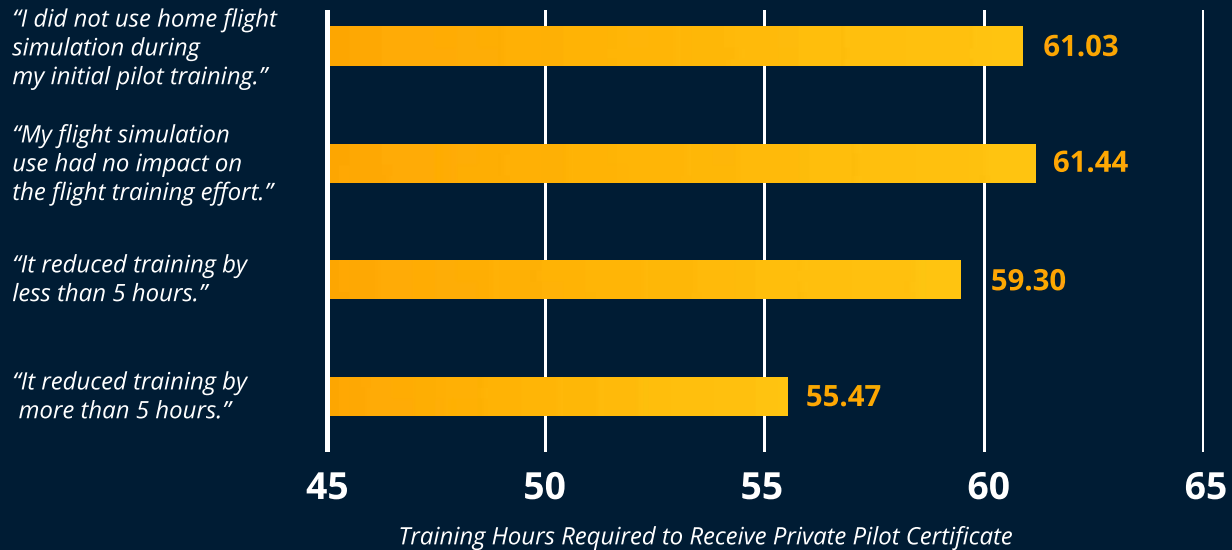> "

> "
> *I work for a flight school overseeing our pilot programs. We see a significant reduction in hours needed to solo and achieve the Private Pilot License, based on the amount of home simulator usage. Typically, the reduction is 3-5 hours before solo, and about 7-10 hours in total.*
> "

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[1] The FAA's FAQ page states that it takes the average pilot 75 hours to earn their Private Pilot Certificate: https://www.faa.gov/faq/what-are-hourly-requirements-becoming-pilot

WHAT IMPACT DID FLIGHT SIMULATION HAVE ON YOUR TRAINING?
Pilots who received their Private Pilot Certificate between 2013-2023

"I did not use home flight simulation during my initial pilot training." — **61.03**

"My flight simulation use had no impact on the flight training effort." — **61.44**

"It reduced training by less than 5 hours." — **59.30**

"It reduced training by more than 5 hours." — **55.47**

45   50   55   60   65

*Training Hours Required to Receive Private Pilot Certificate*

Opinions of Flight Simulation

Regardless of the quantitative benefit flight simulation might provide, respondents overwhelmingly indicated that flight simulation would be a benefit to flight training. This subjective question was asked to all survey participants, regardless of their experience with home flight simulation.

WHETHER OR NOT IT HELPED YOU, RATE YOUR AGREEMENT WITH THE FOLLOWING STATEMENT:

"Home flight simulation would be an asset to any pilot's initial training and/or subsequent ratings training."
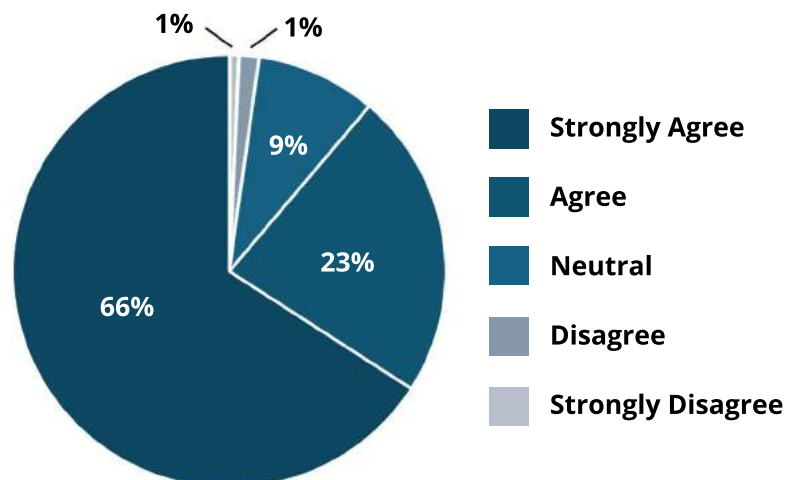
1%   1%
9%
23%
66%

