A STUDY OF TRAINING DEVICES USED BY FLIGHT TRAINING ORGANIZATIONS

Michael Wiggins, Stephen Hampton,

Derek Morin, Andreas Larssen, and Antonio Troncoso

Embry-Riddle Aeronautical University

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EXECUTIVE SUMMARY

Recent advances in computer technology have created many new devices and computer programs that are being used throughout the flight training industry. Little is known about the exact number and nature of training devices currently in use and there is no central repository of data regarding these various training devices. A survey of 354 flight training organizations was conducted to gain insight into how training organizations use different types of training devices. These organizations included 99 universities, 153 Part 141 flight schools, and 102 Part 61 flight schools. The data revealed that 381 flight training devices (FTDs), 224 Personal Computer Aviation-Training Devices (PCATDs), and 99 other types of training aids (OTAs) are being used in various combinations in private and commercial pilot certificate programs and instrument and multi-engine rating programs. The data revealed that university programs make more use of these devices on average than do non-university Part 141 and Part 61 schools. Flight training devices are still the largest number of devices in use and instrument rating programs use these devices more than do the other types of training. A large number of universities are making use of a computer program that is available to the general public even though no credit is allowed under current regulations for its use. Most FTDs are certificated as Level 1 devices under the guidelines of Advisory Circular AC120-45A, Airplane Flight Training Device Qualification (FAA, 1992). The data also reveals several demographic data about the responding schools, manufacturers and models of the devices reported, numbers of schools using various devices, and amounts of use.

INTRODUCTION

The use of flight training devices (FTDs) and personal computer-aviation training devices (PCATDs) are becoming more prevalent in today's flight training organizations. Advances in technology permit greater use of different training devices for training and evaluating flight students. Because of increases in the complexity of the National Airspace System, increases in air traffic, and increases in airplane and fuel costs, many training organizations are using training devices more than ever before. These devices can provide in-depth training and provide a very positive high transfer of learning (by Lintern, Roscoe, Koonce, & Segal, 1990; Hampton, Monroney, Kirton, & Biers, 1994; Taylor, Lintern, Hulin, Talleur, Emanuel, & Phillips, 1997).

The Federal Aviation Administration (FAA) recognizes the value of training devices by awarding credit for their use in training in general aviation and airline pilot certification and qualification (FAA, 1992; 14 CFR Part 61, 2002). For example, 20 of the 40 hours of flight training required for an instrument rating and up to 50 hours can be done in an FTD that has been approved by the FAA. Training for a commercial certificate done under 14 CFR Part 142 can use up to 100 hours in approved devices (14 CFR Part 61, 2002).

In May 1997, the FAA approved the PCATD (FAA, 1997). A PCATD is a training device that uses a personal computer to run a program that emulates an airplane cockpit, and has control input devices that also emulate airplane controls. The cost of a PCATD is significantly less than an FTD (Koonce & Bramble, 1998). An entry level FTD can cost tens of thousands of dollars whereas a PCATD can cost only a few thousand dollars. The maintenance and operational costs of a PCATD are significantly lower than that of an FTD.

The approval of the PCATD for the flight training toward the instrument rating created some interesting options for the general aviation flight schools. In the time since the FAA approved the use of PCATDs for instrument training programs, PC-based flight simulators have developed rapidly (Hampton, 1997). Flight training schools started to use PCATDs in conjunction with other training aids (OTAs) that many consider games. While these devices are not FAA-approved, they can be used effectively for informal flight training. These devices include Microsoft Flight Simulator and other computer programs that are designed for flight and communication training. The programs are commercially available through most large pilot shops and electronic stores.

Currently, the number of devices in use, the types of these devices, and how these devices are integrated into training programs is unknown. There is no central repository of information regarding the make and models of training devices currently being used. Therefore, no data exists about the number of devices in use, the makes and models of these devices, or for what level of pilot certification they are being used. Without this data, it is difficult to determine the extent to which these types of training devices are being used and what credit can be awarded based on rapid advances in fidelity and sophistication.

Statement of the Problem

There are FAA approved and non-approved training aids in use by flight training organizations across the country. Currently, there is no valid data indicating what types of training devices are being used and what levels of training for which they are used. It is not clear if they are used in formal training, informal training, or simply used for individual practice. This makes it difficult to understand the true effect these devices have on today's flight training environment.

Before any study can be done to determine and validate the effectiveness of these various training devices, data needs to be collected about the number in use, the makes and models in use, and for what levels of training they are being used. It is assumed that flight training organizations would not invest in devices for which they felt had no training value, either by reducing costs, increasing safety, or enhancing the overall training effectiveness.

The purpose of this study was to collect data about training devices used by flight training organizations so an electronic database can be created. This database can then be used to reveal data about the devices that are being used in flight training programs in general aviation.

METHOD

Subjects

The subjects used for this study were UAA member institutions (UAA schools), a sample of flight schools operating under CFR14 Part 141 (Part 141 schools), and a sample of schools operating under CFR 14 Part 61 (Part 61 schools). Data from the UAA listed 113 institutions as having aviation programs of some sort (Kiteley, 1999). No sampling technique was used as all 113 institutions were targeted in this study. In all cases, the UAA schools were FAA-approved 141 schools. For the purpose of this report, no distinction is made between a college and a university.

A total of 433 Part 141 schools were identified from the Advisory Circular AC 140-2DD, FAA Certificated Pilot Schools Directory, dated September 5, 2001. The UAA schools listed in this advisory circular were eliminated in an attempt to identify FAA approved flight schools that were not part of a college or university. Part 61 schools were randomly selected from a website developed by the "Be-A-Pilot" (GA-Team 2000, 2002) promotional campaign administered by GA Team 2000, Inc. This listing of flight schools was the most comprehensive list available for Part 61 schools.

