Creating Business-Education Partnerships

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

Prepared for the DOT National Workforce Summit 2012

Linda Castner, Maxine Scheer, Sue Stafford, and Rich Stowell

Principals, Take Flight Solutions LLC

www.TakeFlightSolutions.org

Creating Business-Education Partnerships
A Case Study Using an Airport as a Living Laboratory for STEM
Prepared for the DOT National Workforce Summit 2012
Linda Castner, Maxine Scheer, Sue Stafford, and Rich Stowell

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. Transportation has been identified as a vital STEM area, and the aviation sector in particular offers a unique gateway into STEM fields. For example, the United States boasts more than 5,000 public-use airports.[1] Collectively, however, these airports remain underutilized as educational resources even though many are naturally STEM-rich environments.

This case study provides results and observations from a successful demonstration project funded by a Garrett A. Morgan Technology and Transportation Education Program (GAMTTEP) grant.[2] Hunterdon Central Regional High School (HCRHS) in New Jersey was the grantee. Nearby Alexandria Field (N85), a privately owned, public-use airport, was the nexus of grant activities. Linda Castner, co-owner/operator of N85, served as Program Director.

The grant funded the creation of the Central Jersey GAMTTEP Collaborative (the Collaborative), representing a partnership between a small airport and local school districts, universities, businesses, and community organizations. Over 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 also targeted to nurture populations that remain largely underrepresented in transportation.

II. Purpose

The purpose of this paper is to:

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

[1] "Administrator's Fact Book," FAA, March 2011, p. 16.
[2] www.alexandriafield.com/announcementofgrantaward/

2. Inspire transportation stakeholders to adapt the lessons learned from this case study to their sectors.

3. Heighten awareness of the connection between factors contributing to the reluctance by many individuals—especially women and minorities—to visualize themselves as capable of piloting an aircraft, and the challenges stakeholders face in attracting qualified individuals to, and retaining them in, transportation-related STEM careers.

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

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

    b. STEM Education and Workforce Development.

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 these airports were shared by public and private sectors. Many airports were designated as 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 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 outer space. Thus the linkage between community airports and STEM education is relevant now to the development and implementation of initiatives suggested

in the MOU to promote aviation and space education and aerospace workforce development.[3] The current network of 5,000+ civil public-use airports offers a readymade resource for a coordinated program of STEM workforce development.

IV. Run-up to the GAMTTEP Grant

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 Program Director Linda Castner.

The Principals

With educational and professional experience coaching female athletes to achieve peak performance, Linda Castner has demonstrated a lifelong passion for helping children and women to excel. She has been a licensed pilot since the age of twenty, and began her career in transportation as co-owner/operator of the family airport in 1993. The nagging question, "Why don't more women want to learn to fly?" drove her to conduct a five-year research project.

Along the way, Castner was introduced to Dr. Sue Stafford. Also a licensed pilot, Stafford is an Emeritus Professor of Philosophy at Simmons College and has a professional background in artificial intelligence and a long-standing interest in knowledge transfer and the education of women. Castner's research intrigued Stafford and the two combined efforts.

Castner and Stafford discovered an association between an aversion by women to the "physical risk taking" associated with flying an aircraft and their overall attitudes about new learning, leadership, and career options. Thus Castner/Stafford developed an aviation-themed workshop that focused on developing three key leadership traits: *confidence*, *adaptability*, and

[3] Memorandum of Understanding Among the United States Department of Transportation And United States Department of Education, And United States Department of Labor To Promote Aviation and Space Education and Aerospace Workforce Development, September 21, 2011.

collaboration. This work was assisted with grants from the New Jersey Department of Transportation[4] and the Wolf Aviation Fund.[5]

Significantly, the 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 a general aviation aircraft in flight, the workshops harnessed the power of aviation metaphors and the influence of adrenaline to facilitate new learning.[6]

An alliance grew with Rich Stowell as the workshops were being developed. A nationally recognized expert on inflight loss of control, Stowell is a Master Flight Instructor who specializes in teaching pilots how to deal with the risks and emotions associated with emergency situations. Stowell collaborated on the workshop curriculum and served as chief flight facilitator.

Maxine Scheer's independent research and modeling of transportation stakeholders and their involvement in STEM education and workforce development identified the Take Flight workshops as a best practice.[7] Consequently, Scheer reached out to Castner/Stafford to make the connection between the workshops and the need to motivate STEM students and teachers alike. Scheer provided communications and strategic consulting services in support of the GAMTTEP effort.

Key Educational Institutions

Rutgers University is an academic member of an FAA Center of Excellence (COE). Rutgers also has a program dedicated to women faculty of STEM. Discussions with leaders from Rutgers' Office for the Promotion of Women in Science, Engineering, and Mathematics and with the FAA COE led Castner/Stafford to GAMTTEP, which in turn led them to work with HCRHS to establish the business-education partnership that qualified for the grant in 2010.