- **Strongly Agree**
- **Agree**
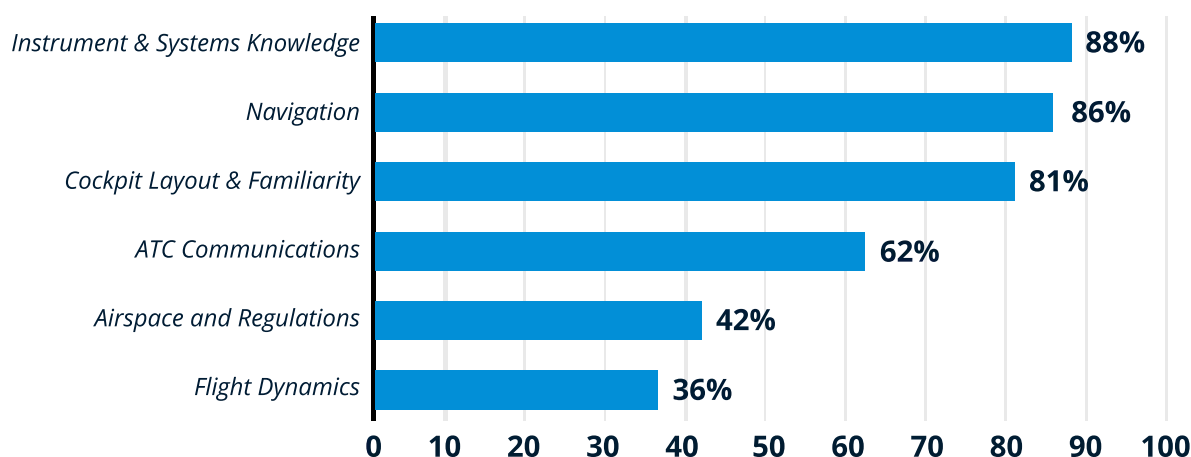- **Neutral**
- **Disagree**
- **Strongly Disagree**

> *I had been out of flying for 27 years. Home flight simulation helped me learn GPS approaches, operation of Garmin equipment, and how to use my iPad as a navigation tool. I've been practicing . . . before taking any new cross-country flights in the real aircraft. I have saved thousands of dollars this way: even if you can't log the flight, you can take away the knowledge and experience.*

Flight Simulation's Strengths

Respondents were also asked to indicate which aviation topics they felt transferred well from home flight simulation to real-world aviation and training. The results align well with other anecdotal feedback we've heard, indicating that flight simulation is most beneficial when used as a procedural trainer to practice skills broadly applicable to aircraft operations.

FLIGHT SIMULATION AND REAL-WORLD TRAINING SKILLS TRANSFER

Percentage of respondents who indicated the associated skill would transfer well from home flight simulation to real aircraft training.

Skill	Percentage
Instrument & Systems Knowledge	88%
Navigation	86%
Cockpit Layout & Familiarity	81%
ATC Communications	62%
Airspace and Regulations	42%
Flight Dynamics	36%

Flight simulation's strengths closely align with those items in the Private Pilot Airman Certification Standards that are not directly related to the 'hands and feet' operation of the aircraft.

Comparison to the Annual FlightSim Community Survey

Since 2018, the annual FlightSim Community Survey has collected data regarding the interests and habits of the flight simulation community. The survey is organized by Navigraph, a provider of charts and navigation data for home flight simulation, and typically garners over 20,000 responses.

The 2023 FlightSim Community Survey[1] sought qualitative analysis regarding the impact of home flight simulation on real-world pilot training. Facts and findings include:

● Over 70% of respondents who held a pilot certificate indicated that they began using flight simulation before earning their certificate. This finding has been consistent since 2021 and underscores flight simulation's role in shaping the early interests and skills of aspiring pilots.

● 80% of respondents who held a pilot certificate acknowledged their engagement in flight simulation has helped facilitate their pilot training.

