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AGATE OUTCOMES ANALYSIS: LAYING THE FOUNDATION FOR SATS

Nanette Scarpellini Metz and Brent D. Bowen

ABSTRACT

This study explored the policy implications of a specific jointly funded government-industry-academic research and development initiative on future planning. The researcher sought to uncover what trends or patterns of the National Aeronautics and Space Administration (NASA) Advanced General Aviation Transport Experiments (AGATE) had a positive affect on the outcomes of the consortium. By identifying these trends, the research may be able to help foster a more practical transition to follow-on programs. AGATE focused on developing innovative cockpit technologies that highlighted safety, affordability, and ease-of-use based in such areas as flight systems and integrated design and manufacturing. A qualitative analytic methodological approach encompassing qualitative data analysis software and the policy research construct was applied to analyze the organizational policy trends through the application of lessons learned from the AGATE program with reference to the current NASA program—the Small Aircraft Transportation System (SATS). Both NASA programs consist of a similar participant pool. By examining the effects of recommendations from previous studies, this analysis illustrated the transitional effects identified through the analysis. This planning framework illustrated the evolution of program and goal structure and the catalytic effect on the aviation industry and product development through increased interaction.

This study's research question focused on identifying possible underlying trends that may influence future programs by identifying and exploring the patterns of a joint research alliance through data analysis. Additionally, secondary research questions looked for common trends in areas that led to the program's success as well as points of dissension. This study examined the salient patterns that emerged within the National Aeronautics and Space Administration (NASA) Advanced General Aviation Transport Experiments (AGATE) program. By identifying patterns that indicated how this organization functioned and performed, the study revealed valuable information that may contribute to similar initiatives, such as the Small Aircraft Transportation System (SATS).

A qualitative framework was employed for the design of this study given that, "Qualitative research is an inquiry process of understanding based on distinct methodological traditions of inquiry that explore a social or human problem" (Creswell, 1998, p. 15). From this qualitative framework, the researcher analyzed a dataset consisting of interviews with key members of AGATE, a recent industry-university-government alliance (Scarpellini Metz, 2002). The data analysis focused on field notes and transcripts from the interviews to code and identify patterns within the dataset as well as exploring the areas mentioned with the highest frequency. Moreover, the policy research construct was applied to specific areas of the research to further examine the findings of the dataset produced by the interviewing tool. This strengthened the reliability and validity of the instrument. Additional analysis was conducted using NVivo qualitative software (NVivo, 2001) to further validate the findings.

The opportunity to take lessons learned from one NASA program and apply them to another follow-on program should help in the effectiveness and productivity of successive programs. Data analysis, through the policy research construct and the qualitative analysis software, investigates the environment and basis of problems policy attempts to solve as well as the policy responses' competence in lieu of these problems (Scharpf, 2000). The successes and failures of NASA-funded programs have a

direct impact on the current and future programs under consideration. By seeing how such programs operate, policy decisions are made and future plans influenced. AGATE and SATS were developed to work in conjunction with each other with mutually shared information and resources (GAPO, 2001).

INDUSTRY ENVIRONMENT

The mid-1990s were marked by renewed national attention to general aviation (GA). GA includes civil aircraft operating outside of commercial airlines and the military. In decline since the late 1970s, GA sales and production had decreased significantly in the US (GAMA, 2001). In 1993, aircraft production totaled 954 aircraft versus 18,000 aircraft in 1978 (GAO, 2001). The downturn was felt throughout the industry including in the number of new pilots and advanced ratings. By 1994 only 96,000 student pilot licenses were issued compared to 150,000 in 1980 (GAO, 2001). As opposed to a mere subsidy that may have only short-term affects, the GA community was searching for a more long-term solution.

In 1994, the General Aviation Revitalization Act (GARA) was passed as an effort to remove some of the limitations placed on the industry by expensive lawsuits. In terms of product liability lawsuits, GARA established an 18-year time limit against the manufacturers of aircraft with 20 or fewer seats (GAO, 2001). This time limit applied to aircraft related components, engines, and airframes. No time constraints had existed prior to GARA's passage. In addition to GA operatives and industry members, the National Commission to Ensure a Strong Competitive Airline Industry (NCESCAI) was a principal GARA supporter. The NCESCAI endorsement, linked with NASA Administrator Dan Goldin as a vocal GA champion, were critical in achieving a successful passage of the law (Bolen, 2001). That same year, NASA formed AGATE to handle the mounting concerns of the GA industry. With NASA in the leadership role, the federal government modified its position as a subcontractor and became more of a venture capitalist participating in AGATE with industry and academia. Just as the space program introduced the U.S. to space travel, AGATE was created to open air travel via personal aircraft up to the general public.

