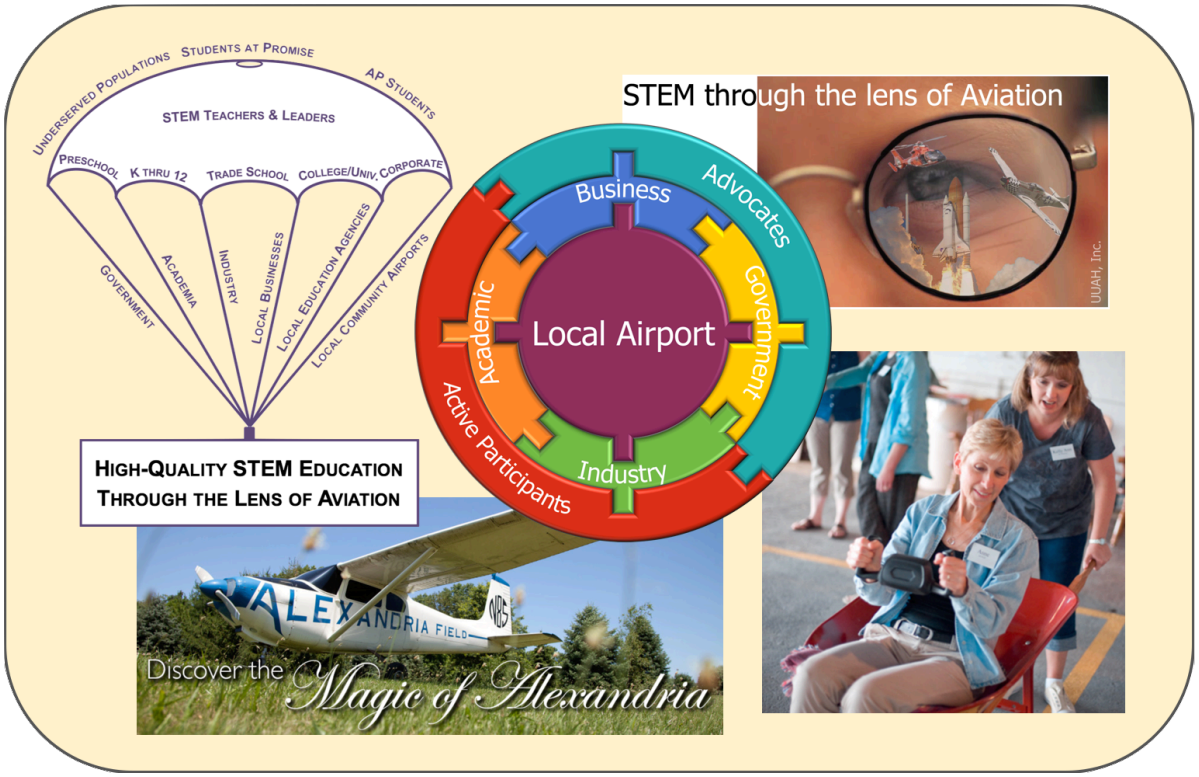
Effective Outreach: Preserving General Aviation by Putting the "Public" in Public-Use Airports

A Case Study Using a Small Airport as a Living Laboratory for STEM



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Abstract

This paper discusses seventeen years of experimentation and research exploring non-traditional uses and alternative revenue streams for airports and airport businesses. Lessons learned from successful and unsuccessful programs are presented, and barriers to change are identified.

The central thesis is that by increasing the social value of general aviation airports with effective outreach and high-quality, aviation-themed STEM education, airports can be positioned as valued community assets.

Keywords: outreach, STEM, airport, aviation, preservation, collaborative, pilot

I. Introduction

Many initiatives are under way in an attempt to arrest our nation's freefalling STEM education system and respond to future STEM workforce needs.[1] Transportation has been identified as a vital STEM area, and the aviation sector in particular offers a unique gateway into STEM fields.

Unfortunately, one-in-four public-use airports in the U.S. has closed since 1969, with slightly more than 5,000 of them remaining.[2] Even though airports are STEM-rich environments and could be an integral part of the solution to the nation's STEM problem, most are underutilized as educational resources.

This paper presents the results of seventeen years of experimentation and research exploring non-traditional, STEM-related uses and alternative revenue streams for small airports. Central to these efforts was a yearlong demonstration project funded by a Garrett A. Morgan Technology and Transportation Education Program (GAMTTEP) grant.[3] Alexandria Field (N85), a privately owned, public-use airport, was the nexus of grant activities. Co-author Linda Castner, also co-owner/operator of Alexandria Field, served as Program Director.

The grant helped fund the formation of the Central Jersey GAMTTEP Collaborative (the Collaborative), which represents a partnership between a small airport and local school districts, universities, businesses, and community organizations. During a one-year period, $100,000 of grant funding, $50,000 of in-kind donations, and hundreds of hours contributed by volunteers were leveraged into more than twenty programs. Women and minorities were targeted to nurture populations that remain largely underrepresented in STEM and transportation. Thus, high-quality STEM education was advanced, while promoting diversity in STEM fields.

Follow-on efforts guided by the Collaborative model are presented as well. Critical lessons learned and potential barriers that may be preventing the aviation industry from seeing non-traditional ways local airports can be used are identified.

II. Purpose

The purpose of this paper is to show how a shift in traditional thinking about the role of small airports not only can result in an increase in their value to communities, but also can provide new revenue-producing activities for airports. This is accomplished by:

1. Promoting an appreciation for the untapped value of community airports as resources for STEM education and workforce development.