Instrument

The development of the questionnaire began in the spring of 2001. No standardized instruments were currently available to collect the data needed to evaluate the hypothesis, so a questionnaire was developed based on an instrument under development at The Ohio State University. Throughout the development of the instrument, subject matter experts at ERAU

reviewed it for both content and the construction. The UAA simulation committee members and the representatives from the FAA reviewed drafts of the survey for content, face validity, and overall layout. Suggested changes were made and the instrument was then subjected to a pilot study. The cover letter accompanying the instrument was also subjected to the same review process.

A pilot study was conducted at three institutions in central Florida that offer aviation programs. The length of the questionnaire, wording for the cover letter, the demographic section, and the content of the questionnaire were the focus of this pilot study. Comments and suggestions from the pilot study were used to develop the final instrument. After the pilot study, the instrument was assumed to be valid.

The instrument consisted of two parts: demographic questions about the institution and the kinds of training devices used by the institution. The demographic section included questions for type of training environment, number of students trained yearly and currently, percent of students that use simulation devices and if the simulation devices are used for examinations. The second section of the questionnaire asked for the type of training device, number in use, type of training done, hours of use per week, if the device is FAA approved, and if the device is used in conjunction with a training course outline which is approved under 14 CFR Part 141. A copy of the cover letters and the instrument are in Appendix A.

Design

The study was descriptive and used a questionnaire to collect the data either by mail or telephone. All UAA institutions were used as a population for the data collection so no sampling techniques was used for this group. For Part 141 schools, surveys were sent to all 433 schools. Follow-up telephone calls were made to elicit as many surveys as possible. A random sample of Part 61 schools was surveyed via telephone.

Procedures

During the summer of 2001, a list of 113 UAA institutions that offered aviation programs was obtained from the UAA office. All institutions on the list were called to verify name and address before mailing the questionnaire. In July 2001, 113 questionnaires were mailed. After the first mailing, 50 questionnaires were returned. Several of the UAA institutions included on the first mailing reported their flight training was contracted out to local flight schools, did not offer flight training, or did not own training devices. All non-responding institutions were contacted via telephone as a means of follow-up. Based on the data collected, the number of UAA institutions that offer flight training programs was reduced to 95. In September 2001, 45 questionnaires were sent out in a second mailing. This resulted in 10 more surveys returned by mail. At the end of October 2001, researchers attended the UAA Annual Meeting held in Nashville, Tennessee. During this meeting, 15 more surveys were completed. Since the database would be incomplete without one hundred percent compliance, the remaining 20 institutions were repeatedly contacted via telephone until all institutions had responded. By December 2001, responses had been obtained from all 95 UAA institutions with flight training programs.

In June 2002, development began on a mailing list for Part 141 schools. The best source of this data was the Advisory Circular AC 140-00DD, FAA Certificated Pilot Schools Directory (FAA, 2002). As the mailing list was developed, UAA schools were eliminated to prevent duplication of data. A total of 433 schools were identified. It should be noted that telephone numbers for the schools are not listed in the Advisory Circular. Surveys were mailed in mid-August 2002. By the end of September 2002, 93 of the surveys were returned. Because of the lack of telephone numbers in the FAA Certificated Pilot Schools Directory, follow-up activities were difficult. Telephone numbers were located using various methods, most notably, the "Be-A-Pilot" website, discovered by the researchers in mid-October, 2002. An additional 73 surveys of Part 141 schools were completed over the telephone. Of the surveys mailed, 23 were returned because of some problem with the address. Follow-up telephone calls were made or e-mail messages sent to clarify missing or confusing data on some of the surveys. Of the 433 Part 141 schools targeted, 166 eventually responded to the survey, for a return rate of 38.3%. Time restrictions prevented more schools from being contacted.

The "Be-A-Pilot" website was the most comprehensive listing of flight schools found. The site contains over 1600 listings for flight schools. These listings are separated by state. The site makes no distinction between Part 141 schools and Part 61 schools. The only way this could be determined would be to contact each school individually or to check website links if they were provided. Even then, a school's individual website did not always reveal whether or not the school was approved. The best determination that could be made was there were 1076 Part 61 schools listed on the website. Schools were randomly selected by state. A total of 102 Part 61 schools (9.6%) were contacted via telephone and completed the survey.

RESULTS

Respondents

A total of 354 flight training organizations responded to this survey, 99 universities, 153 Part 141 schools (included the 12 schools who identified themselves as airline training centers), and 102 Part 61 schools. It was discovered that of the 166 surveys completed from the targeted Part 141 schools, 13 were from universities, leaving 153 Part 141 schools. The data from these 13 universities were added to the data from the 86 universities previously surveyed, increasing the total number of universities in this study to 99.

Twelve of the Part 141 schools identified themselves as airline training centers. While the original survey had a selection for airline training center, it became clear that as the surveys were returned, there was no consistent definition of what was meant by this terminology. Therefore, these 12 airline training centers are included in the Part 141 data. One university reported they had an airline training center. However, the data for the center were not distinguishable from the university data. For the purposes of this report, no distinction was made and only the university data were reported. One other note is that

during the telephone interviews, several schools reported they conduct training under both Part 141 and Part 61. In these cases, the data was reported under Part 141.

Three schools reported using full-flight simulators (FFS). Two schools reported having one FFS each and one school reported having two FFSs, for a total of four. While one of these three reported using their FFS in an approved curriculum, it was not used for any level of certification covered in this study. One institution reported using it for multi-engine training, but not as part of an approved curriculum. This institution is known to use this device for airline-type prep training beyond multi-engine certification. These FFSs are not discussed as part of this report.