The eight years since the passage of GARA and the advancement of AGATE have seen significant changes in the GA industry. The AGATE Program triggered technological transformations that have reverberated throughout aviation (GAPO, 2001). The period has been marked by substantial development and enhanced safety mechanisms that have benefitted aviation (GAO, 2001). In addition to safety, the AGATE technologies have been able to increase the affordability of aviation, as well as augmenting airspace capacity (GAPO, 2001).

According to GAMA (2001), there has been a significant turnaround in the aviation industry since the inception of AGATE and GARA. AGATE has provided crucial contributions to the revitalization of the industry (GAPO, 2001). Since 1996, aircraft deliveries increased 300 percent and industry billings rose 350 percent (GAMA, 2001). Since 1994, sector jobs have risen by 10 percent and the U.S. export market has reclaimed nearly 20 percent of its lost business (GAMA, 2001). Industry growth has been accentuated by an applauded downturn in accidents. Aviation accidents declined by 41 percent between 1992 and 1999. (GAO, 2001). There is no indication of a reversal of this trend. AGATE technologies played an important role in this industry rebound (Bolen, 2001).

AGATE Organizational Framework

Through NASA's General Aviation Program Office (GAPO), based at NASA's Langley Research Center in Langley, Virginia, AGATE focused its efforts on bolstering the industry and creating new transportation opportunities. This joint effort between industry, NASA, and the Federal Aviation Administration (FAA) allowed the AGATE program eight years (1994-2001) to revive the GA industry (GAO, 2001). NASA allocated $52 million to operationalize this rebirth (AGATE Alliance, 2001). Centered on industry revitalization, NASA created separate work packages to group consortium members based on three principal areas. These areas were fundamentally safety, affordability, and ease-of-use.

AGATE's primary goals were to develop the technological components that would render a safe, low cost, efficient, private use aircraft. As a follow-on program, SATS was tasked with developing the infrastructure for a transportation system that could alleviate the congestion at major hub-and-spoke airports as well as within the interstate highway system (Bowen, Holmes, & Hansen, 2000). GAPO provided the primary leadership role and maintained budgetary control.

Within AGATE, the approximately 72 participant organizations were organized into work packages with a total of eight work packages completing the program. Each work package functioned with mutually shared program

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and work package goals as well as the competing interests of the participants. Additional 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 remainder, or 38 percent, came from the private and nonprofit sectors (GAPO, 2001).

By the time AGATE was fully structured and in operation, the work packages focused on innovative cockpit technologies that were broken down into eight sections. The work package number and working titles of these sections were as follows: (1) Flight Systems, (3) Integrated Design and Manufacturing, (5) Integration Platforms, (6) Flight Training Curriculum, (7) System Assurance, (8) Management of Public-Private Alliances, (11) Systems Engineering, and (12) AGATE Program (AGATE Alliance, 2001). The other work packages, such as, (2) Propulsion Sensors and Controls (4) Ice Protection, were canceled due to changing priorities and funding during the course of the program.

Companies participated at three categories of membership: principal, associate, and supporting. The level of participation depended on the financial and workforce resources that a company was willing and able to contribute. Principal members often 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. Competitive groups operated within and between the work packages.

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 GAPO. Overall, these leaders came from government organizations deemed by NASA to be 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 also functioned as the chairperson of these councils. The technical council established the work package's research and technology (R&T) priorities, prepared annual R&T plans, and distributed funds to work package members.

