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Partnership and the Revitalization of Aviation: A Study of the Advanced General Aviation Transport Experiments Program, 1994-2001

Nanette Scarpellini Metz
University of Nebraska

UNO Aviation Institute

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Executive Summary

As the Advanced General Aviation Transport Experiments (AGATE) program drew to a scheduled end, its outcomes reflected the diverse nature of its participants. AGATE involved several different types of institutions, including federal agencies, business and industry, universities, and non-profit organizations in a jointly funded research and development initiative. In the seven-year life span of the program, the total investment exceeded $300 million dollars. Sixty-two percent of that was from federal sources, the reminder, or 38 percent, came from the private and nonprofit sectors (General Aviation Programs Office, 2001).

AGATE's primary goals are directly linked to General Aviation Revitalization Act (GARA) of 1994. This legislation established "time limitations on certain civil actions against aircraft manufactures" as a result of personal or property damages involving an accident or incident involving a GA aircraft (GARA, 1993). The revitalization of the government and the reinvention of industry initiatives was part of the plan. Through NASA, the Federal Government initiated a new role in its AGATE involvement. The government moved from being solely a subcontractor to a combination of subcontractor and venture capitalist bargaining on the long-term growth and stimulation of the U.S. GA industry.

As AGATE completed the project cycle, the Small Aircraft Transportation System (SATS) launched into action. SATS builds on the technologies created by AGATE that open up new opportunities for intercity travel beyond aviation enthusiasts. Equally important are the benefits SATS gains from the lessons learned through AGATE's earlier development of partnerships.

To examine the real and perceived outcomes of the AGATE program, an interview instrument template was constructed and the applied throughout the course of thirty-three interviews with AGATE members and periphery affiliates. The information gathered is based on their perceptions of GA and the entire country prior to the actions of September 11, 2001. That day marked the end of the information gathering phase of this study.

Findings

Several common trends began to appear throughout the interview process. The strength of these trends often varied based on the size of the participant's company and work package. Certain

participants spoke at length about the problems while others glossed over the problems and focused on the successes. The problems and successes fell into several key areas. By examining both sides, we are able to explore the dynamics of the developing partnerships. The findings also reveal trends that focus on the organizational makeup of AGATE. The perceptions include an examination of the federal management and leadership, as well as recommendations for future partnerships.

This interview-based study and documentation revealed the AGATE participants' perceptions of successes and problems. The study provides insight into the workings of a unique jointly funded research and development initiative that involved a multi-institutional partnership. By gathering together this range of individuals, the study is able to produce a collective picture of the organizational development and policy implications of AGATE and possibly to other related programs.

Conclusion

This study attempts to reveal the correlation between the various perceptions communicated via the interview instrument. By determining the congruent and incongruent responses, a continuity of comments exposes several useful trends of the partnership network. These trends can be applied to other similarly oriented partnerships that may result from the base group as well as from partnerships not yet discovered.

Abstract

As the Advanced General Aviation Transport Experiments (AGATE) program completes its eight-year plan, the outcomes and industry effects reveal its successes and problems. AGATE engaged several different types of institutions, including federal agencies, business and industry, universities, and non-profit organizations. By examining the perceptions of those intimately involved as well as periphery members, this study shows the powerful consequences of this type of combination both now and in the future. The problems are a particularly useful illustration of the interworking of a jointly funded research and development initiative. By learning how these problems are addressed, the study reveals lessons that may be applied to future government-industry partnerships.

Introduction

As the Advanced General Aviation Transport Experiments (AGATE) program draws to a scheduled end, its outcomes reflect the diverse nature of its participants. AGATE involved several different types of institutions, including federal agencies, business and industry, universities, and non-profit organizations. Together, these institutions functioned as a jointly funded research and development initiative. Funding came from several of the participants in equitable proportions. In the seven-year life span of the program, the total investment exceeded $300 million dollars. Sixty-two percent of that was from federal sources, the reminder, or 38 percent came from the private and nonprofit sectors (General Aviation Programs Office, 2001).

According to the General Aviation Programs Office (GAPO) at National Aeronautics and Space Administration's (NASA) Langley Research Center, "The AGATE Project pioneered technological innovation and revolutionized aviation" (2001, p.2). In tandem with the General Aviation Revitalization ACT (GARA) of 1994, considerable growth and increased safety has occurred in the aviation industry since the start of AGATE in 1994. The National Commission to Ensure a Strong Competitive Airline Industry (NCESCAI) was a primary advocate of GARA. The NCESCAI support, coupled with that of NASA Administrator Dan Goldin, played a significant role in the law passage. General aviation (GA) encompasses all civil aircraft not operated by the military or commercial airlines. GARA supported the industry by establishing an 18-year time limit for product liability lawsuits against aircraft manufactures of components, engines, and airframes for aircraft containing 20 or less seats (GAO, 2001). Prior to GARA, no time limit existed. The technologies developed by AGATE have not only increased safety for GA aircraft, but also ensured greater affordability and increased airspace capacity (GAPO, 2001).

Within this environment of revitalization, AGATE is reported to have shown excellent returns. According to GAMA (2001), in the last five years there has been a 300 percent growth in aircraft deliveries. Industry billings have increased by 350 percent. Approximately 20 percent of the export market has been recovered. Additionally, there is a 10 percent increase in sector jobs (GAMA, 2001). Even though the industry was growing, the number of accidents decreased 41 percent from 3,233 in 1982 to 1,989 in 1998 (GAO, 2001). The technologies conceived, tested, and developed in AGATE contributed in part to this rebound (Bolen, 2001).