2. Inspiring stakeholders to adopt and adapt the lessons learned from this case study.

3. Heightening awareness of the connection between factors contributing to the reluctance by many individuals—especially women and minorities—to visualize themselves as

[1] STEM: Science, Technology, Engineering, and Math
[2] "Administrator's Fact Book," (FAA, June 2012, available https://permanent.access.gpo.gov/lps112214/lps112214/www.faa.gov/about/office_org/headquarters_offices/aba/admin_factbook/index.htm), p 16.
[3] See http://alexandriafield.com/history-of-gamttep/

capable of piloting an aircraft, as well as the challenges stakeholders face in attracting qualified individuals to, and retaining them in, aerospace and other STEM careers.

4. Encouraging the inclusion of community airports as legitimate stakeholders in critical discussions about:

    a. The National Strategic Framework for Transportation Workforce Development and the development of policy setting between Transportation, Education, and Labor Departments at all levels; and,

    b. Overall STEM education and workforce development.

5. Demonstrating to aviation stakeholders in particular that the future of general aviation depends on:

    a. Recognizing the potential of airports as more than merely places where pilots are trained, airplanes are kept, and fuel is sold;

    b. Positioning small airports as community resources with positive economic and social impacts; and,

    c. Creating alternative revenue streams for airports and airport businesses.

III. Historical Linkage Between Small Airports and STEM

The influx of military pilots returning home to civil pursuits after WWII spawned unprecedented growth in general aviation. Communities soon realized the economic value of local airports, and incentives for building airports were shared by public and private sectors. Many airports were designated part of the National Plan of Integrated Airport Systems (NPIAS). True public-private partnerships resulted wherein individuals across the country became responsible for thousands of nodes in the national transportation system.

Young people also migrated to these community airports and were exposed to the myriad STEM disciplines associated with building and flying airplanes, and operating and maintaining airports. Passions were kindled that led to innovations in aerospace and other fields, including today's burgeoning race to commercialize space. The linkage between community airports and STEM education is relevant now to the development and implementation of initiatives suggested in the September 2011 Memorandum of Understanding to promote aviation and space education, and aerospace workforce development.[4] The existing network of public-use airports offers a readymade resource for a coordinated program of STEM workforce development.

IV. Run-up to GAMTTEP

The case study made possible by the GAMTTEP grant was the culmination of a decade of research, development, and tenacious effort by numerous individuals, most notably co-author Linda Castner.

[4] See https://www.transportation.gov/sites/dot.dev/files/docs/Aviation_Workforce-Mgmtce_6-21-2012.pdf

With diverse backgrounds in corporate health and wellness, as well as collegiate coaching of female athletes to achieve peak performance, Castner had demonstrated a lifelong passion for helping children and women to excel. She began her career in aviation in 1993 as co-owner/operator of her family airport. The nagging question, "Why don't more women want to learn to fly?" drove Castner to conduct a five-year research project.

An association was discovered between an aversion by women to the physical risk taking associated with flying an airplane and their overall attitudes about new learning, leadership, and career options. Consequently, an aviation-themed workshop was developed that focused on cultivating three key leadership traits: *confidence*, *adaptability*, and *collaboration*. Workshop research was assisted with grants from the New Jersey Department of Transportation and the Wolf Aviation Fund. [5,6]

Significantly, these workshops were not intended to create more women pilots. They were designed to empower women to achieve peak performance in their daily lives. Combining carefully facilitated discussions on the ground with piloting general aviation airplanes in flight, the workshops harnessed not only the power of key aviation metaphors, but also the influence of adrenaline to facilitate and retain new learning.[7]

Independent research and modeling of transportation stakeholders and their involvement in STEM education and workforce development identified the workshops as a best practice.[8]

Forming Partnerships

Rutgers University was an academic member of the FAA's Centers of Excellence (COE). Rutgers also had a program dedicated to female faculty involved in STEM. Discussions with leaders from the FAA COE and Rutgers' Office for the Promotion of Women in Science, Engineering, and Mathematics pointed Castner to the GAMTTEP opportunity. This led her to establish the business-education partnership with Hunterdon Central Regional High School (HCRHS) that would qualify for the grant in 2010.

V. Representative Programs during GAMTTEP

Highlights of some of the more than twenty programs conducted under the GAMTTEP grant follow.

In-School Outreach

Although Alexandria Field served as the hub of grant activities, several educational programs took place in local schools. These activities reached more than 1,500 students and adults during the twelve months of the project, and included one high school aviation science course plus eight classroom and two career day presentations.

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[5] New Jersey DOT Division of Aeronautics Educational Grant awarded in April, 2003.
[6] Wolf Aviation Fund Grant awarded in February 2004.
[7] See http://www.takeflightworkshops.com/index.php/about-2/the-supporting-research/workshop-development
[8] Maxine Scheer, *Stakeholder Relationship Mapping for Aviation Education and Workforce Development* (National Conference on Aviation and Space Education, October 18, 2008).

Students who previously had not been exposed to aviation were given in-classroom opportunities to learn about STEM through the lens of aviation from airport personnel and teachers with aviation backgrounds. For instance, a former airline Captain-turned-local high school science teacher accepted a leadership role as a *teacher champion.* He shared ideas for aviation curricula with colleagues and encouraged them to incorporate aviation concepts and activities in their classrooms. It is likely similar latent STEM champions are waiting to be tapped in schools across the country.

Community Outreach

Outreach efforts touched an additional 2,000+ students and adults. Activities included:

- Two major forums (Kick-off Event; STEM Path Aviation Forum)
- Three presentations at state and national meetings
- One 12-month small business airport internship
- Eleven one-day job shadowing opportunities
- Eighteen scholarships, including twelve for introductory flights, four for private pilot ground school, and two for STEM courses at a local community college
- One two-month internship on a Boeing 727 reuse project

Aviation Science Club

Through the grant, an aviation science club was established at Alexandria Field comprised of students from participating K–12 schools. Airport tenants and others from the community volunteered to mentor club participants. Coincidentally, the majority of volunteers were engineers. Two types of club activities emerged: *planned activities*, and *incubated activities* resulting from publicity generated by special events, press coverage, and word of mouth. Examples of two such projects follow:

- Aircraft Building – The science club was offered the opportunity to build an experimental aircraft from a kit.
- Airport Courtesy Car – As a fundraiser, a local car dealership provided the club with a new, 2011 Hyundai Sonata Hybrid. Students were tasked with designing and wrapping the car with decals promoting the club, the airport, and community businesses. One club member produced a video documenting the effort.[9] Additionally, the Chamber of Commerce provided coupon books for local attractions. An Adventure Package consisting of the hybrid car and coupons was made available at no charge to pilots who flew to Alexandria Field. In return, courtesy car users were encouraged to donate to the science club.