● Respondents indicated flight simulation is best used as a procedures trainer and tool to acquire fundamental aircraft and airspace knowledge. It is also useful as a source of inspiration.

[1] Navigraph's FlightSim Community Survey is available at https://navigraph.com/survey

RESULTS PART II: ATC IMPACTS
Survey of Current FAA Air Traffic Controllers

Home flight simulation technology isn't just about pilots: it also encompasses virtual air traffic control. Through online networks such as VATSIM and PilotEdge, it is possible for flight simulator pilots to communicate with virtual air traffic controllers, who provide air traffic services that mirror those available in the real world. This concept, referred to as Online Air Traffic Control, is described in more depth in the Key Concepts section of this document.

Given the ongoing shortage of air traffic controllers in the United States, the survey sought to answer whether flight simulation with Online Air Traffic Control could provide a benefit for real-world air traffic controller training.
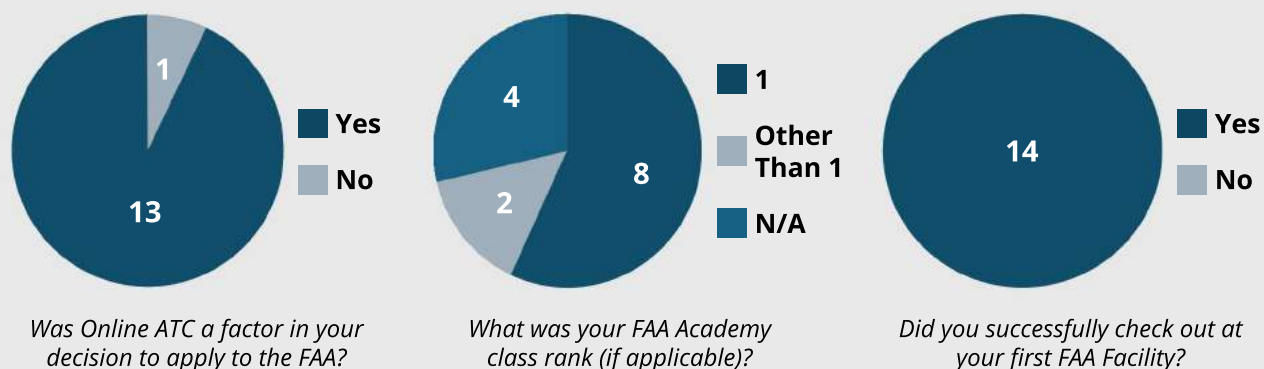
> " *My confidence speaking with ATC in the real world comes from being a virtual controller and flying with others through networked home flight simulators. My FAA Designated Pilot Examiner commented on how well I spoke on the radio during my checkride.* "

To gather insights, an in-depth, qualitative survey took place where 14 FAA air traffic controllers who currently or formerly participated in Online Air Traffic Control were asked to describe their experience. Controllers discussed their Air Traffic Skills Assessment (ATSA) results, FAA Academy class rank, and subsequent career progression. They also elaborated on if they felt their virtual controlling experience provided an advantage during formal air traffic controller training.

The controllers reported Online Air Traffic Control played a substantial role in discovering air traffic control as a career, ultimately inspiring them to apply as professional controllers. And while Online Air Traffic Control was not always cited as a reason for controllers' performance, the survey set was consistently ranked at the best of their class at the FAA Academy and had a 100% success rate when checking out at their first facility.

AIR TRAFFIC CONTROLLER SURVEY RESULTS
Out of 14 FAA Air Traffic Controllers with experience in flight simulation

1
13
Yes
No

Was Online ATC a factor in your decision to apply to the FAA?

4
8
2
1
Other Than 1
N/A

What was your FAA Academy class rank (if applicable)?

14
Yes
No

*Did you successfully check out at your first FAA Facility?*

Online Air Traffic Control Stigma

Controllers frequently mentioned that they do not discuss their involvement with Online Air Traffic Control in any real-world context because of the stigma associated with it. While they find it helpful as both an inspiration and training aid, they do not feel their peers would see it in the same way.

Respondents overwhelmingly agreed that Online Air Traffic Control is a legitimate source of talent acquisition the FAA should be considering in their controller selection process. In the same way that an individual with only flight simulation experience would not be a safe real-world pilot, nobody is suggesting that individuals with Online Air Traffic Control experience transfer directly into the FAA. Instead, the controllers interviewed indicated that the FAA should be looking favorably upon those with Online Air Traffic Control experience as individuals who have already proven their interest and passion for the subject. At a minimum, the FAA could work to change the culture surrounding the role Online Air Traffic Control could play in recruitment, selection, and retention.