AGATE: Creation and Development

NASA created AGATE to address the rising concerns of the GA industry. Generating advanced technologies for GA, was the primary focus. This included developing technologies, such as new avionics, airframes, engines and pilot training systems, which would lower accident rates while increasing the number of small aircraft flying. Since the late 1970s, GA sales and activities in the U.S. weakened dramatically based on a severe reduction in sales and production of lightplanes (GAMA, 2001). These areas languished in part due to outdated technology. The flight deck technologies had changed little since the 1950s though the prices continued to rise. In 1994, annual shipments of new U.S. manufactured GA airplanes hit an all time low of 928 units as opposed to 17,811 units shipped in 1978 (GAMA, 2001, p. 4). Advances in GA were slow and hampered by strict and unwieldy certification and regulatory controls. Increased liability claims were stifling the manufacturers. The decline was also reflected in a diminishing number of GA pilots and student pilots. Student pilot licenses decreased from 150,000 in 1980 to 96,000 in 1994 (GAO, 2001) By 1994, the entire industry was in retrogression.

The members of AGATE identified Bruce Holmes as the key visionary and leader of the AGATE movement. In the late 1980s and early 1990s, his connection with industry and government leaders made AGATE possible. Holmes used his vision of a stimulated GA to inspire and convince a failing industry into saving itself through the help of the government and the cooperation of competitors. Dan Goldin, NASA Administrator, lent his support and sponsorship through the rocky times and the good. According to Holmes, "...the ultimate strength of AGATE was the combination of diverse motivations toward the common purpose" (AAAI, 2001, p.2).

AGATE's highest level goals are directly linked to GARA. This includes the revitalization of the government and the reinvention of industry. Through NASA, the Federal Government initiated a new role in its AGATE involvement. The government moved from being a subcontractor to a venture capitalist bargaining on the long-term growth and stimulation of the U.S. GA industry. Industry was able to successfully involve both government partners: the Federal Aviation Administration (FAA) and NASA to make use of their expertise and input in certification and

regulations. While the government may not have been reinvented, its partnership with industry was new. The government, industry and university team were able to successfully collaborate in a variety of areas. These new relationships produced technological advances throughout GA. Research and development continue at a higher level than ever before in GA.

NASA stepped in to bolster the industry and create new transportation opportunities. Through a joint effort between industry, NASA and the FAA, the AGATE program had eight years (1994-2001) to revive the GA industry. NASA allocated $52 million to operationalize this rebirth (AAAI, 2001). Centered on industry revitalization, NASA created separate work packages to group consortium members based on three principal goals areas. These areas included safety, affordability, and ease-of-use. The work packages focused on innovative cockpit technologies that were broken down into these sections: (1) Flight Systems, (2) Propulsion Sensors and Controls, (3) Integrated Design and Manufacturing, (4) Ice Protection, (5) Integration Platforms, (6) Flight Training Curriculum, (7) System Assurance, and (8) Management of Public-Private Alliances. Companies participated at three categories of membership: principal, associate, and supporting. The level depended on the financial and workforce resources that a company was willing and able to contribute. Principal members offered important technical contributions in one or more work packages. Principal and government members led tasks. Associate or supporting members handled only agreed upon sub-tasks. Each member played an important part in the creation of a successful team.

AGATE operated under the Joint Sponsored Research Agreement (JSRA), a unique Space Act process (Office of Aeronautics, 1998). The JSRA removed many of the obstacles typically faced under federal acquisition regulations. This unique agreement allowed for greater flexibility while allowing participants to take risks with higher payoffs, accelerate technology transfer, manage control of proprietary and joint technologies, and increase efficient use of limited resources.

The organizational structure of AGATE blended management and leadership within the public and private sector. Typically NASA managers acted as work package leaders and reported back to the GA Program Office. Overall these leaders came from government organizations most suitable to a specific area of focus. Also, every work package had a technical council made up of

a representative from each of the voting members organizations. Work package leaders acted as the chairperson. This council established the work package's research and technology (R&T) priorities, prepared annual R&T plans, and distributed funds to work package members.

Additional leadership roles were held by the AGATE Executive Council. Each work package elected a voting industry representative. The council also consisted of non-voting members-at-large and observing members. The Executive Council's principal roles included determining the strategic direction for AGATE and assigning funds to the technical teams. The technical team formed the primary organizational unit for designing and executing work. The careful combination of member-led council and government guidance allowed for greater ownership of the resultant projects.

Environmental Situation Precipitating Study

As AGATE completed the project cycle, the Small Aircraft Transportation System (SATS) began its cycle. Elizabeth Ward, acting at the SATS Education and Outreach Officer, requested the research to provide a comprehensive overview of the AGATE organization based on the perceptions of its members. SATS builds on the technologies created by AGATE and on the lessons learned through AGATES's example of public/private partnerships.

By conducting an analysis of AGATE, the researcher hoped to reveal the secrets to its success as well as solutions to the problems it encountered and managed. The study is based on the perceptions of those involved both at primary and secondary levels. These findings may then be applied to other similarly constructed jointly funded research and development initiatives, such as SATS. Since the infrastructure of SATS is just solidifying, now is the opportune time to examine lessons learned and how they may proactively link to build a brighter future.

Study Framework

To examine the real and perceived outcomes of the AGATE program, an interview instrument was generated and implemented in interviews with AGATE members. Research questions and the subsequent interview questions were developed based on a recent literature survey and

AGATE published reports. The research questions stated that AGATE achieved its goals based on an effective multi-institutional partnership.

Prior to beginning the interview process, the researcher reviewed written and video materials related to the creation, development, and outcomes of the AGATE. Reports of AGATE in the national and local media are minimal and provide very little background information. However, considerable attention has been paid to the AGATE program and other NASA initiatives within the aviation industry magazines both in the U.S. and abroad. Also, industry organizations such as the General Aviation Manufacturers Association (GAMA) and the National Business Aircraft Association (NBAA) have played an active role in promoting the potential of AGATE through policy changes and industry support. NASA and AAAI produced numerous newsletters detailing the progress and direction of AGATE over the course of the program. This information is combined with the participants' perceptions. The objective is to gain a clearer understanding behind the success of this jointly funded research and development initiative. To obtain this objective, this study focuses on seven questions.