Refer to Lessons Learned for additional discussion about these two programs.

[9] See http://vimeo.com/28070356

Public Events

Although airshows and fly-ins are common airport events, additional events can be designed around STEM-related educational activities. Drawing on previous experiences, Alexandria Field provided a number of impressive grant-related events.[10] During the grant Kick-Off Event, for example, students engaged in role-plays of historical events in aviation. Preschoolers engaged in the mock building of an airport, and demonstrated a real windsock and radio communications through a headset. Parents of children who had learned to fly at Alexandria Field discussed how their child's interests in aviation affected their families and influenced education and career choices. Motivational speakers included a former NASA Space Shuttle Astronaut and a senior executive from FedEx. Airport tenants and their aircraft actively participated as well.

Post event surveys revealed that the presentations given by parents of children who learned to fly provided some of the most powerful messages.[11] The success of such an event also illustrates the need to cultivate small airports as vital STEM collaborators and stakeholders.

Airport Tours

Six airport tours running the gamut from preschool to high school students and adults were conducted. The content of tours developed for preschool age groups, for example, explained that "A" is for *Air, Airport and Airplane* and included toy airplanes that could be disassembled and reassembled. Older groups manipulated more sophisticated models and learned about full-scale aircraft components. They were also introduced to basic aerodynamic principles and given a walking tour of the facility. Tours typically ended with a picnic lunch during which groups watched takeoffs and landings. Participants also received customized logbooks.

An engineering tour focused on design and use components of airport infrastructure. Components included airport layout and general design; runway, taxiway, and ramp areas; airport lighting; water management; foliage and wildlife management; fuel farm design; and airport structures. Components were described, demonstrated, and/or physically viewed, and were explained from engineering design as well as airport operator perspectives. Scripted questions prompted interaction with participants.

The most exciting tour sponsored by the grant was a trip to the William J. Hughes FAA Technical Center in Atlantic City for students and faculty. Students learned that aviation-related STEM careers also extend to Federal careers in research and development that can influence the progress of the industry.

What separated these airport tours from seemingly-similar tours conducted across the country was the depth of learning that took place and the level of community involvement. For example, William Fritsche, co-owner of Alexandria Field and a retired airline Captain, participated in the engineering tour. He explained the visual approach lighting system and helped students apply their knowledge of geometry to understand the system's underlying principles. Local engineers

[10] For example, the Magic of Alexandria Balloon Festival ran from 1989 to 1998, with attendance reaching 65,000 a year each of its last three years. More than $250,000 was donated to non-profits over the 10 years of the festival.
[11] See http://alexandriafield.com/kick-off-event/

and mechanics likewise volunteered their time to explain the technical details of other aspects of the airport's infrastructure.

Such diverse and structured tour activities demonstrate how a small airport, positioning itself as an educational resource, can bring added value to the local community and stimulate a lifetime of learning.

Aviation Education Camps

Aviation Education Camps exist all over the country. When designed with a focus on STEM and offered in conjunction with the other aviation-related programs described above, these camps can become powerful motivators.

Since 2001, Alexandria Field has offered its "Cleared for Take-off" camp specifically designed for elementary and middle school students. The proven curriculum offers campers personal growth experiences and opportunities to explore a variety of STEM content areas, including those related to becoming a pilot. The curriculum facilitates the development of confidence, leadership, and the ability to contribute to team learning experiences. The experience integrates STEM issues, problems, and solutions using an interactive approach. Campers are motivated to address the challenges posed in a creative and fun environment. The *living laboratory* concept piques curiosity about careers in aviation and other STEM fields.

The grant offered full scholarships to ten campers and funding for four teaching assistants, three of whom were once campers themselves. Participation by these former campers as assistants attests to the continuing impact of the camp experience—an impact that extends beyond aviation to personal growth and development, as well as a deeper appreciation for all STEM fields.

Take Flight Workshops

A highlight of the demonstration project involved two Take Flight workshops: one for twelve female high school and college level teachers of STEM, and one for a college female and eleven high school girls nominated by their teachers as promising STEM students. Scholarships were awarded to all workshop participants. STEM faculty came from Rutgers University, Raritan Valley Community College, Hunterdon Polytech, Lafayette College, Hunterdon Central Regional High School, Delaware Valley Regional High School, and Alexandria Township Elementary; the STEM students at promise came from Lafayette College and local high schools.

The two-day workshops included classroom instruction, experiential training on the ground, and flight experience in general aviation aircraft. The crowning activity was piloting a real airplane in flight. Experienced ground and flight facilitators introduced participants to new learning challenges and coached them to achieve peak performance in meeting those challenges. Ground facilitators worked with participants to use the flight experience as a metaphor for their classroom experience. Thus, experience in the cockpit was transferred to experience in the classroom and beyond.

An extensive evaluation by outside evaluators was conducted before, during, and after the workshops.[12] Evaluation results confirmed what earlier research had suggested. Specifically, the workshop experience influenced the following nine skills either positively or very positively for 23 of the 24 participants: collaboration with others, leadership, confidence, ability to relate new metaphors to academic work, ability to adapt, communication, decision making, respect of the opinions of others, and comfort in risk-taking.