DO YOU FEEL ONLINE AIR TRAFFIC CONTROL IS A LEGITIMATE SOURCE OF EARLY TALENT RECOGNITION THAT THE FAA SHOULD BE THINKING OF AS IT SEEKS TO FILL VACANCIES IN CONTROLLER STAFFING?

- 1
- 13
- Yes
- No
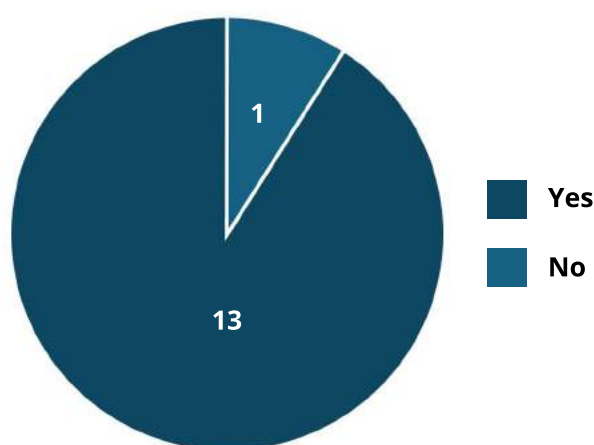
AN INSPIRATIONAL ROLE

Alongside the quantitative training benefits of home flight simulation, its value as an inspirational tool for the next generation of aviators should not be overlooked. With flight simulation options now available on phones, tablets, and gaming consoles, it's never been easier for the technology to spark the "aviation bug".

Particularly for young individuals, flight simulation has the power to inspire: what might start off as a casual interest in a game often transitions to a more serious interest, leading to strong passion for aviation supported by a high fidelity simulation environment that closely mimics the real-world.

This type of journey isn't unique: we've heard it countless times from members of Flight Simulation Association, attendees of FlightSimExpo, and even in the responses to this survey.

Other examples of flight simulation's impact include:

- Capturing an interest in aviation at a young age.

- Teaching adolescents about the types of careers available in aviation and inspiring them to pursue it professionally.

- Providing those not medically qualified to fly with a means to explore their passion for aviation.

> *Online Air Traffic Control opened my eyes to the air traffic side of aviation. I always knew about a flying career, but air traffic is something I hadn't thought about before I discovered it virtually. The fact that you can bring so much realism into a simulated environment free of cost is amazing. I attribute so much of my career and progression to my training and experience in Online Air Traffic Control.*

RELATED WORK

A literature review revealed a limited amount of previous work to compare with this effort. Typically, academic or professional studies regarding flight simulation involved professional, certified equipment, and focus on researching human factors issues relating to transport category flight crews or flight decks. Such publications are not an appropriate comparison for this study, which is aimed specifically at the benefits of home flight simulation towards for real-world pilot training.

One study that does offer insights was conducted in 2022 at a flight school in Australia. The ethnographic study used observation and in-depth interviews to assess the benefits of flight simulation for general aviation training. Of particular interest to the researchers was answering why there was a hesitancy of flight instructors to encourage students to use flight simulation, despite the documented benefits of using such technology.

The study ultimately found that:

● Instructors and managers placed too much emphasis on the possibility of students forming bad habits from using desktop simulators, rather than on how this technology can facilitate learning, implying that a stigma or bias toward simulators may have existed in the research environment.

● Even if a student did form a bad habit during training, such as focusing too much on the inside of the cockpit instead of scanning outside, that negative training could not conclusively be attributed to the use of home flight simulation technology. Instead, it could simply be representative of a natural learning process.

This study concluded that instructors' negative perceptions about home flight simulation could be holding back further progress in improving the quality of flight training, and could also be preventing students from embracing the technology to enhance their learning.

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[1] Marques, E., Carim Junior, G., Campbell, G. & Lohmann, G (2022). *Exploring the adoption of desktop simulators in pilot training: An ethnographic approach*. https://doi.org/10.14742/apubs.2022.134

METHODOLOGY

Part I: Pilot Training

Data for Part I of this study were collected via an online survey that was shared with members of Flight Simulation Association and registrants of FlightSimExpo from 2018-2023 who indicated they were certificated pilots. The survey was also shared by other flight simulation developers to their respective mailing lists and customer bases, including on social media.