Research Questions
1. While each member has a unique perspective, is there a common trend regarding the perceptions of AGATE?
2. Did the participants establish a consensus on the mission and purpose of AGATE?
3. Did AGATE have clear, concise goals?
4. Did NASA manage AGATE in a manner that would provide for the greatest success of the program?
5. Throughout 1994-2001, did NASA provide strong, effective leadership?
6. Did the participants' roles evolve over time to meet the changing needs of the AGATE program?
7. Can AGATE members provide useful recommendations that may be applied to other multi-institutional programs or project efforts?

This paper provides an overview of the interview feedback compiled about the AGATE program. Using a combination of face-to-face and phone interviews, the interviews were recorded on

microcassettes that were later transcribed. Thirty-three interviews provide a representative sample of the AGATE participants.

Overall, AGATE is considered to be a successful program. It achieved many of the principal goals laid out at the onset of the program. By examining its history from a variety of perspectives that include both primary and peripheral participants, the researcher intends to elucidate trends that could be useful to the operation of future multi-institutional, private and publicly funded programs. To facilitate and group the findings, interview transcripts are examined in the context of the seven research questions. Each area reflects a compilation of the 33 interviews. The findings offer a consensus view to illustrate the overall trends that revealed themselves through the interviews. Occasionally individuals showed perceptions or opinions contrary to the trend.

Limitations

The limitations of this study involve several areas. It is assumed that the selected list of interviewees (see Appendix) represents a cross section of the program. Secondly, it is assumed that the scope of questions is sufficient in terms of meeting research objectives. Based on review by content experts, it is estimated that the questions are a reliable qualitative assessment to obtain information from research objectives.

Method

This study developed through an interview instrument method of inquiry. To reveal the real and perceived outcomes of the AGATE program an interview template was constructed and applied throughout the course of thirty-three interviews with AGATE members and periphery actors. Research questions were developed based on a recent literature survey and AGATE published reports.

Interview Standardization

The interview consisted of five multi-part open-ended questions listed below. These questions were selected from a larger pool of questions to focus on specific areas of AGATE that may be helpful to a future multi-institutional partnership such as the newly launched SATS that is currently under GAPO's guidance. The interview questions were developed from a

comprehensive review of materials and literature about the program. They were consolidated, constructed, and validated through expert analysis.

The structured interview was designed to meet the needs of the research assignment within the limitations of the interview setting. The material was reviewed in terms of design and methodology by the office requesting the study as well as by a GA expert (GAO, 1991). Broad overall questions were translated into questions that attempted to assess the issues under consideration. Of the pool of questions, the five most appropriate and useful ones were chosen. They offered the interviewees the opportunity to answer with as much or as little information as they personally desired. The interviews were analyzed to determine the related perceptions that connect aspects of reality in respect to the objectives of the study (Holstein & Gubrium, 1995). This agreement was applied to the research questions and the subsequent relation to SATS.

Interview Questions

1. How long have you been involved in AGATE and how has your role evolved over that time?
2. From your perspective, what were AGATE's problems and successes?
3. How would you characterize the federal leadership and management of AGATE?
4. What kind of advice do you have for future partnerships?
5. If you had to do it over again, would you still become involved in AGATE?

Interview Environment

The majority of the interviews occurred throughout the Experimental Aircraft Association AirVenture 2001 in OshKosh, Wisconsin. Most of the AGATE industry members were at the show to display their products and engage the public and other industry contacts. Time was valuable and easily interrupted by the events of the day including a low pass by a C-5 or a rousing routine by Patty Wagstaff. As such, time and attention was limited. Interviewees answered the five questions based on their interest and schedule. All interviewees were given an opportunity to add comments as desired. Interviews lasted from ten minutes to an hour.

The information gathered is based on perceptions of GA and the entire country prior to the actions of September 11, 2001. As of that day the information gathering was considered complete and halted to ensure that the impact of the event was not considered herein. Review these findings with that in mind. The GA industry has been affected by these new events. Only in time will the new course of GA be discovered.

Participants

Participants were selected based on their involvement with the AGATE program. Out of 75 possible members, 33 participants were ultimately selected to provide a broad overview of the entire program. The participant pool included a mix of large and small companies, as well as federal and higher education members. The pool also included members directly involved with AGATE as well as though who worked with the program from outside the inner circle. All participants interviewed were male. AGATE had very few female members, none of which had a leadership role. Masculine pronouns are used to refer to the study participants since all interviews were conducted with males.

Prior to the airshow, none of the participants were aware of this research project or the possibility of being interviewed. Interviews were scheduled on the spot with little lead-time for anyone involved. In order to gain the spontaneous responses, interview questions were not released prior to the interview. The majority of industry members were interviewed at the EAA AirVenture to minimize travel time. The interviewer traveled to NASA Langley Research Center in Hampton, Virginia to complete the remainder of the interviews with the NASA and AAAI participants as well as several other industry members based in Virginia. In order to include a representative sample, several phone interviews were conducted with individuals unavailable for a face-to-face meeting. Participants were allowed to review their interview transcripts and make changes if they felt necessary

Interview Transcripts

All participants were assured confidentiality as well as the opportunity to review interview transcripts. All identifying remarks were removed from the transcripts. The transcripts were coded to provide a means of reference without identifying the specific participant.