When asked, "Did you learn and do things you never thought you would?" 23 of 24 participants responded, "Yes." When asked what those things were, eighteen responded "flying" and five responded "using aviation metaphors." Participants repeatedly commented on their newly developed sense of confidence as well.

Participant comments offered compelling evidence about the power of the workshops to change lives long after the experience. After participating, for example, one high school science teacher worked with a colleague to develop a new aviation physics course for their school. Another high school science teacher subsequently was promoted to the position of Science Department Supervisor. She stated the following in an email:

> I remember wondering why it is so easy for men to apply for positions of power and authority, yet seemingly so difficult for women. Then I found myself in that exact scenario and actually leaning…toward not applying. It was at that point that I thought back to the [Take Flight workshop] and decided to toss my hat into the ring.

This example has become a familiar workshop outcome. Rather than a talented female STEM professional sitting on the sidelines and not even trying to advance by "throwing her hat in the ring," the workshop provided added confidence to excel. It is precisely this fear of risk-taking and lack of motivation that must be addressed if women and minorities are to advance in STEM careers in meaningful numbers. The Take Flight workshops made a demonstrable difference, and if offered within the context of community collaboration, could be equally as effective for others.

Other participants reported taking their new understanding of aviation-related STEM careers back to their classrooms. A faculty member from Rutgers University remarked that flying the airplane "really resonated" with her. When looking at molecules, or making images of molecules, "you're working in three dimensions, on three axes." She later learned that the first molecular graphics programs were written by engineers who had been instrumental in developing flight simulators. The relation between the workshop experience and the science classroom clearly was evident to this participant.

The workshop proved motivational for female STEM students as well, as illustrated by this comment received from a promising high school student:

> I am majoring in Aerospace engineering and minoring in flight in college this upcoming fall. Your workshop gave me that final push towards this decision and I am ecstatic to start college now!

[12] Dr. Susan W. Lubking and Jenepher P. Shillingford, *Evaluation of the Central Jersey GAMTTEP Collaborative* (RFA Number DTFH61-10-RA-00001, CFDA Number 20.200, November 2011).

Comments elicited by workshop evaluators confirmed that the workshop experience not only promoted enhanced risk-taking and a sense of personal empowerment, but also imparted a new understanding of general aviation and promoted the introduction of aviation-related content into STEM curricula.

Such personal and professional insight and empowerment simply cannot be gained from books, classroom presentations, or introductory flights alone. Experiential learning is powerful and life changing.[13] When set in the larger context of community collaboration, these workshops stimulate a process of change that is fueled by the other program activities previously discussed. With the collaborative approach, STEM mentoring begins in preschool and continues through professional career choice and development.

The experience gained through the GAMTTEP grant demonstrated the growth potential for community airports as value-added educational resources. The collaborative approach, when coupled with the proven educational content and experiential activities employed in this project, stimulates interest and motivates achievement in STEM. Further, the approach facilitates partnerships between government, academia, industry, local businesses, and local educational agencies by positioning these airports as *living laboratories* within their communities.

VI. The Collaborative Model

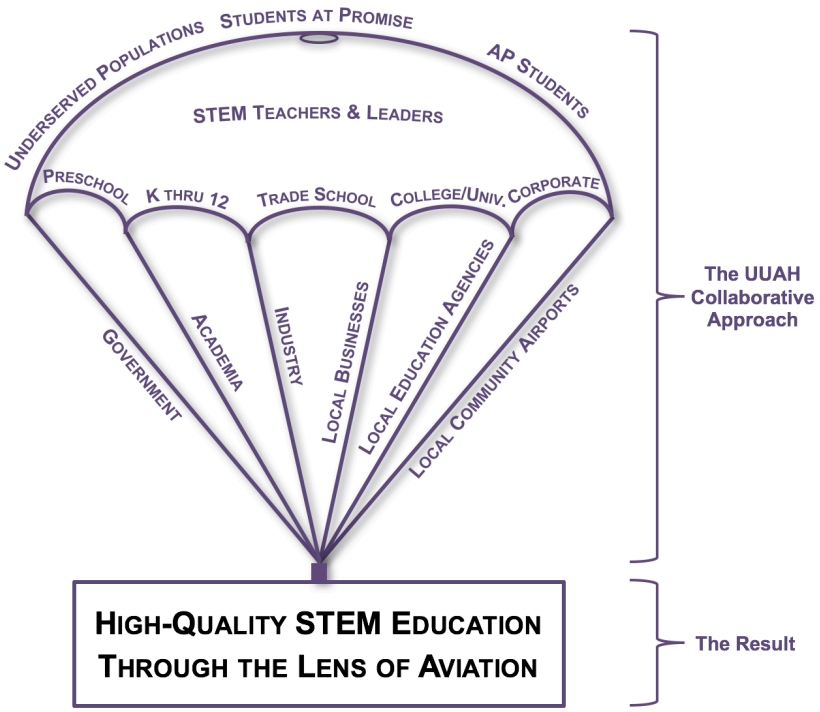
Although many of the GAMTTEP activities may seem similar to informal programs provided by other organizations involved in STEM education, it was the context in which these activities were undertaken that made them uniquely effective. All the activities were conducted using the Collaborative model developed by Castner. Depicted as a parachute, the model is constructed of the following components:

The parachute's canopy represents the fabric of STEM education and is where a lifetime of peak performance is fostered. The edges of the canopy represent STEM students/trainees. The bottom edge suggests a continuum of STEM education starting with preschool all the way through to corporate training programs. The top edge represents key student populations that merit special attention. STEM teachers and leaders are the heart of the canopy—these individuals also need the resources, encouragement, and continuing education to remain effective educators and champions of STEM.

The suspension lines represent the various stakeholders who bind the model together: government (all levels), academia, industry, and at the local level, businesses, educational agencies, and community airports.