Of these 99 universities, 95 reported using training devices in their programs. Forty-three universities reported using FTDs and eight reported using PCATDs. An additional 44 universities reported using training devices in combination. Of the 433 targeted Part 141 schools, 153 responded, for a response rate of 35.3%. Of the 153 Part 141 schools, 108 reported using some sort of training device. Fifty-one schools reported using FTDs, 41 reported using PCATDs, and 4 reported using OTAs. Twelve schools reported using these devices in some sort of combination.

Of the 1076 identified Part 61 schools, 102 completed the survey, for a response rate of 9.6%. Forty-seven Part 61 schools reported using some sort of training device in their programs. Of these 47 schools, 16 reported using FTDs, 26 reported using PCATDs, and 4 reported using OTAs. One school reported using both FTDs and PCATDs. This data is summarized in Table 5.

Demographic Data

The following demographic data was collected from the five questions in Part 1 of the survey instrument. The data is summarized in Table 1. Several schools reported zeros for Questions 2, 3, and/or 4 on the surveys. Also, during the some of the phone surveys, the person responding did not know the figures, in which case, the answer was recorded as zero. In the case of Question 5, it makes sense that schools without any device would report a zero. Zeros were not included in the calculation of averages, and/or minimum and maximum figures as they are missing data, and do not reflect true enrollments or usage. Only those schools that reported numbers greater than zero were used to calculate these figures. The totals for the student trained annually and currently enrolled in Table 1 include all schools.

Question 1: What is your type of training environment?

A total of 354 flight training organizations responded to this survey: 99 indicated they were a university, 153 reported they were a Part 141 school, and 102 reported they were a Part 61 school. As previously noted, the data for those identifying themselves as an airline training center was included in the Part 141 data. The data for the one university that reported having an airline training center was included with that university's data.

Question 2: How many students do you train yearly?

Of the 354 schools responding to the survey, 328 reported data on the number of students trained annually. The average number of students trained annually for universities (n = 97) was 169.3, with a high of 1500 students and a low of 6 students per year. Part 141 schools (n = 141) trained an average of 160.1 students annually, with a high of 5000 students and a low of 6 students. The school reporting 5000 students trained annually was a helicopter training facility. Part 61 schools (n = 90) trained an average of 64.1 students annually, with a high of 400 students and a low of 3 students.

Question 3: How many students are currently enrolled in your training program?

Of the 354 schools responding to the survey, 327 reported data on the number of students currently enrolled. The average number of student current enrolled in universities (n = 97) was 171.8, with a high of 1500 students and a low of 10 students. Part 141 schools (n = 139) had an average current enrollment of 61.3 students, with a high of 400 students and a low of 5 students. Part 61 schools (n = 91) had an average current enrollment of 39.5 students, with a high of 300 students and a low of 2 students.

Question 4: Approximate percentage of your students use these devices for training?

Of the 354 schools, 243 reported figures on the percentage that their students use training devices in their flight courses. Universities (n = 95) reported that an average of 78.0% of their students use training devices in their programs, with 100% being the highest percentage reported and 1% being the lowest reported. Part 141 schools (n = 107) reported an average of 53.3% of their students use training devices, with 100% being the highest percentage reported and 1% being the lowest percentage reported. Part 61 schools (n = 41) reported an average of 32.5% of their students use training devices, with the 100% being the highest percentage being reported and 3% being the lowest percentage reported.

Question 5: Do you use any of these devices for check rides or examinations? If so, which check rides or examinations?

A total of 33 schools reported they use training devices for checkrides: 15 universities and 18 part 141 schools. No Part 61 schools reported using them for such purposes. A total of 28 schools reported using training devices for some type of examination: 18 universities, 10 Part 141 schools, and 0 Part 61 schools. One institution reported using a device as part of a pre-hire screening program for a regional airline. It is assumed this evaluation is not part of any flight training program. The data did not reveal any clear information regarding which checkride or examination for which the devices are used. It is possible that the schools are reporting the devices that are used for FAA computer written test applications, but the exact use was not revealed. This data is tabulated in Table 8.

Table 1

Demographic Information of Surveyed Organizations

	Universities	Part 141	Part 61
Number of schools in study	99	153	102
Total students trained annually	16,419	22,581	5,769
Average students trained annually	169.3	160.1	64.1
Highest number of students trained annually	1,500	5,000	400
Lowest number of students trained annually	6	6	3
Total students currently enrolled	16,665	8,514	3,594
Average students currently enrolled	171.8	61.3	39.5
Highest number of students currently enrolled	1,500	400	300
Lowest number of students currently enrolled	10	5	2
Average percentage of students using devices	77.8%	53.3%	32.5%
Highest percentage of students using devices	100%	100%	100%
Lowest percentage of students using devices	1%	1%	3%

Manufacturers and Number of Flight Training Devices

A total of 381 FTDs was reported. These devices were from eleven different manufacturers. Table 2 shows a summary of manufacturers and number of FTDs reported. The largest number by a single manufacturer is 212, which are devices made by Frasca International. The second largest number is 72, which were manufactured by ATC, Inc. The third largest number is 58, which were manufactured by Aviation Simulation Technology, Inc. The largest users of FTDs in this sample were universities, averaging of 2.6 devices per school. The Part 141 schools averaged of 0.7 devices per school whereas the Part 61 schools averaged of 0.2 devices per school.

One school reported the manufacturer of their device as a “CPT.” While this term is commonly used for a cockpit procedures trainer, it is not known whether or not this is the case or if CPT is the actual name of a particular device. The CPT model reported here is an MU-2B, most likely for a Mitsubishi MU-2B turboprop airplane. This device was reported as an FTD, and therefore is included in the FTD data. One issue that is not clear is the manufacturer of the GAT device. Singer-Link used to manufacture a single-engine FTD known as the GAT 1 and multi-engine FTD known as the GAT 2. Environmental Techtonics currently manufactures an FTD known as the GAT-II, which can be certified as a Level 2 FTD or Level 3 FTD. No one reported the manufacturer of these devices as anything other than a GAT. It may be possible that the 4 GAT 2 devices reported are made by Environmental Techtonics, especially considering that the older Singer-Link devices would not likely be certified as anything other than Level 1.