Findings

The findings are based on 33 interviews conducted over the course of the 2001 summer. Each interview was reviewed to detect trends based on the framework of seven research questions. The findings are organized in correlation to the seven research questions from which the interview instrument evolved. The numbered subheading correlates to the number of the related research question. The lessons learned are proactively tied to the upcoming SATS program. Specific comments are summarized and included throughout the findings. All information that would identify the participant is removed from the transcript to protect the participant and provided a degree of confidentiality assured during the interview. A complete listing of study participants is provided in Appendix.

Question 1. Perceptions of AGATE

Several common trends began to appear throughout the course of the interviews. Some of the trends were reflected by the majority of participants while others appeared stronger or more evident in smaller companies or industry partners. This trend development was based on participants' perceptions of AGATE's problems and successes. Certain participants spoke at length about the problems while others glossed over the problems and focused on the successes. The problems fell into several key areas: startup time, competition and proprietary issues, teamwork or not-work, program structure, communication and information sharing, cost distribution, and program range. Similarly the successes also fell into several groups: cooperation and relationship building, GA revitalization, certification, technological advances, and small business. By examining both sides, the study explores the dynamics of the developing partnerships.

Trends in Perceived Problems

Startup time.

Initially the problem was in defining AGATE. There was considerable confusion over who was going to be involved. Many of the best possible participants did not join because they came from companies that were too small to contribute the required resources. For most of the participants,

getting AGATE organized and underway took too long. Even still, work was started before there was an overall plan. As a result some companies lost motivation in the whole process.

There were many issues at work within this area. Both NASA and industry were concerned over the amount of time it took to get AGATE going. Industry people did not see why the agreement had to go through so many steps. NASA did not understand why industry was so attached to intellectual property. Universities seemed more interested in publishing than in getting the projects. Once the plan was developed, new companies came in with new ideas that wanted to change it. This started new problems.

Competition and proprietary issues.

According to the participants, there was considerable anxiety and posturing over what companies were in and which ones were out. This often caused a battle between the larger and smaller companies. The smaller companies had a hard time gaining acceptance. The larger companies seemed to be just after the money and did not want anyone else to get it. Once established, in-fighting was mainly the result of the protectionist desire for control, combined with a lack of knowledge. In many groups there was a tendency not to want to give up ownership of technology. Everyone fought for right to maintain intellectual ownership as associated with company identity. This made the demand for integrated systems difficult to satisfy. The problem was especially true when new companies joined the project. The older partners wanted to be able to protect the work they had already done. A lot of fighting involved figuring out how to include new companies and protect the old ones. Even though new partners were often brought on board when earlier ones failed or quit the program leaving their projects unfinished; they were still viewed with distrust. With the diversification of all different identities, it was difficult to balance the disparate product desires of companies. The blending of the different interests was very difficult. There were many miscellaneous political agendas that varied from what AGATE desired. This muddled the process and made working together difficult.

Teamwork or not-work.

According to the participants, the greatest problem seemed to be in the phase where companies were learning to work together. Initially there was no sharing of information since companies

were always very security conscience. AGATE enabled companies to work toward common goals, but it took three years before the sharing really started. Then they realized they could work together and survive and even thrive. The planning failures and project delays hampered AGATE's success. Plenty of mistakes were made along the way, but members came to appreciate that these lessons would have had to be learned at some time—either in AGATE or on their own.

Program structure.

The lack of structural design led to a lot of problems in day-to-day operations. Great research was done, but there was no way to coordinate it in some cases between groups or even within work packages. Management was driven by a set of two different agendas: work package leaders involved the technical problems, and GAPO dealing with the pressures of the companies and their business plans. Original problem within teams came from members being miscast based on skills. As a result companies dropped out. Some companies took money and did not deliver. Also documents were produced, but never the product. If the product was delivered, it did not always work. AGATE never established a baseline. Therefore it became difficult to determine progress or how well goals were met. The measurement remained subjective. Stronger systems engineering design needed to be in place to aid to traceability and accountability of program members.

Communication and information sharing.

There was no cross communication between work packages. Individual packages had to make special effort to try to reach these people. Even within groups not a lot of information was shared. Individually team members got along well, but they could not get all the information they wanted. One project was forced to develop displays because they could not get them from anyone else in other work packages. Participants agreed that communication was the biggest problem. Information needed to be received in a timely manner. Often the engineers were so focused on the technology that they were not able to articulate the developments. A lot of under-the-table negotiations occurred. Some companies quit without any notice. Without compulsory and unified report standards, some of the information was lost to other companies.

Cost distribution.

According to participants, AGATE did not balance implementation costs. Everything cost too much partly due to an imbalance of competitors. There was enough money to live on, but not enough money to thrive. Many of the projects could not get over the initial startup hump. Federal money is still based on local politics. In the beginning, companies contributing money wanted to spend all the money on research in their areas. The project group had a tough time trying to figure out how to allocate resources. Selfish commercial interests added to the conflict. Sometimes funds were used too close to a specific company's project. Since the direction of the project was not always right for each individual company, it made the whole experience frustrating, wonderful, and fascinating. A sore point for many of the participants was that the FAA never came through with the funding. As a result, AGATE tried to fund too many people. Some packages never got adequate funding to pursue the prescribed goals. Funding should have focused on those where there was buy-in among the work package members.

Program range.

The program did not go far enough. The big airframers were unwilling to go the full length of the project with government oversight. There was a reluctance to put flight test technologies on government aircraft. Too much power was give to AGATE Alliance Association, Inc. (AAAI). It resulted in them being on a power trip. They should have stuck to just running the administrative end and archive. There is some disappointment that AGATE did not live up to the potential it could have.

Trends in Perceived Successes

Cooperation and relationship building.