[4] New Jersey DOT Divisions of Aeronautics Educational Grant awarded in April, 2003
[5] Wolf Aviation Fund Grant awarded in February, 2004
[6] http://www.leaderstakeflight.com/Research/Research.htm
[7] *Stakeholder Relationship Mapping for Aviation Education and Workforce Development,* National Conference on Aviation and Space Education (NCASE), October 18, 2008. See Figure 2.

V. Representative GAMTTEP Programs

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

In-School Outreach

Although N85 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.

Students who previously had not been exposed to aviation were given in-classroom opportunities to learn about STEM vis-à-vis transportation from airport personnel and teachers with aviation backgrounds. For instance, a local high school science teacher and former airline Captain 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. Note that the motivation to develop aviation-related curricula came from a local teacher. Other latent STEM champions are waiting to be tapped in schools across the country.

Community Outreach

Community outreach touched an additional 2,000+ students and adults. Activities included:

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

Aviation Science Club

Through the grant, an Aviation Science Club comprised of students from participating K–12 schools was established at N85. Airport tenants and others in the community volunteered at the airport to mentor club participants. Coincidentally, the majority of the volunteers happened to be engineers. The club's activities included those *planned* with high school science teachers and those *incubated* as a result of publicity generated by special events, press coverage, and word of mouth. The unique projects that ensued exemplify what can happen when local airports and communities collaborate:

- Aircraft Building – A local family provided the club with a complete kit of a full-scale, experimental aircraft. Additional meaning was attached to the project through a touching personal story about the unopened kit, and airport tenants and parents were recruited to assist club members.

- Airport Courtesy Car – As a fundraiser, a local car dealership provided the club with a 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 documented the effort by producing a video posted on the Internet.[8] Additionally, the Chamber of Commerce provided coupon books for local attractions. The Adventure Package of hybrid car and coupons remains available gratis to pilots who fly to Alexandria Field. In return, those who use the courtesy car are encouraged to make a donation to the science club.

As illustrated above, a proactive Aviation Science Club using a local airport as a *living laboratory* offers win-win opportunities for all involved.

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

Public Events

Although airport events are typically associated only with airshows, additional airport events can be designed around STEM-related educational activities. Drawing on previous experience,[9] Alexandria Field was able to provide a number of impressive grant-related events. 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, demonstrating a real windsock and radio communications through a headset. Parents of children who had learned to fly at N85 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.[10] 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 covering the gamut of age groups 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 observed airplanes taking off and landing. Participants also received an aviation logbook customized just for them.

An engineering tour focused on design and use components of airport infrastructure. Components included airport layout and general design; runway, taxiway, and ramp areas;

[9] 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.
[10] Excerpts from the Kick-Off event are available at http://www.alexandriafield.com/Kickoff/index.html.

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 the tour 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 allow the industry to progress.

What separated these tours from similar airport 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 N85 and a retired airline Captain, participated in the engineering tour, explaining the visual approach lighting system and helping students apply their knowledge of geometry to understand the system's underlying principles. Local engineers and mechanics likewise volunteered their time to explain technical details of other parts of the airport infrastructure.

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

Aviation Education Camps

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

Since 2001, Alexandria Field has offered a camp program called "Cleared for Take-off" that is specifically designed for elementary and middle school students. The proven curriculum offers the campers personal growth experiences as well as 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 that motivates campers to address the challenges posed in a creative and fun environment. The *living laboratory* concept piques campers' curiosity about careers in aviation, transportation, and other STEM fields.

The grant offered full scholarships to ten campers and funding for four teaching assistants, three of whom were previous campers themselves. Participation by the 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 was 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 STEM teachers as promising STEM students. Scholarships were awarded to all workshop participants. STEM faculty came from Rutgers, Raritan Valley Community College, Hunterdon Polytech, and Lafayette College; 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 real time. 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. 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 how the workshops changed lives both personally and professionally long after the experience. After participating, for example, one high school science teacher is now working 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 at HCRHS. She sent the following 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 Leaders Take Flight program 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 make a demonstrable difference, and if offered within the context of community collaboration, they can be equally as effective for others.

Other participants reported taking their new understanding of aviation-related STEM careers back to their classrooms as well. A faculty member from Rutgers University remarked that flying the airplane "really resonated" with her because 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 also been instrumental in developing flight simulators. Thus the relation between the workshop experience and the science classroom was clearly evident to this participant.

Comments elicited by the workshop evaluators confirmed that the Take Flight workshop experience not only promotes enhanced risk-taking and a sense of personal empowerment, but also imparts a new understanding of general aviation and promotes 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.[11] 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.