The package that is purposefully being delivered is high-quality STEM education through the lens of aviation. From the airport's perspective, this means improved participation in aviation; from the community's perspective, helping to create a STEM workforce that is sustainable, well educated, motivated, balanced, and of sufficient size to meet projected needs.

[13] For some testimonials, see http://www.takeflightworkshops.com/index.php/testimonials/video-testimonials and http://www.takeflightworkshops.com/index.php/testimonials/written-testimonials-2



Using a local community airport as a *living laboratory* for STEM proved central to the success of the GAMTTEP case study. The project demonstrated that local airports and the varied technical, managerial, and motivational aspects of aviation transportation can inspire transportation-related careers, grass roots, geographically-based business-education partnerships, and better integration and utilization of airport resources by local communities.

VII. Ripple Effects

Opportunities for collaboration and innovation were spawned locally and nationally as a result of communications efforts, presentations, media visibility, and strategic networking by the GAMTTEP team. These opportunities highlight ripple effects that can result from the adoption of the Collaborative model and its overarching concept of *STEM through the lens of aviation*. For instance:

- Johnson & Johnson sponsored a Women in Science and Engineering (WISE) Exploration Day for Girl Scouts and others. GAMTTEP representatives were invited to participate.
- The New Jersey Aviation Association (NJAA) offered scholarships for the Aviation Education Camps the following year.
- FedEx offered to donate a retired Boeing 727 to the Collaborative (unfortunately, the logistics could not be worked out in time to make this opportunity happen).
- Castner's company became a stakeholder organization under the Partnership to Enhance General Aviation Safety, Accessibility and Sustainability (PEGASAS, see Lessons Learned).
- Companies and individuals stepped forward to contribute financial and other support to sustain various programs.

- Seeing the need to grow to accommodate the non-traditional programs, Alexandria Field converted 600 square feet of valuable hangar space into a multi-purpose classroom.[14]

The Collaborative model demonstrates what can be accomplished when a diverse group of potential stakeholders is identified and invited to participate in aviation-themed STEM education. With a local airport at the center, business, government, industry, and academic stakeholders, along with active participants and advocates, can work together with great effect.

Current STEM initiatives can benefit from the lessons learned in implementing the Collaborative model. Future collaborative efforts can benefit by drawing on STEM initiatives that may be underway already under the auspices of the various stakeholders.

VIII. Follow-on Efforts

Castner has continued to refine existing program content and incubate new programs under the Collaborative model. Several follow-on programs are discussed below.

The Flying Effect[15]

In 2013, twelve female faculty members from Rutgers University completed the two-day, Take Flight workshop as part of a research effort supported by a grant from the National Science Foundation.[16] Managed by the Rutgers Office for the Promotion of Women in Science, Engineering, and Mathematics, a mixed-methods based evaluation study tested the workshop's program theory named, *The Flying Effect*.

According to the theory, consistently achieving peak performance in situations that are perceived as challenging and risky is made possible by:

- Developing new understandings of the power of metaphor within a particular context;
- Seeking the connection between body, mind, and emotion;
- Using tested *tiny techniques*; and,
- Recognizing the importance of trust and teamwork.

The ability to internalize and continuously integrate these elements is optimized when learning takes place in an intense, adrenaline-rich environment.

The evaluation was to assess participant "experiences, meaning and potential effects of those experiences in relation to the motivational side of STEM education and professional (career)

[14] See http://alexandriafield.com/classroom/
[15] *The Flying Effect* is a trademark of Up, Up, and Away in Hunterdon, Inc.
[16] See https://www.youtube.com/watch?feature=player_embedded&v=UC72I0wlIls for a video about the project produced by Rutgers Today.

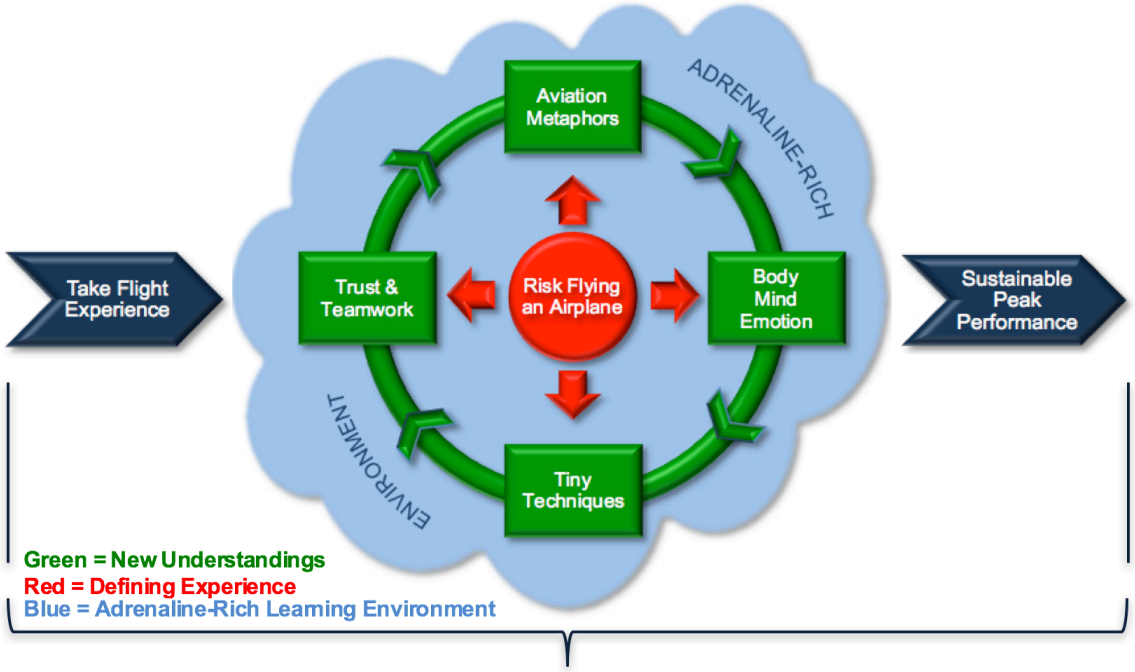
growth."[17] All twelve participants stated they had learned techniques for using mind and body to control emotion to achieve peak performance, which was one of the workshop's intended outcomes as well. Five of the eight techniques offered were perceived as especially effective in the effort to achieve peak performance.