AGATE was the first time companies that would not even talk to each other were working together and sharing technology. Participants agreed that AGATE created a new way of doing business. The success was being able to bring people from diverse backgrounds together. Eventually they were able do so something for the common good. There was a concrete production of products and services. By cutting down the risks, work packages found products that could get to market. Having all these people together talking to one another would not have occurred without AGATE or it would have been a long way out. By working together, cost

decreased. Financial resources did not limit small companies. This careful, protected cooperation is one the greatest successes of AGATE. The participants' perception was that AGATE allowed a lot more companies to get into general aviation. Others support the reinvention of government—AGATE changed the relationship of how companies dealt with government as a partner as opposed to contractor.

GA revitalization.

According to many of the participants, AGATE created a pressure that helped revitalize general aviation. These tangible results created an exciting atmosphere that showed where they were going. While previously there was not a real research and development movement in GA, that now exists. Tremendous revolution in what was going on in GA. According to participants from all parts of the program, AGATE revitalized an industry that had gone into the toilet. The joint research and development resurrected GA by giving a new capability into an old product. No one company could have achieved that alone, but by working together it happened.

Certification.

Many participants agree the biggest success was in dealing with certification issues that before were too time-consuming and expensive. Participants say they have changed the way materials are certified. The program had a profound effect on aircraft over the next five to ten years. Now it is possible to certify materials faster, safer and cheaper than before which can really expedite the development of composite aircraft. Also, there has been a tremendous improvement in production with standard methods established for certifying material. FAA could not have done more in this area. There has been superb cooperation between FAA and NASA in certification. The impact on the industry goes beyond the U.S. to worldwide markets. By forcing the FAA to look at specific areas, it was able to review definitive certification processes. As a result, it helped to reduce the cost and documentation of certifying composite materials. The Advisory Circulars that have come out of AGATE illustrate its real world success. These are concrete independent markers that signify the success of some of the AGATE partnerships.

Technological advances.

The improvements in crashworthiness are significant advancements based on testing collaboration. Additionally, a newly established database will help further improve this area in small aircraft. "We have a product that saves lives. How do you put a price tag on that benefit?" Guidelines were established for bringing advanced technology into the cockpit of small aircraft. This changed the way you fly airplanes. Now airplanes virtually fly themselves. The computer source databus group allows a person to plug in and activate different devices on computer as soon as they are hooked up. No additional wiring is needed. The graphical displays for Highway in the Sky (HITS) displays replace the steam gauges. According to the participants, a low cost and high value technology with a profit potential is recipe for a healthy industry.

AGATE showed that small aircraft represents real proving ground for technology. Exciting new stuff was done on small aircraft at much less expense than associated with larger aircraft. While it may not have achieved the dream, it accomplished the broad overall goals. More importantly a tremendous synergy developed between the companies that worked together. AGATE was a wonderful way to stay up in the front of technology changes. According to the participants, they were able to involve more people such as students and bring the changing technology into the classroom for added understanding. Additionally AGATE allowed smaller companies to work with the larger more established companies. In the end, the smaller companies were able to deliver on many levels. A simple demonstration that government cost-shared and risk-shared accelerated product development.

Small business.

According to most of the participants, both large and small businesses have benefited from the increased exposure due to their association with AGATE and NASA. Many companies, particularly the small startups, credit the AGATE project with helping them form a successful company. The NASA's Small Business Innovation Research (SBIR) program was also cited as providing a definite competitive boost to who participated. Involvement in AGATE has stimulated interest in small businesses that would not have been there otherwise or would have taken much longer to generate. Some members were originally not qualified to be partners due to limited resources and other factors. Later they went on to play an active role. AGATE not only

allowed them to demonstrate their technology in a real world sense, it was also instrumental in developing new technology. The association with well-known companies, as well as NASA, enhanced company credibility in the industry. As a result technology made it to market faster and thus elevated and promoted general aviation.

Question 2. Consensus regarding mission/purpose

Bruce Holmes is considered by all participants to be the founder and visionary of the whole of the AGATE program. "The whole idea was to invigorate the industry." Though he consulted with other key people in the industry, his sense of mission and purpose is regarded to be primary. The participants are in agreement that Holmes has established the mission. There are variances in each one's interpretation of this mission and purpose. Many of the companies have rewritten it to fit their needs. According to most of the participants, saying there was a consensus regarding the mission and purpose of AGATE would be a broad stretch of the term.

The original points used by Holmes to create AGATE were often passed over by better ideas and then surpassed. The JSRA was put into place to define how business would be conducted. Unfortunately, it was not followed that closely and was influenced by private interests. Even within the work package it was still very hard to find common ground. There was and continues to be a divergence between agenda and goals of the members of large companies versus those of the small company members. They have different timelines and objectives.

While the intent was good in terms of structure based on mission and purpose, everyone had varied motivations. Achieving results would mean getting products customers could buy versus creating a more interesting research project. Some of the problems sorted themselves out in almost a Darwinian manner as those who could work together stayed and some of the big companies left. This contributed to the greater harmony of the whole. According to many participants, divergent research projects consumed a bunch of money. NASA must be credited with "keeping the spark growing" as they pushed for realistic outcomes. Some participants were in the program just to defeat the program. They feared it was a threat to competition. NASA's mission is one of public good—industry should realize this.

Question 3. Goals

While the broad goals were determined and laid down on paper, the actual working goals were difficult to control and sometimes altered due to changes in funding. Most participants felt there was considerable grayness about what was the end result. When the program first started there was not proper or adequate planning performed to define the big picture. More planning should have gone into the beginning. Some projects did not contribute in any significant way to the AGATE program.

According to the majority of the participants, AGATE achieved a great deal, but it did not achieve its original goal—a fully automated aircraft. AGATE did raise the level of general aviation's technology and "...opened the door for people to work together toward common standards." To some of the participants, AGATE was a fantastic program but in the end it was inefficient and unsatisfying. This was due in part to a lack of project direction. AGATE needed set clear and specific goals throughout the program even though that might have undermined some research. The goals they had were ambitious, but not enough attention was paid to integration of results. In fairness, many participants said it was conceivable that the drive was supposed to come from the industry side. Overall, NASA should have realized if a goal was not reachable in life of a project, they should not set that goal.