Table 2

FTD Manufacturers and Number of Devices Reported

	Universities	Part 141	Part 61	Total Devices	Schools Reporting*
AST	43	14	1	58	41
ATC	36	24	7	67	41
CPT	0	1	0	1	1
Emulation Systems	0	0	1	1	1
FlightMatic	0	1	0	1	1
FlightSafety Int.	0	4	0	4	1
FLYIT	0	1	0	1	1
Frasca	155	52	5	212	96
GAT	21	0	3	24	8
Mechtronics	0	2	0	2	2
Mitsubishi	3	3	1	7	5
Vector systems	3	0	0	3	1
TOTALS	261	102	18	381	

* Schools cannot be totaled as some have devices from more than one manufacturer.

Manufacturers and Number of PC-Aviation Training Devices

A total of 224 PCATDs was reported. Universities reported a total of 133 devices, Part 141 schools reported a total of 63 devices, and Part 61schools reported a total of 21 devices. These PCATDs were from four manufacturers. Table 3 shows a breakdown of manufacturers and number of PCATDs reported. Forty-seven universities, 51 Part 141 schools, and four Part 61 schools reported using PCATDs. Universities were the largest users with an average of 1.3 devices per school. Part 141 schools averaged 0.4 devices per school whereas Part 61 schools averaged 0.3 devices per school.

The largest number of PCATDs reported was 95 made by Aviation Teachware Technologies, under the name of Elite Personal Simulators. Jeppesen Sanderson, Inc. was the second largest manufacturer with 79 devices being reported. Aviation Supplies and Academics, Inc., was the third largest PCATD in use, with 21 being reported.

Table 3

PCATD Manufacturers and Number of Devices Reported

	Universities	Part 141	Part 61	Total Devices	Schools Reporting *
ASA	19	8	2	29	15
ATT	47	28	20	95	66
Jeppesen	59	19	1	79	36
PFC	8	8	5	21	19
TOTAL	133	63	28	224	

* Schools cannot be totaled as some have devices from more than one manufacturer.

Manufacturers and Number of Other Training Aids

A total of 99 OTAs was reported. Eighty-six OTAs were reported in use by universities, nine OTAs were reported in use at Part 141 schools, and three OTAs were reported in use at Part 61 schools. These devices are from nine manufacturers. The data is contained in Table 4. It should be noted that OTAs include both training devices and training programs run on PC computers. Fourteen universities, seven Part 141 schools, and four Part 61 schools reported using OTAs. The average number of devices per school is not a good measure of relative use because of the small number of schools using them.

The largest number of this type of device is Microsoft's Flight Simulator program, with 74 being reported in use. The second largest number reported is 8, which is the computer program COMM1 VFR and IFR communications training program published by e-publishing group (sic).

One school reported their OTAs as "American Megatrends." A search on the Internet revealed American Megatrends is a manufacturer of computer components and no reference could be found to any aviation application. The model was reported as a Virtual Pilot Pro, which is the name of computer program used for aviation training. These two devices are included in the OTA data. One school reported their device as an Aspire ARC 6100. As with American Megatrends, Aspire appears to be the name of a computer made by Acer, Inc., and not a program. A search on the Internet found no aviation training device or program by this name. This device is included in the data. In this case, it is assumed this school uses this computer to run some sort of computer based aviation training program.

Table 4

OTA Manufacturers and Number of Devices Reported

	Universities	Part 141	Part 61	TOTAL	Schools Reporting*
American Megatrends	0	2	1	3	3
ASA	0	2	1	3	3
Aspire	0	1	0	1	1
ATT	6	0	0	6	1
Diamond	1	0	0	1	1
e-group publishing	6	2	0	8	3
Honeywell GPS trnr	0	1	0	1	1
IFT	2	0	0	2	1
Microsoft	71	1	2	74	15
TOTAL	86	9	4	99	

* Schools cannot be totaled as some have devices from more than one manufacturer.

Combination of Devices in Use

The data revealed many schools use more than one type of device. Only seven schools, all universities, reported using all three types of training devices. Of the universities, 43.4% reported using FTDs as their only training device whereas 33.3% of the Part 141 schools indicated FTDs were their sole type of device. Only 15.6% of the Part 61 schools reported using only FTDs.

With respect to PCATDs, only 8% of the universities reported using them as their sole training device, whereas 26.7% of the Part 141 and 25.5% of the Part 61 schools use them exclusively. The various combinations that training organizations use training devices and aids are depicted in Table 5.

Table 5

Combinations of Devices in Use

	Universities	Part 141	Part 61
FTDs only	43	51	16
PCATDs only	8	41	26
OTAs only	0	4	4
FTDs and PCATDs	30	9	1
FTDs and OTAs	5	2	0
PCATDs and OTAs	2	1	0
FTDs, PCATDs, and OTAs	7	0	0

Flight Training Device Certification Levels

Advisory Circular AC120-45A, Airplane Flight Training Device Qualification, (1992) specifics the requirements for certification of FTDs at seven levels. The data revealed that the levels of certifications for the FTDs in use range from Level 0 to Level 6. Table 6 shows the number of FTDs reported for each level of certification. Only the levels of certification that were reported are shown. There were many cases in which the person making the report was uncertain of the certification level. Most of these data resulted from the telephone call efforts and the person responding either was not sure or simply did not know. If the level was not certain, it was reported as unknown.