Participants considered the *checklist* metaphor to be the most helpful, with *three axes*, *slow flight*, *Vx climb*, *airspace*, and *flying scarf* metaphors tied as second most helpful.

Asked to describe *The Flying Effect*, one faculty member-participant wrote:

> The flying effect is the empowerment we feel having done something brand new and risky (flying), and being able to use that empowerment to employ a new toolkit of techniques to handle challenging situations.

Findings suggested that *The Flying Effect* exists and is measurable, but additional research is needed to quantify the effect further.



The Living Labs Experience

In 2014, the Living Labs Experience was created to involve STEM engagement through experiential learning opportunities at an airport. These two-hour field trips combine classroom theory with hands-on problem solving in an aviation context. Math, science, and English Language Arts are integrated into experience-based labs that meet Next Generation Science Standards and Common Core standards. Labs follow a consistent lesson format: history, theory, application, experimentation, observation, makerspace, and word wall.

[17] Rutgers Professional Service Provider Agreement, Exhibit A.

The first labs were developed in response to discussions with a teacher at Kingwood Schools in New Jersey. Once developed, the teacher applied the appropriate standards to the content. In another instance, the same teacher asked Castner to develop a new lab based on an existing unit the teacher liked and was using in her classroom.

As a result of this partnership, Alexandria Field has been delivering multiple living labs per year to sixth graders bussed to the airport from Kingwood Schools.

The Dynamite Room

In 2017, the N85 Aerospace Club completed a two-year project building a multi-purpose, interactive learning space. The project began with a traditional airport use idea in mind: build a desktop flight simulator with a single monitor. Driven by club members with interests in design and virtual reality, however, the project soon grew to include non-traditional uses.

Inspired by Disney Imagineering concepts, the club developed a design schema informed by the living lab experience and STEM education through the lens of aviation. Imagination and adventure would be used to promote a growth mindset and new learning.

The club repurposed 50 square feet of space that had been the flight school's weather and flight planning area. Club members conducted research, produced design sketches for the space, selected and purchased components, built up the computer, managed the project budget, and engaged in carpentry and electrical work.

The result is a sophisticated environment that combines Traditional/Non-Traditional (TNT) uses in a highly-functional space. It can be used as a traditional flight training device for student pilots, or in non-traditional roles to pique curiosity during living labs, airport tours, and other programs involving the community.

Exploring the full capabilities of this space and creating curricula for it are underway.

IX. Lessons Learned

Myriad ideas have been tried and avenues traveled during seventeen years of exploring non-traditional uses for small airports. A keen sense has been developed about what works and what doesn't. Tactical planning, for example, is a critical first step to exporting Collaborative programs from Alexandria Field. Among other things, tactical planning is used to identify potential stakeholders, vet team members, evaluate existing assets, and recommend programs that are most likely to succeed. Two more key takeaways:

The Flying Effect

Writing about Take Flight workshops for the Aircraft Owners and Pilots Association, Julie Boatman recommended:

> If you are in the position to introduce someone to flying…you should make the most of that opportunity for a good first impression.
>
> If you can identify some way to give the person control over the experience—whether it's advancing the throttle or simply the explicit ability to end the flight at any time — you give him or her an important tool.[18]

Concepts used in Take Flight workshops can be used to create empowering flight experiences far beyond the intent of traditional intro flights. Simply advertising "Introductory Flights" shrinks the potential market of people who might consider visiting a flight school. Marketing flight *experiences* with content based on proven Take Flight workshop concepts, however, could expand the base of potential flight school customers.

Sustainability

The sustainability of non-traditional programs at public-use airports hinges on attracting and keeping personnel who are invested in the type of outreach promoted in the Collaborative model. One idea is to create a career track where individuals can concentrate on the knowledge and skills associated with small airport management coupled with effective outreach techniques. Such a track would not necessarily be limited to existing aviation programs, but could include, for instance, those interested in becoming teachers. Nonetheless, these individuals would need to be fluent in traditional and non-traditional uses for airports.

Those involved in small airport operations often must wear many hats. A small airport internship program would allow interns to try on several of these "hats" in pursuit of an alternative aviation career. An intern mentored at a small airport as both an intern and an apprentice would increase the individual's:

- Education concerning real-world issues facing general aviation airports and businesses
- Practical knowledge of all facets associated with airport and flight school operations
- Ability to apply the skill sets acquired during the internship program to fill positions at other airports
- Value to employers at airports across the country

A multi-faceted internship experience with real world responsibilities is ripe for investigation.

* * *

While the viability of the Collaborative model and many of its programs has been established, a critique of unsuccessful projects is instructive as well. Failures in endeavors such as these often boil down to some combination of poor timing, inadequate follow-through, and the wrong personnel:

[18] Julie Boatman, *Reasons to Take Flight: Approaching Aviation from a Different Angle* (March 1, 2006, available https://www.aopa.org/news-and-media/all-news/2006/march/01/reasons-to-take-flight)

Aircraft Building

The science club was offered the opportunity to build an experimental aircraft from a kit. Unfortunately, the club was still in its nascent stage, liability was an issue, and a good project leader could not be found. The project may be revisited in the future.

Airport Courtesy Car

The Courtesy Car Adventure Package project lasted two years. It netted about $1,000 for the science club. Geography played a major role in the shelf life of the program. Alexandria Field is remotely located from population centers, and drive times to local attractions were not insignificant. Further, most transient pilots stop at Alexandria Field for fuel rather than as a tourism destination.