[11] A video, with testimonials captured after the second flight is available on the following website: http://www.takeflightsolutions.org/2011/10/take-flight-solutions-launches-youtube-channel/

VI. The Collaborative Model

Although many of the GAMTTEP activities described above may appear to be 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 so uniquely effective. All of the activities were conducted using a Collaborative model developed by Castner. Depicted as a parachute (Figure 1), 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 a STEM Workforce that is sustainable, well educated, motivated, balanced, and of sufficient size to meet projected needs.

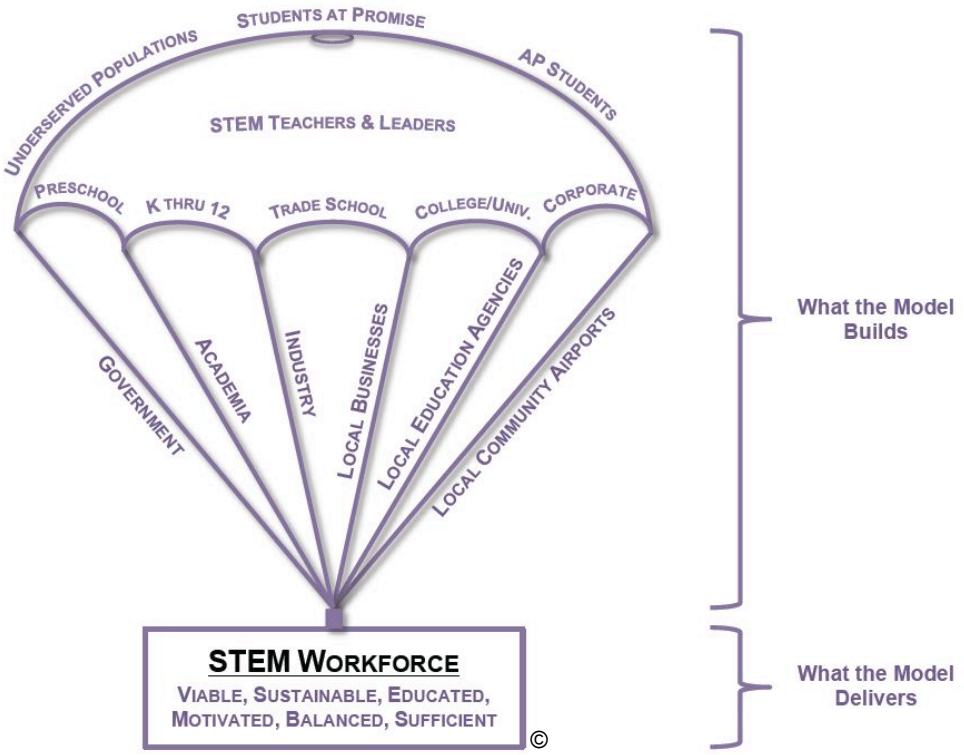

Figure 1: Arresting the STEM Freefall with the Collaborative Model

Using a local community airport as a *living laboratory* for STEM proved central to the success of this 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. The Ripple Effect

Opportunities for collaboration and innovation were spawned locally and nationally as a result of communications efforts, presentations, media visibility, and strategic networking by the project team. These opportunities highlight ripple effects that can occur as a result of adopting the Collaborative model. For instance:

- The Girl Scouts sponsored a Women in Science and Engineering (WISE) Exploration Day held at the local Johnson & Johnson facility; GAMTTEP representatives were invited to participate.
- The New Jersey Aviation Association (NJAA) has offered scholarships for the 2012 Aviation Education Camps.
- FedEx offered to donate a retired Boeing 727 to the Collaborative. Discussions are ongoing concerning how the aircraft might be used.
- Several airport owners who heard about the project have inquired about how the Collaborative model was implemented. Discussions are ongoing regarding developing Collaboratives centered at these airports.

The Collaborative model demonstrates the power of identifying a diverse group of potential stakeholders and inviting them to participate in transportation and STEM education. Figure 2 represents the breadth of possible stakeholders. Future collaborative efforts can benefit by drawing upon STEM initiatives that are already underway under the auspices of these stakeholders. Current STEM initiatives can benefit as well from the lessons learned in implementing the Collaborative model.