Table 6

Level of Certification for FTDs Reported

	Number of Devices
Level 0	3
Level 1	209
Level 2	18
Level 3	35
Level 4	0
Level 5	6
Level 6	1
Level 7	0
Level Unknown	109
Total	381

The data also revealed that of the 381 FTDs in use, 138 of them were reported to have a visual system, 92 were reported to have dynamic control loading. The data does not reveal the number of devices that have both systems on the same device.

Use of Training Devices in Flight Training Programs

The data revealed that most of the reporting schools use training devices in more than one pilot certificate training program. The data collected was limited to four levels of pilot certification and/or ratings, the private and commercial pilot certificate and the instrument and multi-engine ratings. Table 7 shows the number of schools that use each type of device for training leading to each of these four levels of certification. The data does not show if the devices are used as part of an approved curriculum or not for these four types of training programs.

While it can be assumed that most of the schools use FTDs and PCATDs in their programs, it cannot be determined if their use is limited to approved training course outline (TCO) activities only or if they are possibly used for additional training outside or in addition to the approved TCO. It is possible that some schools use them outside of an approved curriculum for individual practice, remediation, or other additional training. It can be assumed that all use of non-approved OTAs is done outside any FAA approved curriculum as no training credit is currently awarded for their use. Table 7 shows the breakdown of the number of schools using each type of device in four training programs: private and commercial pilot certification and also in instrument and multi-engine rating programs. It is interesting to note the number of Part 61 schools reporting use of devices in approved curriculums. This may have resulted from confusion from schools that offer both Part 141 and Part 61 training.

Table 7

Number of Schools Using Training Devices in Training Programs

Universities

	FTDs	PCATDs	OTAs
Private	61	25	9
Instrument	83	45	8
Commercial	56	18	4
Multi-engine	63	14	4

Part 141

	FTDs	PCATDs	OTAs
Private	29	19	6
Instrument	61	49	7
Commercial	40	10	2
Multi-engine	33	17	3

Part 61

	FTDs	PCATDs	OTAs
Private	3	7	2
Instrument	15	26	3
Commercial	4	3	1
Multi-engine	2	2	1

The data in Table 8 shows how many schools reported using devices in approved TCOs. A total of 203 FTDs and 90 PCATDs are used by schools in approved curriculums, but the data does not specify which device is used in which program. Data about weekly use is also included in this table.

Table 8

Schools Using Devices in Approved Curriculum

	University	Part 141	Part 61
Schools using devices in approved curriculum	83	99	31
Schools using FTDs in approved curriculum	73	58	12
Schools using PCATDs in approved curriculum	31	12	18
Average hours per week used- FTD	24.5	21.2	7.8
Average hours per week used- PCATD	24.4	10.2	6.8
Average hours per week used-OTA	13.4	6.7	13.5
Use devices for checkrides	15	18	0
Use devices for examinations	18	10	0

Appendix B shows a complete breakdown of the device type and model by manufacturer, including level of certification. Table C shows the FTDs broken down by manufacturer, model, and certification level.

DISCUSSION

The data suggests that many flight schools are embracing the recent advances in technology to augment their flight training program by using various training devices and computer programs in lieu of flight time in airplane. This makes sense from both economic and pedagogical standpoints. By using training devices, certain aspects of flight training can be done with less expense to the student and flight school while increasing control over the training environment. University programs seem to make more use of some type of device in their programs than do other flight training schools. Universities reported an average of 78.0% of their students use them whereas Part 141 and Part 61 schools reported averages 61.3% and 39.5%, respectively.

The data collected reveals that FTDs are the primary training aid used in flight training programs. Notwithstanding the long history of FTD development and use, it is not surprising that they are the primary devices other than the airplane. Of the 354 reporting training organizations, 162 (40.3%) use FTDs somewhere in their flight training programs. The data showed these devices are from 12 manufacturers. These manufacturers are: Aviation Simulation Technology, Inc., ATC Inc., CPT, Emulation Systems Company, FlightMatic, Flight Safety International, FLYIT, Frasca International, Mechtronix, Mitsubishi, and Vector Systems. The predominate manufacturer of the FTDs reported is Frasca International. Of the 381 reported FTDs, 212 (55.6%) were devices made by Frasca International.

What is interesting to note is the universities seem to make more use of FTDs than do Part 141 schools and Part 61 schools. The average number of devices per university is 2.6 compared to 0.7 devices per Part 141 school and 0.2 devices per Part 61 school. This does seem logical because most university programs are supported by the larger infrastructures

and financial resources of the university that most non-academic training organizations do not have. Economic constraints may limit many smaller schools from purchasing FTDs, especially new ones with costly sophisticated dynamic control loading and visual systems.

Of the 381 FTDS reported, 209 were certified as Level 1 devices. This number probably reflects older devices that were granted this certification level when AC 120-45A was issued. It is interesting to note is that of the FTDs reported, the certification level of 109 devices was unknown to the person reporting the data. This may be an indicator of some confusion that may exist regarding the terminology or other specific information regarding the certification requirements for FTDs. One anecdotal point that reinforces this is that several people who were responding to the survey via the telephone were reporting their FTDs to be simulators. One respondent reported their device to be an "FTD OnTOP." When clarifying this, it was discovered that the individual was actually referring to a PCATD. Other respondents reported their devices to be such things as "fidelity simulators, level 6" and one reported their device to be a "FANT" which was subsequently determined to be an FTD. What this suggests is there is a fair amount of confusion about the terminology of a simulator versus an FTD versus a PCATD in the context of the current regulations and advisory circular definitions.

A total of 224 PCATDs were reported in use. These are made by four different manufacturers; Aviation Supplies and Academics (ASA), Aviation Teachware Technologies (ATT), Jeppesen Sanderson Company, and Precision Flight Control (PFC). It needs to be noted that PFC produces only hardware that may be used with other software. The predominant manufacturer is ATT with 95 of their PCATDs reported in use. As with the case of FTDs, some respondents reported devices like Microsoft's Flight Simulator as both FTDs and PCATDs. One reported the Jeppesen PCATD to be an FTD. This underscores the issue of confusion about terminology that exists in the industry.