In essence, the survey asked respondents to identify the year in which they obtained their Private Pilot Certificate (PPL), the number of flight hours required to obtain that certificate, and whether they felt flight simulation was a factor in their training. Those who felt flight simulation impacted their training were asked to explain why.

Additional diagnostic data was collected regarding which aviation authority issued each respondent's pilot certificate. If the respondent indicated they used flight simulation, they were also asked which specific platforms they used.

> *I had been out of flying for 27 years. Home flight simulation helped me learn GPS approaches, operation of Garmin equipment, and how to use my iPad as a navigation tool. I've been practicing . . . before taking any new cross-country flights in the real aircraft. I have saved thousands of dollars this way: even if you can't log the flight, you can take away the knowledge and experience.*

Although data was reviewed and sanitized for duplicate information and clear statistical outliers, there were no controls in place validate that someone who claimed to hold a Private Pilot License actually held such a certificate.

Results were collected between May and November 2023, and data analysis took place in early 2024.

Part II: Air Traffic Controller Training

Data for Part II of this study were collected through a series of long-answer anonymous survey questions that were subsequently read and analyzed. The questions asked respondents to detail their real-world aviation experience, virtual controlling experience, timeline for applying to the FAA Academy relative to when they began virtual controlling, performance at the FAA Academy, and career progression as certified FAA air traffic controllers.

Controls were placed on the collection of questions to ensure respondents were actual FAA controllers who also had experience with home flight simulation.

Results were collected between February and March 2024, and analysis took place shortly thereafter. The data collected from respondents for Part II of this study is available in tabular form in Appendix A.

LIMITATIONS OF RESULTS

The results of this survey should not be construed as a scientific study. Flight Simulation Association (FSA) is an organization of pilots and home flight simulation enthusiasts, not data science experts.

The online surveys used for data collection were conducted anonymously, without randomly selecting respondents. Responses can therefore not be considered representative of the entire pilot or air traffic controller population, nor assigned a margin of error.

Additionally, the survey of certificated pilots only explored those individuals who achieved a Private Pilot License. It did not analyze home flight simulation's impact on subsequent ratings or certificates, nor did it consider those who underwent some amount of flight training but did not achieve their Private Pilot License.

Overall, FSA considers these results a meaningful first step in what could become a more scientific approach to answering the question of what impact home flight simulation could have on real-world pilot and air traffic control training.

ACKNOWLEDGMENTS

Flight Simulation Association wishes to acknowledge the following organizations that supported this survey, either by providing feedback on survey drafts, and/or sharing the survey with their audiences to help gather responses:

Additionally, Flight Simulation Association wishes to thank the 1,212 pilots and flight simulation enthusiasts who answered the survey and provided data, from which these results were derived.

CONTACT

Have questions or comments about this survey? Please reach out using the information below.

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APPENDIX A

Survey Respondent Demographic Information

The three major pilot certificates were all represented in the data, with most respondents holding a Private Pilot Certificate.

PILOT CERTIFICATE BREAKDOWN

- 80% of respondents holding a pilot certificate held an FAA certificate.

- Of the 20% of respondents holding a foreign certificate, representation included 20 issuing authorities, primarily: EASA member states, Canada, and the United Kingdom.

21%

55%

24%

- **Private Pilot Certificate**
- **Commercial Pilot Certificate**
- **Airline Transport**
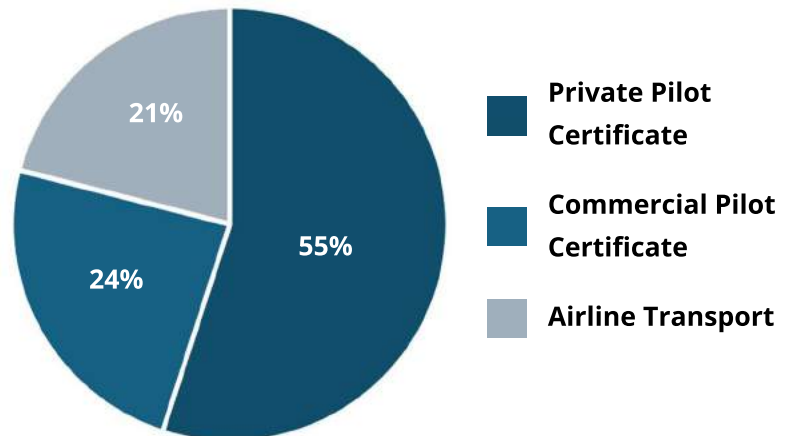
Respondent data was also plotted based on the year in which the Private Pilot Certificate was obtained. Of note, there is representation in the survey from pilots who received a certificate before the advent of home flight simulation. The earliest certificate was earned in 1950, but the first version of Flight Simulator was not released until 1979 by Sublogic.