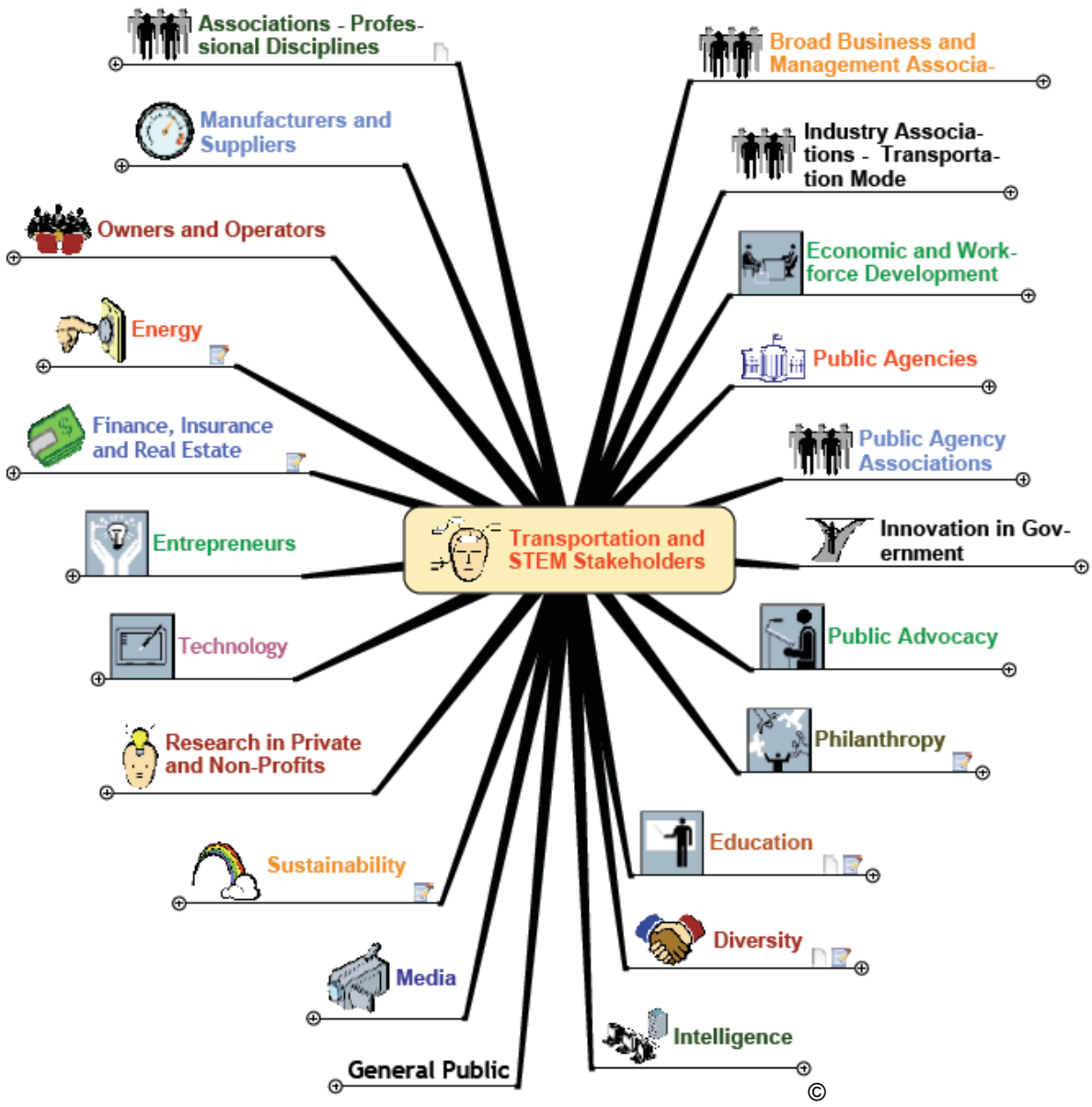

Figure 2: Transportation and STEM Stakeholders

VIII. Concluding Remarks

Meeting the transportation workforce challenge will take the combined efforts of a broad range of transportation and STEM stakeholders. The project described in this paper—repositioning a community airport as a *living laboratory* educational resource—illustrates a viable method of

meeting that challenge on a grass roots level. The Aviation Education Collaborative model, vetted during the year-long GAMTTEP grant, possesses the following significant attributes and advantages:

- The model is tried and tested.
- The approach is scalable—the Collaborative model can be implemented at small general aviation airports throughout the country.
- The model provides a unique, multi-layered approach to attracting and retaining women and other underrepresented groups to transportation-related STEM careers.
- The model taps existing resources and expertise in the form of thousands of potential public-use airports, prepared information concerning transportation careers, and individuals (including senior executives) willing to share their time with students, teachers, and parents.
- The model points to ways to improve existing activities such as school programs, airport tours, and aviation-related summer camps, while maximizing available resources.
- The model implements the collaboration across agencies and disciplines needed to successfully meet the STEM challenges ahead.

The United States has committed significant resources to improving STEM education, and the Summit has set a related goal of developing a national framework for workforce development in the transportation sector. Community airports can—indeed must— play a significant role in both of these endeavors. This case study and the Collaborative model described herein demonstrate an approach that has been tested, has succeeded, and is ready to be replicated across the country.

* * *