Question 4. Federal Management

Program management is a vital part of the success of a program. This is especially true when taking part in the first multi-institutional partnership that comprised AGATE. There is considerable concern over what entity should manage such a venture and how the process should develop to the greatest benefit for all. In the case of NASA's management of AGATE, opinions vary greatly with some participants thinking NASA excelled in its management role while others found NASA entirely lacking. The principle areas of contention were related to long-term vs. short-term benefits, inconsistency in management styles, management accountability, and integration difficulties.

Participant indicated a lack of understanding with NASA not acknowledging that companies needed to keep on working on other products while they were doing research for AGATE. Some

participants suggested NASA may have been too bold and aggressive going into the program. Their vision may have been contrary to what the companies had since they did not get across to companies the message that "What we are doing is to their benefit." Companies needed to be profit motivated. NASA tended to look more to the long-term, not the short-term profit. NASA management did not encourage companies, it just assumed people were going to participate. This contributed to a number of false starts. Different companies had different ideas and company headquarters were looking for the short-term success to goals.

Overall participants said NASA management was inconsistent and depended on individual personalities that ranged from excellent to nonexistent. That was one of the difficulties in working in a consortium. Team leaders seemed very comfortable and easy to work with over other government people. Most participants acknowledged that people within AGATE run the gambit from very good, to pretty good, to frustrating just like other government offices. Some companies were tugged both ways by government making the process very expensive and time-consuming. Several participants said NASA should look for managers based on manager's capabilities not on old rules of management. The mix of individuals lacked variety in terms of race and gender.

NASA's use of matrix management had a negative effect on accountability. The NASA people were not always directly linked to AGATE and their raises and promotions were based elsewhere. If they did not like the plan as laid out by the work package, they would not do it. This structure stymied integration. The bureaucracy of NASA was a real hindrance that prevented things that needed to be done from getting accomplished. The first project leader may outline the goals, then the next person who came in said, "We're not doing it that way." NASA needed to be a stronger guide. The changes in NASA management created a learning curve each time someone new came in. By the time the new manager got up to speed, they would change again. A NASA mediator was needed who would "stand up and lay out the goals and say this is what we need to do." To NASA's credit, this type of management is entirely new and is not in any textbooks. Participants said NASA people began bailing out in 1994-1995. Upper level managers told them that they would not get promoted if working in GA. "This is no way to run a program."

There was a tendency by NASA not to manage program in real time, as there was a tremendous need to declare success. In some cases there was a failure to corral some of the companies especially those that appeared to be more interested in the money than in the cooperation. Overall NASA remained professional and held to its standards when people tried to bend the rules. Every organization has its own inefficiency. In this case, engineers were very focused on technology, not on explaining to public why they were spending the money. In general, it improved members' opinion of the federal government. There were many innovative and dedicated people to work with from the FAA and NASA.

Question 5. Leadership

Participants also shared their perceptions of federal leadership within the AGATE program over the course of its lifecycle. All spoke highly of Bruce Holmes position as visionary and leader of AGATE, but just as his presence was strongly felt, so was his absence. Dan Goldin also received recognition for his pivotal position at the helm of AGATE. Several of the work package leaders were singled out as providing excellent leadership to their specific work group. Other aspects of AGATE leadership received a more mixed response.

"At the highest level, Bruce Holmes has done an excellent job of promoting his vision." He was able to bring different views together and make them seem coherent. Holmes has a tremendous ability to network people together. To be most successful, Holmes needed to have more direct involvement throughout the course of AGATE. "He is a 'silver-tongued devil with good vision, and easy to follow." Holmes provided superb leadership in addition to coming up with an idea and selling it to people. Additionally, "the program wouldn't have happened without the support of Dan Goldin." He provided the funding per original commitment. NASA provided the much needed strong leadership.

NASA formed a nucleation point for industry. The program had a profound effect on small communities and remained inherently democratic. "Impressed with how well they organized AGATE." Holmes and Goldin had it down just right along with the second part of getting people to follow and generating a lot of excitement. However in some work packages, the

perception was that when it came down to the individuals at NASA that level of leadership was not there. There was no buy-in or motivation. In contrast, about an equal number of work packages found the leadership was excellent.

Most team members liked NASA's role—completely different from other corporate partnerships. "Within our work package we had good leadership and support from the work package leader." "He was always there to help push things along." Many participants said some work packages changed leadership too often. This hampered their progress. A key problem was the government perspective that all the companies would be happy to work together. They did not realize that the partners still had to make money.

Just as some work packages had good leadership, an equal number expressed concern wit the lack of leadership. "Sometimes we'd face an issue and expect a group leader to be there to work through it…there'd be no one to help." This was not always the case. "NASA is fat with managers and very few leaders." Unless a program is fully defined a leader is needed. A stronger leader would have helped the process work better. "A leader with teeth, that did not try to please everyone, would have been better yet. Too often companies that did not deliver still were paid." In order to get companies to contribute money; NASA gave up some of its leadership role. The regulations were relaxed so that the companies in the consortium could share their technology, but retain ownership. Even groups that had leadership did not always have the resources to act. "Other than a couple isolated cases, nobody from the FAA provided leadership. They supported it in name only, not it money."

Question 6. Role evolution

In the beginning everyone was protecting the group, it became more interesting as it developed and more productive at the end. Watching the group and team learn how to do work together was very interesting experience. "No one knew where each work package was going; it all evolved."