At university programs, as with the FTDs, the average number of devices per school suggests they make more use of these types of devices in their programs than do Part 141 and Part 61 schools. Forty-one Part 141 schools reported using PCATDs as their sole training device compared to 51 that solely use FTDs. The data also revealed that 23 Part 61 schools use PCATDs as their sole training device compared to 14 that only use FTDs. The suggestion is that while Part 141 schools tend to make more use of FTDs, the use of PCATDs seems to be an acceptable alternative. However, the shift to using more PCATDs than FTDs in Part 61 schools suggests that economics is a major factor.

One thing to consider is most universities have significantly more computer resources than do non-academic schools. The cost of putting a PCATD into use may be less for them because of the purchasing power of universities, especially when university computers are rapidly upgraded. This makes the previous generation of surplus computers more accessible and affordable. Also, because university programs are more under the control of professional educators, the value of these types of devices may be perceived to be higher than it is in non-academic schools.

PCATDs seemed to be used more by Part 61 schools than do FTDs. One major reason may be the acquisition and maintenance costs of PCATDs are significantly less than those associated with FTDs. One point to consider is whether or not students are as willing to pay for time on a PCATD as they are for time in an FTD. This is not a question of the efficacy of the PCATDs but of the perceived value of their use for a fee by students.

There were 99 OTAs reported. The primary one used was Microsoft's Flight Simulator with 74 being reported. This program has a fairly sophisticated visual system when you consider the cost of the program is minimal compared to FTDs and even to some PCATDs. It can be operated on most computers with the simple addition of an inexpensive joystick to the computer. Other OTAs reported included part-task trainings, such as the GPS trainer by Honeywell and the COMM1 VFR/IFR communications training computer program made by e-publishing group (sic) as well as PCATD programs that lack the cockpit-like control input devices.

It appears that the use of these types of devices and programs are enhancements to the regular flight training curricula, as they cannot be used for credit according to the current training regulations. This does not mean they are not effective. In many cases, the use of these devices may reduce the actual training hours in aircraft, FTDs, and PCATDs. While no data exists to support this idea, the mere fact that many training organizations use them lends some support that they are effective in some way or another. Universities were again the largest users of OTAs. While the regulations allow for certain credit to be given for training done in approved FTDs and PCATDs, no credit is currently allowed for training done using OTAs. While credit is allowed for using FTDs in all levels of training, it is assumed that the use of PCATDs and OTAs in private, commercial, and multi-engine training is done in addition to the regulatory training hours. This use could be for conceptual or procedures training, remediation, or simply additional practice without the student incurring the costs of airplane or FTD training time. Also, these devices could be used for individual practice without an instructor being present.

The largest use of any type of training devices was in training programs for the instrument rating. This makes sense, as most all of these devices and programs are primarily designed for instrument training, whether it is conceptual training, procedures training, or skills training. Of the 354 schools in this survey, 159 (44.9%) use FTDs, 120 (33.9%) use PCATDs, and 18 (5.1%) use OTAs for instrument training.

The next level of training that showed a high use of training devices was training leading to the private pilot certificate. Of the 354 schools, 93 (26.2%) reported using FTDs, 51(14.2%) reported using PCATDs, and 17 (4.8%) reported using OTAs. For commercial pilot training, 100 (28.2%) schools reported using FTDs, 31 (0.9%) schools reported using PCATDs, and 11 (3.5%) schools reported using OTAs. Ninety-six (26.7%) schools reported using FTDs for multi-engine training while 31 (8.8%) schools reported using PCATDs, and 7 (1.9%) schools reported using OTAs.

What is not clear is how much each device is used in any particular curriculum. What the data does not show is in which curriculum are these devices approved for use. Also, the

data does not show whether or not the hours students gain while training in these devices are used to meet the minimum hours required for certification.

It is interesting to note that seven universities reported using all three types of training devices in their programs. This seems to indicate that there is value to be gained by their use, otherwise the schools would not have invested in them. Also, 75 schools reported using PCATDs only in their programs, indicating that while these schools may not be able to afford the cost of a certified FTD, the cost of the PCATD may be such that they are able make use of them. It is not clear from the data why 110 schools use only FTDs in their programs. Whether or not this is a cost issue or a resistance to new technology is unclear. The data regarding the weekly use of these devices is inconclusive because several schools failed to report these numbers. The numbers that were reported show that these devices are used a considerable amount. It is interesting to note the numbers for the FTDs and PCATDs show very similar use in terms of hours per week.

There are some limitations that need to be considered when reviewing this data. First, because of the response rate from the Part 141 schools, (35.1%) it cannot be assumed that the data is completely generalizable to the entire population. The reasons that schools chose not to participate are not known. It may be that because they did not use any devices in their programs, they felt it was not necessary to participate. If this is the case, data from the complete population may show less overall use than is indicated by these numbers. Second, when several of the schools were contacted via telephone, the person answering the survey did not have complete knowledge of data requested, such as the exact type of devices, certification level, etc. This could answer why the data identified some devices that are not generally known to be aviation-related training devices or programs, but are names of the computer devices or generic names.

RECOMMENDATIONS

This study attempted to gain insight into the types of training devices, training aids, and programs used in flight training programs in flight schools across the country. One issue that is not clear from the data is what maneuvers or piloting tasks are being taught in these devices. Also, it is not known which learning domains these devices target. It stands to reason that some devices may be better suited to teaching psychomotor skills while others may only be effective for cognitive tasks. Also, it would be interesting to discover if any effort is made to use these devices to teach decision-making. Another interesting issue that needs to be explored is how these devices are used. If these devices are used to conduct training the same as it is done in the airplane, then the only difference would likely be the overall cost of the instructional period. What needs to be discovered is if any operator is using these devices in ways that break with traditional flight training and the efficacy of these methods. Therefore, the following recommendations are made.