The above notwithstanding, the Courtesy Car Adventure Package is a unique program that could be viable wherever local Chambers of Commerce actively promote their tourism industry.

NJ Department of Education

As a result of Collaborative networking, the New Jersey Department of Education expressed interest in programs at Alexandria Field. Insufficient resources at the time prevented adequate follow-through. Even so, inroads have been made since as evidenced by the delivery of Living Labs to sixth graders multiple times during the school year, and presentations given by Castner at education events such as the New Jersey School Boards Association conference.

PEGASAS

Castner's company was included as a stakeholder for the Outreach and Diversity phase of the PEGASAS project. Over approximately an 18-month period, Castner interacted with project management personnel (PMP) from a core university in the network of FAA Centers of Excellence. In addition to providing all requested information about the Collaborative model and its programs, interactions also included an on-site tour of Alexandria Field by PMP, as well as PMP participation as special guests during an Art and Science of Flying workshop in Boise, Idaho conducted by Castner and Stowell.

Castner then traveled to the host university and conducted a successful preliminary meeting with some of the potential stakeholders. Several of those in attendance understood the Collaborative concept and the potential of the programs discussed. Soon after, however, PMP reneged on an agreement for the following deliverables:

- Content for five Living Labs
- A three-day Train-the-Trainer workshop to be held at the host university.

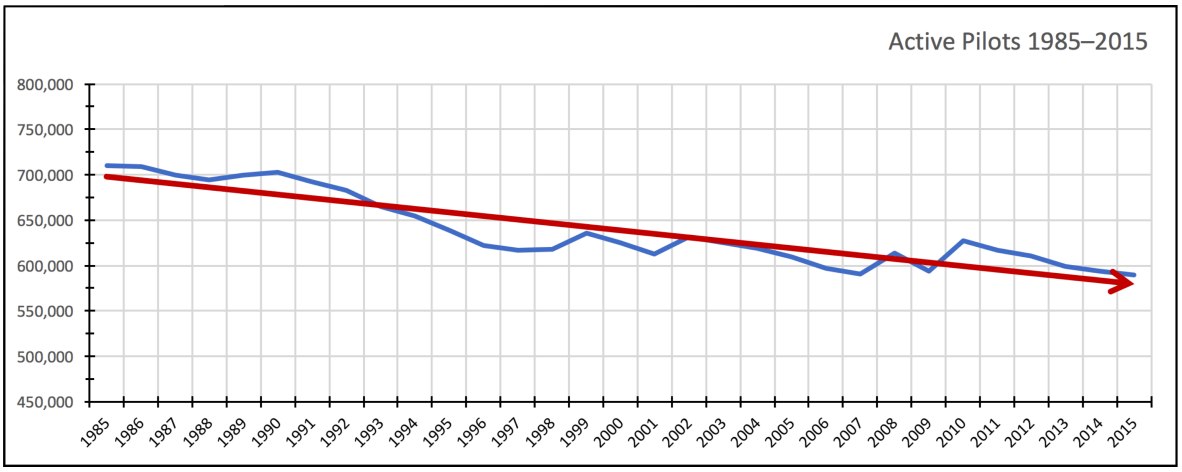
It was evident PMP had never been fully invested in exploring innovative outreach, or participating in a collaborative effort. PMP decided instead to do an in-house, after-school program to satisfy its obligation to Outreach and Diversity. This promising project failed for reasons that include:

- Inadequate vetting by FAA of Outreach and Diversity PMP
- Inadequate attention paid to the importance of tactical planning
- Lack of understanding by PMP of the true meanings of outreach and collaboration
- Inadequate skills and fixed mindsets by PMP regarding the potential for effective outreach to help general aviation airports
- Parochialism and political machinations

X. Barriers to Change

The institutional inertia of the aviation industry itself may be the biggest challenge to recognizing the enormous potential for airports to become community resources for STEM education. Historically, the industry's primary focus has been on creating more pilots. Initiatives aimed at growing the pilot population, however, have proven to be ineffective at either increasing the number of active pilots, or helping to preserve public-use airports.

The active pilot population has been declining steadily since 1985. This despite a quarter of a century of programs that have included an estimated 340,000 ACE Academy participants and more than two million Young Eagles flown.[19,20] Twenty-five years into the Recreational Pilot program, general aviation has 175 active Recreational Pilots; a decade into the Sport Pilot program, just under 5,500 active Sport Pilots.[21]



[19] http://marickgroup.com/news/2016/summer-stem-ace-academy
[20] http://www.flyingmag.com/harrison-ford-flies-2-millionth-young-eagle
[21] 2016 Civil Airmen Stats, see https://www.faa.gov/data_research/aviation_data_statistics/civil_airmen_statistics/)

Active pilots have never represented more than one-third of one percent of the U.S. population. Since 1990, more people have been sitting in U.S. jails than in airplane cockpits. An estimated sixty-seven percent more people in the U.S. practiced some form of Paganism in 2008 than practiced touch and go's.[22]

More pilots do not translate into airport preservation, either. During the period 1969–1980, the number of public use airports decreased by eleven percent at the same time the pilot population increased by 15 percent. According to a Transportation Research Board study, the 40-year decline in the number of public-use airports "appears largely unrelated to changes in the historical numbers of FAA-certified pilots, general aviation hours flown, and active general aviation aircraft."[23]

A look at aviation in New Jersey is instructive. More than half of the state's public-use airports have closed since 1952. New Jersey has the highest population density of any state, and the highest number of people per public-use airport.[24] In 2013 for example, there were 207,000 residents per public-use airport compared to just 209 active pilots per airport. Active pilots in New Jersey make up just one-tenth of one percent of the state's population.