In some work packages, competitive bidding brought about a more successful work arrangement than consensus agreement. Originally there were a lot of industry, university, FAA and NASA

involvement. "Everyone met for one and a half years and not much was accomplished." In osme cases, the Executive Council introduced competitive tasking and it changed the shape of the work package. Since only the one who put a team together was allowed to bring anyone else in who wanted to play. As a result the team developed cohesiveness as opposed to fights that broke out in other work packages. Desired end results were produced. NASA changed some arrangements from consensus agreement to competitive bidding. In the end, there was a nice blend of academia and other companies to integrate the issues related to some work packages.

Other organizations' roles evolved them right out of the program. Many participants said due to time and budget constraints their involvement ebbed and flowed. The roles evolved as members became more educated on the process. Eventually some became less involved, as the pressure to grow their companies was also very strong. There was only so much time and money. There was a level of frustration with a lot of the AGATE process.

Question 7. Recommendations

AGATE participants gladly made recommendations for future multi-institutional program or project efforts. There was considerable concern that the lessons learned by the participants would be lost or filed on a dusty shelf in some library or executive's office. AGATE did not run without conflict. Many of the participants wanted to share what they learned from the experience so that others may avoid the same pitfalls and delays. The recommendations fall into five principal areas. Developing a strong and interactive communication network is at the forefront of the recommendations. This is followed closely by outlining goals and establishing a strong, but flexible framework. Better marketing to general public is seen as an area of missed opportunity. Partnership buy-in and product standardization finish out the primary trend of recommendations. Several partners expressed the desire for the aviation industry to be more like the auto industry and able to turn out vehicles in a similar pattern. The overall experience was positive, if a bit rocky.

Communication Network

Develop a more effective means of communication. "The communication structure is too loose." "Program needs to be responsive to participants." Take the time to respond immediately. Many

participants said a lot of time wasted working on the wrong things because they did not get any response from other group members or work packages. There should be careful and prompt communication between work package leaders and participants. Perhaps create a web page that everyone needs to work and make comments on. Certify that you have noted the web page each month. By establishing a trust factor and relationship building upfront, that will set the tone for future collaboration and sharing that has to happen.

Outline Goals

All participants agreed the program needed to have a clearer set of goals. "Make sure that it is designed based on more than giving NASA people jobs." Figure out the order of facts and what needs to be done first, second, and so on. "Establish a more results-oriented focus with defined outcomes even though there are no clear outcomes." Get some of these objectives down on paper that are concrete and useful to the industry while being attentive to national interest.

Build on what was learned in AGATE. Half the time and energy was spent learning how to get things done. Focus on one process. The planning process can take very long. Need more time for execution. If NASA sets up a vision of what they want, make sure industry is willing do it in a competitive operation process. Goals must be in line with what industry wants and needs. The timeframe needs to be reasonable. Lay out goals and accomplish them. The program cannot offer funding and then reduce it. Companies come out on the line, when funding is pulled, it makes the program and its goals seem unimportant. Prepare a general spending plan that includes expectations and possibilities.

Program Framework

This program framework was appropriate for AGATE. Programs such as SATS are made up of much more complicated partnerships that would require a more integrated model. There are so many layers. "These layers allow for gaps in communication that may grow larger and more separated from NASA." Change and adapt the basic structure to fit the needs of new consortium. Lay out a roadmap in the beginning to determine tasks to support end goal. A balance between government and industry must be developed that will allow for a strong government directive function that maintains a neutral course. Delegate a procurement process early on. Many

participants were frustrated at thought of people in future programs reinventing the wheel as opposed to learning by the trials and errors of AGATE.

"What AGATE and SATS are doing is better than the Erie Canal or the Eisenhower Highway. They will have a revolutionary impact and as such deserve more funding than an accounting error." While not in the majority, there was strong support expressed for the creation of an AGATE II. Many participants felt the technologies did not have a chance to fully develop given the extended startup time. A continuation of the program was seen as necessary to ensure that the AGATE technologies became fully operational. Some saw this in place of SATS and others saw it as working in conjunction. By continuing AGATE technologies, it will benefit not only the AGATE partners, but also make SATS better off.

SATS is going in a different direction. "SATS is more operational and less technological." Make sure to take the time to develop an infrastructure. Establish team members and relationships that will allow them to compete fairly. Five to six years in a nice time slice for a program. AGATE needed longer. For a program such as SATS even though it is a different animal, there is a lot of people already involved. Many participants were concerned that there does not seem to be the money in the program to provide the AGATE technology for vehicles to prove SATS program can work. The money must be put into concept to develop the aircraft. The aircraft dropped by the wayside in AGATE, but they are needed to properly demonstrate what SATS can do.

Marketing to General Public

More marketing is needed to inform the public as to the improvements developed by program. "Sometimes there is a lack of understanding how important the market place is." Cannot bring about market and market development on its own. "Single biggest failure is we didn't get to general public…AGATE program would have better served with making people more comfortable." The program did not address creature comforts and noise especially as marketing. "To make this work, we have to do our own internal advocacy." Educate local engineers and employees. A lot of people would be very supportive if they knew about program. It could gain momentum through their support even if not directly involved.

A national meeting should be arranged to present the results of the AGATE program to important people in Washington DC such as Congress, the Senate, and Vice President Chaney. "By showing what has been accomplished, we would be better able to sell them on what can be done with SATS." People who can appropriate the money must be brought in.

Partnership Buy-in

Partnerships are a good idea. "AGATE really benefited by bringing together competitors." However, everyone did not exhibit the same amount of dedication to the program. At the onset, it may be helpful to require a verbal and written statement witnessing the buy-in of the all the participant companies' chief executive officers. This will strengthen the enforcement policy. Many participants indicated that government money should not be used to the benefit of one company. By establishing a proprietary mechanism in the beginning, the participants will have something to work from there.