1. To gain better insight into the maneuvers and piloting tasks taught in training devices, a study to determine what areas of operation and tasks, as defined in the practical test standards (PTS), should be conducted. This would provide more insight into how the

industry is using these various training devices to train pilots at various certification levels. Maneuvers and piloting tasks should be based on the areas of operation and tasks defined by the PTS so to standardize terminology and yield consistent results. This study should also attempt to discover if these devices are being used in a traditional manner or if any innovative techniques are employed. This study should also attempt to gain insight into which learning domain is by the use of these devices.

2. While previous studies have attempted to determine the effective transfer of learning from these devices, a study should be conducted to determine if and how each of these devices can be used to enhance the skill levels of today's pilots and to aid in the maintenance or enhancement of the skills necessary to remain current and safe in ways that are different from traditional flight training.

3. Studies should be done to see if the credit allowed for the use of training devices could be increased because of the increased sophistication. As overall flight training costs are increasing, the proper and effective use of aviation related training devices may help keep overall training costs reasonable, allowing for continued growth in general aviation and to maintain a supply of properly trained pilots for airlines, corporate aviations, and other flying careers.

4. Develop some method of informing those in aviation education and flight training about the proper nomenclature regarding training devices. While this does exist in several advisory circulars and other material, old terminology and confusion seems to remain in the flight training industry.

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APPENDIX A

Samples of Cover Letters and Survey Instrument

September 1, 2001

MEMORANDUM

TO: University Aviation Association Institutions

FROM: University Aviation Association Simulation Committee

SUBJECT: Use of Training Devices in Flight Education Curricula

The FAA is conducting a survey in order to determine the make and models of General Aviation training devices currently used, and also how many of those are used by UAA institutions.

Because you are identified as your institutions designated representative, the survey has been sent to you. If you are not the appropriate person to complete the survey, we respectfully request that you give this form to the appropriate person.

Should you need further information about the survey, please feel free to call us at (904) 226-6797 or send an email to: Steve Hampton at hamptons@db.erau.edu.

Thank you for your assistance in this matter.

August 5, 2002

TO: FAA Part 141 Approved Flight Training Centers

FROM: University Aviation Association

SUBJECT: Use of Training Devices in Flight Education Curricula

With the rapid increase in technology, many new training devices are now in use in the flight training industry. Unfortunately, there is no real idea regarding the extent these devices are actually being used. Embry-Riddle Aeronautical University and the University Aviation Association are continuing an FAA-funded study regarding the use of various training devices currently used by general aviation flight training organizations. The first phase of this study involved collegiate aviation organizations. Now we are seeking input from Part 141 approved flight schools and selected Part 61 operations.

Please note the information gained from this survey will be used to simply illustrate the current use of training devices in general aviation and provide direction for follow-on studies. Information from this study will be provided to the FAA in aggregate format and individual information will remain confidential.

The chief flight instructor, director of training, or some other individual who has knowledge of the devices used in your organization should complete this survey. If you are not the appropriate person to complete the survey, we respectfully request that you forward this form to the proper representative.

If you have any questions about the survey, please feel free to contact to me at wigginsm@erau.edu, telephone 386-226-7030, or my research assistant, Derek Morin morind@erau.edu, telephone 386-226-6776.

Thank you in advance for your time and for working with us to improve flight training.

Sincerely,

Dr. Mike Wiggins

Please respond first to some demographic questions about your school.

1. What is your type of training environment?
    a. University
    b. Airline training center
    c. FBO

2. How many students do you train yearly? _____

3. How many students are currently enrolled in your training program? _____

4. Approximate percentage of your students use these devices for training?_____

5. Do you use these devices for check rides or examinations? If so, which check rides or examinations?
_____

For the devices in use at your school, please enter a numeric value or circle the appropriate answer. For devices listed as "Other" please write in the device make and model and complete the remainder of the row. Please **print** clearly.

*Pneumatic or Electric Control Loading – Not Spring Loading

FTD Types	# In Use	Visual Display	* Dynamic Control Loading	If Approved, What FAA Level	Used for What Type of Training (P) Private (I) Instrument (C) Commercial (M) Multi-Engine	Approximate Hours of Use Per Week	Approved For Use In FAA Curriculum
AST							
201		Y / N	Y / N		P I C M		Y / N
300		Y / N	Y / N		P I C M		Y / N
Hawk		Y / N	Y / N		P I C M		Y / N
ATC							
510		Y / N	Y / N		P I C M		Y / N
610		Y / N	Y / N		P I C M		Y / N
810		Y / N	Y / N		P I C M		Y / N
Emulation Systems							
200		Y / N	Y / N		P I C M		Y / N
FRASCA							
131/2		Y / N	Y / N		P I C M		Y / N
141/2		Y / N	Y / N		P I C M		Y / N
242/ (T, J)		Y / N	Y / N		P I C M		Y / N
GAT							
-1		Y / N	Y / N		P I C M		Y / N
-2		Y / N	Y / N		P I C M		Y / N
-3		Y / N	Y / N		P I C M		Y / N
Inverted-A							
Minisimulator		Y / N	Y / N		P I C M		Y / N
Mechtronix							
Ascent		Y / N	Y / N		P I C M		Y / N
Pacer Systems							
Mark 2		Y / N	Y / N		P I C M		Y / N
Vector Systems							
Victory One		Y / N	Y / N		P I C M		Y / N
List Other FTDs							
_____		Y / N	Y / N		P I C M		Y / N
_____		Y / N	Y / N		P I C M		Y / N
_____		Y / N	Y / N		P I C M		Y / N
_____		Y / N	Y / N		P I C M		Y / N
_____		Y / N	Y / N		P I C M		Y / N

For the devices in use at your school, please enter a numeric value or circle the appropriate answer. For devices listed as "Other" please write in the device make and model and complete the remainder of the row. Please **print** clearly.