While airport noise can certainly be a factor in community relations, it was not the primary cause of friction between New Jersey airports and their communities—it was lack of communication. Only seven percent of survey respondents cited "reducing noise" as a way for their local airport to become a better neighbor.[25]

Situational awareness is knowing what is going on around you. The systemic target fixation on trying to churn out new pilots misses not only opportunities to serve the remaining 99+ percent of the population, but also potential new revenue streams for airports and their businesses. To reiterate, the perpetual emphasis on creating more pilots has not increased the active pilot population, has little impact on the perceived value of local airports, and fails to reduce the risk of airport closures.

Understanding Outreach

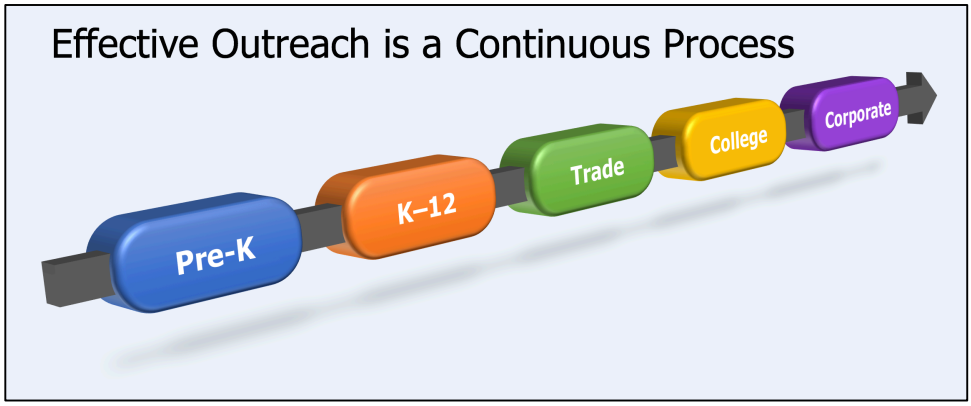
The word "outreach" tends to be misused in aviation. For example, the 2015 Annual Report of the Partnership to Enhance General Aviation Safety, Accessibility and Sustainability (i.e., PEGASAS) uses *outreach* in the context of information disseminated by PEGASAS to other aviation stakeholders.[26] A more appropriate term for this is *inreach*.

Outreach, in contrast, is the activity of providing services to populations who might not otherwise have access to those services.[27] This is how the term was understood during GAMTTEP, and is used in the Collaborative model. While other legitimate aviation outreach programs exist (some quite good, in fact), most tend to be random acts of outreach. That is, well

[22] For more information, see the screencast at https://youtu.be/cY9DdS8xH_M
[23] Transportation Research Board, *A Guidebook for the Preservation of Public-Use Airports* (ACRP #44, 2011), p 8.
[24] Report of the New Jersey General Aviation Study Commission, 1993.
[25] Report of the New Jersey General Aviation Study Commission, 1993, p 55.
[26] See https://www.pegasas.aero/docs/PEGASAS%202015%20Annual%20report%20FINAL.pdf
[27] See https://en.wikipedia.org/wiki/Outreach

intentioned though they may be, they lack context or connections to lead-in or follow-on programs. And rarely do those programs collect data to measure outcomes.

As done in the Collaborative model, outreach is most effective when viewed as a continuous process. Outcomes must be measured and critiqued. Outreach efforts also must offer multiple points of entry where participants can join or rejoin the process.



Value Proposition

An airport's value is the sum of its economic and social impacts. Discussing an airport's economic impact might resonate with local politicians and businesses. Members of the community-at-large, on the other hand, are more likely to be swayed by an airport's social impact, i.e., how it brings about positive change that addresses a pressing social challenge.

STEM education is a pressing social challenge for communities. Airports can increase their social value by positioning themselves as educational resources. Through GAMTTEP and follow-on research, programs developed within the framework of the Collaborative model have been shown to increase Alexandria Field's social value.

XI. Conclusions

The U.S. has committed significant resources to improving STEM education. Community airports can—indeed must—play a significant role in this effort. Doing so not only will help solve a pressing social challenge, but also will improve airport-community relations and provide new revenue streams for aviation businesses. However, as long as functional fixedness about using airports only to "make more pilots" drives the majority of outreach efforts, airports will continue to close because their communities will not value them over other public use options.

Meeting the various challenges will take the combined efforts of a broad range of transportation and STEM stakeholders. The overarching concept presented in this paper—positioning community airports as educational resources—is a viable way to meet those challenges at the grass roots level. The Aviation Education Collaborative model, vetted during the yearlong GAMTTEP project, possesses several attributes and advantages:

- The model is tried and tested. Seventeen years of exploration and research have revealed what works, and what doesn't. Thus, time wasted traveling down dead end paths is minimized.
- The approach is scalable—the Collaborative model can be implemented at general aviation airports around the country.
- The model provides a unique, multi-layered approach to attracting and retaining women and other underrepresented groups to aviation and other STEM careers.
- The model taps existing resources and expertise in the form of thousands of potential public-use airports, prepared information concerning aviation and other transportation careers, and individuals (including senior executives) willing to share their time with students, teachers, and parents.
- The model points to ways to improve and integrate existing activities such as school programs, airport tours, and aviation-related summer camps into high-quality programs, while maximizing available resources.
- The model promotes collaboration across the different agencies and disciplines needed to successfully meet the STEM challenges ahead.
- The model offers alternative revenue streams for airports, with crossover into existing streams.

This paper presented a model and programs that not only have withstood scrutiny, but also are exportable to other airports across the country. Further, the consequences of more effective outreach by airports may be their preservation as well as organic growth in the pilot population. The question is: Are stakeholders able to overcome their tunnel vision to become visionaries?

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The cartoon, "Inventing the Wheel" used with permission from Marjorie Sarnat (www.MarjorieSarnat.com).

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