Future programs need to involve FAA and Air Traffic Control more to get their buy-in. The focus should be on certification. "NASA does not understand certification conceptually or in process." This lack of understanding will definitely hinder the program just as lack of certification serves to limit innovation. The contacts made in the partnership were very important. The FAA needs to be involved up front. Get their commitment and keep them up front and focused.

Go with more of a majority vote. Too often when new members tried to enter alliance, existing members would veto them. "Also allow for a life cycle to bring in new members while maintaining the members that need to be there the whole time." "Young people have a great enthusiasm and should be involved along with the experienced members that will help solve the fundamental problems."

Create a strong Executive Council to lead and independent technical committee to weigh in on issues. "Let the Council vote with its money." The vote of support is both verbal and monetary. This is true with participants, managers, and leaders.

Standardization

Many participants said the aviation industry should strive to be more like the auto industry. Work to achieve a product that is more attainable and desired. Allow all companies to compete on an equal level. Find a party to arbitrate that is extremely intelligent, who truly understands the industry, but have no allegiance or financial benefit from choices. Operation has to be standardized. A focus on safety is important, as is ease of use. "The effort needs to be kept streamlined with narrow focus in order to get meaningful results next year, not twenty years from now."

Reactions and Inferences

The findings reveal a shared sense of discovery. Most participants were satisfied with their involvement, but many felt the government bureaucracy limited their effectiveness and drove good partners away. A large number of the individuals involved were entrepreneurs or came from entrepreneurial companies. They did not have the time or resources to waste on ineffective programs. The forming of relationships was a lengthy process usually taking two years before they were able to trust each other. This delay reduced the power of AGATE. By the time the relationships were formed, the program was a third of the way over.

The trouble with building teams should have been seen as a possible stumbling block. Prior planning may have averted some of the conflict and delay. So many of the participants were the heads of upstart companies. In order to be successful, the personality types associated with such positions do not naturally fall into a team atmosphere. Each one of these participants is a leader in their own right. A room full of leaders provides few followers or teammates. Many work package meetings are reported to have turned into shouting matches as everyone fought to have his opinion heard. Working through this conflict is expensive in time and money.

All participants agreed that the relationships formed during AGATE were extremely valuable. This is true among big and small companies and even with participants who doubted their involvement. Lasting friendships developed through this professional organization. For most the camaraderie was unexpected and very memorable. Most companies viewed their involvement as

tremendously valuable. This was particularly true for small companies just getting started. While the demands on resources were great, the rewards were just as significant. The most important aspect was having the ability to outreach and forge relationships with other companies.

Even though the direction of AGATE was not always in the individual company's best interest, most participants agreed that it was still a very good experience. With few exceptions, the participants would gladly join AGATE again. Granted, many would apply the lessons learned over the last seven years to avoid some of the pitfalls and stalemates that peppered the various work packages at different stages along the way. The struggle over proprietary information hampered and slowed the development of new technologies and the ability to achieve all of the program goals. By establishing these terms earlier in the process, considerable time and money would have been saved.

Participants were greatly troubled by the commitment of the Federal Government and NASA to AGATE. They never knew when funding would be cut and goals eliminated. Considerable resources were wasted and lost when program goals were changed to meet the reduced funding or personnel changes of NASA. Some work packages largely avoided these hindrances more due to luck than planning. Other work packages were eliminated or completely changed when funding was cut or a new work package leader came in with a personal agenda. Without the total buy in of not only the companies, but the government as well AGATE was forced to maneuver across a wandering course with great windshifts and hazards that kept the program from getting fully airborne.

Conclusion

This study attempts to reveal the correlation between the various perceptions communicated via the interview instrument. By determining the congruent and incongruent responses, a continuity of comments exposes several useful trends of the partnership network. These trends can be applied to other similarly oriented partnerships that may result from the base group as well as from partnerships not yet discovered.

While the program's literature and many participants declare a significant success rate, the majority of participants agree that its potential was not fully met. In order for a program of this type to be successful, the proper framework needs to be in place prior to members joining. In turn, each participant, be it government or private, needs to be fully and openly committed to the program goals. This occurs not at the expense of a company's well being, but in conjunction. For SATS to be successful it needs to apply the hard-learned lessons of AGATE and not try to reinvent the process. A partnership is not formed by a signature on a document, but through open communication, mutual cooperation, and an equal share of the benefits and losses.

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APPENDIX
ORAL HISTORY INTERVIEWS

Name	Affiliation
Fred Barber	Avidyne Corporation
Harold Brackett	Harris Corporation
Fred Brooks	AAAI
John Carr	Cessna
Gerry Chubb	The Ohio State University
Stuart Cooke	NASA
Dan DiCarlo	NASA
Noel Duerkson	Raytheon
Dave Ellis	NIAR
Ken Foote	Avrotec
Walt Green	NASA
Bill Hammers	Optimal Solutions Inc.
Steve Hampton	Embry Riddle Aeronautical University
Brian Haynes	PanAm Weather Systems, NavRadio, Honeywell
Steve Hooper	JB Dwerlkotte & Associates (NIAR)
Hank Jarret	NASA
Dale Klapmeier	Cirrus Design Group
Damien Ludwizak	Kennedy Space Center
Paul Masson	STARNET
Frank McLoughlin	Seagull Technology Inc.
Jim Meer	Microflight
Stephen Metschan	TeamVision (CEO)
Don Moore	NavRadio
Lance Neibauer	The Lancair Company
Shahid Siddiqi	AAAI
Jack Sheehan	AAAI
Mike Smith	Global Aircraft Corporation
Tim Smythe	U.S. DOT Federal Aviation Association
Michael Stock	Stock Flight Systems
Mohammed Takalu	Synthetic Vision
Lance Turk	Vision Microsystems Inc.
Ray Warbler	Advanced Creations and Goodrich
Anthony Werner	Jeppensen Sanderson