FAA Approved PCATD's	# In Use	Visual Display	Used for What Type of Training (P) Private (I) Instrument (C) Commercial (M) Multi-Engine	Approximate Hours of Use Per Week	Approved For Use In FAA Curriculum
ASA		Y / N	P I C M		Y / N
ATT Elite		Y / N	P I C M		Y / N
Jeppesen FS - 200		Y / N	P I C M		Y / N
Precision Flight Controls		Y / N	P I C M		Y / N

Non-Approved Simulation Devices					
IFT - PRO		Y / N	P I C M		Y / N
Microsoft Flight Simulator		Y / N	P I C M		Y / N
X-Wing		Y / N	P I C M		Y / N
List Other Non - Approved Simulation Devices					
_____		Y / N	P I C M		Y / N
_____		Y / N	P I C M		Y / N
_____		Y / N	P I C M		Y / N

If you would like to receive a summary of the results from the survey please provide your e-mail address_____

APPENDIX B

Summary of Devices Reported

Mfg	Model	Type	Sum Of Qty
American Mega Trends	Virtual Pilot Pro	Training Aid	3
ASA	ASA	PCATD	29
ASA	On Top	Training Aid	3
Aspire	ARC 6100	Training Aid	1
AST	200	FTD	3
AST	201	FTD	4
AST	300	FTD	41
AST	Hawk	FTD	10
ATC	112H	FTD	1
ATC	610	FTD	35
ATC	710	FTD	13
ATC	810	FTD	16
ATC	920	FTD	2
ATT	Elite	PCATD	95
ATT	Elite	Training Aid	6
Boeing	B-727	FFS	3
CPT	MU-2B	FTD	1
Diamond	Katana	Training Aid	1
e-group publishing, inc.	Comm 1 VFR/IFR	Training Aid	8
Emulation Systems	200	FTD	1
Flight Safety	BE58	FTD	4
FLIGHTMATIC	FLIGHTMATIC	FTD	1
FLYIT	FLYIT	FTD	1
FRASCA	125	FTD	1
FRASCA	131/2	FTD	22
FRASCA	141/2	FTD	149
FRASCA	241	FTD	7
FRASCA	242/J/T	FTD	28
FRASCA	B737-400	FFS	1
FRASCA	Bell 206/407/427/412	FTD	4
FRASCA	C-90B	FTD	1
GAT	1	FTD	17
GAT	2	FTD	4
GAT	3	FTD	3
Honeywell	KLN89B	Training Aid	1
IFT	PRO	Training Aid	2

Mfg	Model	Type	Sum Of Qty
Jeppesen	FS-200	PCATD	13
Jeppesen	FS200AC	PCATD	65
Jeppesen	JT20 3030	PCATD	1
Mechtronics	Ascent	FTD	1
Mechtronics	CRJ	FTD	1
Microsoft	FS2000	Training Aid	70
Microsoft	FS98	Training Aid	4
Mitsubishi	Motus 322i	FTD	1
Mitsubishi	Motus 6	FTD	5
Mitsubishi	Motus 621	FTD	1
PFC	Cirrus	PCATD	22
Vector Systems	Venture P71	FTD	2
Vector Systems	Venture P72	FTD	1

APPENDIX C

Summary of Flight Training Devices and Certification Levels

Mfg	Model	FAA_Lvl	SumOfQty
AST	200	1	2
AST	200	3	1
AST	201	1	3
AST	201	3	1
AST	300	0	1
AST	300	1	28
AST	300	2	1
AST	300	3	2
AST	300	U*	9
AST	Hawk	1	1
AST	Hawk	3	8
AST	Hawk	U*	1
ATC	112H	U*	1
ATC	610	1	18
ATC	610	U*	17
ATC	710	1	10
ATC	710	U*	3
ATC	810	1	8
ATC	810	U*	8
ATC	920	1	1
ATC	920	U*	1
CPT	MU-2B	U*	1
Emulation Systems	200	U*	1
Flight Safety	BE58	5	4
FLIGHTMATIC	FLIGHTMATIC	U*	1
FLYIT	FLYIT	U*	1
FRASCA	125	1	1
FRASCA	131/2	1	5
FRASCA	131/2	2	1
FRASCA	131/2	3	2
FRASCA	131/2	U*	14
FRASCA	141/2	0	2
FRASCA	141/2	1	78
FRASCA	141/2	2	10
FRASCA	141/2	3	19

Mfg	Model	FAA_Lvl	SumOfQty
FRASCA	141/2	U*	40
FRASCA	241	1	6
FRASCA	241	5	1
FRASCA	242/J/T	1	20
FRASCA	242/J/T	2	2
FRASCA	242/J/T	3	2
FRASCA	242/J/T	5	1
FRASCA	242/J/T	U*	3
FRASCA	Bell 206/407/427/412	1	4
FRASCA	C-90B	U*	1
GAT	1	1	15
GAT	1	U*	2
GAT	2	1	3
GAT	2	2	1
GAT	3	1	3
Mechtronics	Ascent	U*	1
Mechtronics	CRJ	6	1
Mitsubishi	Motus 322i	2	1
Mitsubishi	Motus 6	2	2
Mitsubishi	Motus 6	U*	3
Mitsubishi	Motus 621	U*	1
Vector Systems	Venture P71	1	2
Vector Systems	Venture P72	1	1

* U means level of certification is unknown.