- 75% of responses were from pilots who received a certificate in or after 1982.

- 45% of responses were from pilots who received a certificate in or after 2004 (release of Microsoft Flight Simulator 2004), 43% in or after 2006 (release of Microsoft Flight Simulator X), and 20% after 2020 (release of Microsoft Flight Simulator).

YEAR PRIVATE PILOT CERTIFICATE WAS OBTAINED
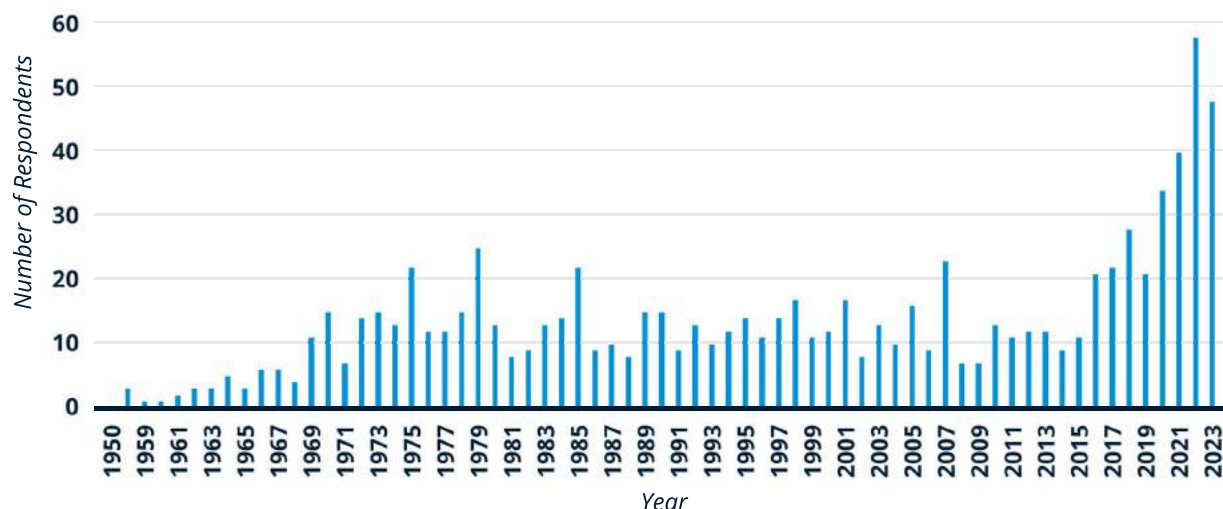
APPENDIX B
FAA Air Traffic Controller Interview Summary

The profiles of the 14 controllers interviewed for Part II of this survey are listed below for reference.

Controller #	Real-World Flight or ATC Experience	Began Online ATC Training	Applied to the FAA	ATSA Result	FAA Academy Class Rank	Successfully Checked Out at First Facility
1	None	2019, while in College	3 years later	Well Qualified	1	Yes
2	Student Pilot, NFCT and FCT Controller Applying on Prior Experience Bid	2012	6 years later	Well Qualified	N/A (CTO Academy)	Yes
3	CPL, Instrument and Muti-Engine Ratings, CTI Graduate	2001, while in High School	7 years later	Well Qualified	N/A	Yes
4	Former FCT Controller	2019	4 years later	Qualified	N/A	Yes
5	PPL, Instrument Rating	2013, while in High School	4 years later	N/A (Did Not Take)	2nd From Last	Yes
6	ATP, CFI, CTI Graduate	2008, while in College	5 years later	Well Qualified	2	Yes
7	None	2013, while in High School	3 years later	Well Qualified	1	Yes
8	PPL	2000, while in High School	5 years later	Well Qualified	N/A	Yes
9	PPL	2013, while in High School	4 years later	Best Qualified	1	Yes
10	PPL, Aircraft Dispatcher	2012, while in High School	4 years later	Best Qualified	1	Yes
11	PPL, Instrument Rating	2013	6 years later	Well Qualified	1	Yes
12	Student Pilot, CTI Graduate, Ramp Controller	2017, while in High School	5 years later	Best Qualified	1	Yes
13	None	2021, while in College	Before Online ATC	Well Qualified	1	Yes
14	CTI Graduate, Ramp Controller	2008, while in High School	4 years later	Well Qualified	1	Yes