The Joint Sponsored Research Agreement (JSRA) governed the AGATE program. The JSRA was constructed to avoid many of the barriers commonly associated with federal acquisition regulations (Office of Aeronautics, 1998). The agreement encouraged an open flow of information and collaboration across groups. Regular reports and feedback were considered critical to assisting the information flow and technological development. "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" (Scarpellini Metz, 2002, p. 9). The JSRA mandated the distribution of AGATE-related information. Additionally, all members agreed to the terms of the JSRA in writing. This included providing quarterly updates on project status and an account of the spending of AGATE funds. However, while the JSRA may have dictated the terms of the program, the agreement was difficult to maintain and enforce with the regular turnover in NASA management and leadership positions.

While NASA has often been the subject of previous research, the AGATE program and subsequent SATS program are unique in their combination of the federal government, private industry, and academia on essentially equal ground (GAPO, 2001). Frequently, NASA handles the development and management of projects by awarding private companies contracts to develop specific elements of a program. This was the case in the Space Shuttle Program and the tragic consequences of the Space Shuttle Challenger in 1986. In this instance, while a technological flaw contributed to the disaster, the larger cause came from a management breakdown (Stillman, 2000). "NASA and ultimately its contractors had left the traditionally conservative design, development, and testing stage behind. The result was they began to rationalize away, they failed to communicate..." (p. 121). The organizational structure of this program, though effective in achieving technological advances, was flawed in its management. This flaw hampered the overall effectiveness of the program and was detrimental to the success of the program. The management and organizational structure of AGATE could also limit the effectiveness of the program if similar shortcomings are not addressed.

POLICY ENVIRONMENT

The policy environment surrounding AGATE had a significant impact on group interaction and progress. Changes in policy environment created new issues, depending on the compatibility between the changes and

current national policy legacies (Scharpf, 2000). According to Scharpf, personal and organizational self-interest operates in conjunction and in conflict with normative obligations and ambitions. This contributed to a differentiation amid system maintenance and goal achievement. Individual institutional norms and motivation, as well as that of the AGATE organization itself, shaped the cognitive orientation of the participants (2000). For example, AGATE participants struggled with their unique institutional norms especially during the development stage of the program structure. Throughout the first two years of the program, there was considerable movement as original members left AGATE because their organizations were unable to adjust to the norms selected and implemented by AGATE. Other organizations with a better fit took their place to finish out the program life cycle.

The environmental instability slowed progress as work packages changed management and funding in response to policy alterations. Learning how to work within and among the work packages was a critical step toward achieving AGATE's program goals. The combination of a flexible policy and growing trust make this possible (Scharpf, 2000).

THEORETICAL BACKGROUND

The ability to take lessons learned from one NASA program and apply them to another follow-on program should help in the effectiveness and productivity of successive programs. Policy research investigates the environment and basis of problems that policy attempts to solve as well as the policy responses' expertise in response to these problems (Scharpf, 2000). The successes and failures of NASA-funded programs have a direct impact on the current and future programs under consideration. By seeing how such programs operate, policy decisions should be made and future plans influenced.

Policy Considerations

Policy change tended to be incremental in nature. By gradually introducing successful programs with innovative ideas, business had the opportunity had to capitalize on the cooperative efforts (Robbins, 2000). Formerly high-risk ventures now seemed within reach. In order to respond to these considerations, the researcher explored the possible implications by analyzing an AGATE-based dataset. The composition of cross-functional teams working to achieve the goals of AGATE helped to illustrate the necessary processes. These include the need to develop, manage, and build trust between people of such varied backgrounds (Robbins, 2000). The processes and trends revealed may be applied to current and future initiatives of this type.

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Scharpf (2000) says, "policy challenges are themselves a complex concept that is best defined by the interaction between three sets of factors—changes in the policy environment impacting on more or less vulnerable socioeconomic structures and on more or less vulnerable policy legacies" (p. 768). According to Scharpf, the research questions for this study should have high predictive power that permit the researcher to identify expectations in terms of trends and processes even though there may be a limited amount of information available. In terms of AGATE, the researcher hoped to discover processes and trends that may aid program developers. This insight might assist the developers in their predictive power to prevent creating the same structural and organizational misjudgments that limited AGATE in follow-on programs.

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Organizational Structure and Theory

The organizational structure used by the AGATE program limits the power of the formal role. This role was not able not dictate participants' behavior. While some of the strengths of the Classical approach of organizational theory, such as straightforward tasks and a stable environment may have been helpful, they also would have restricted the program's natural flow. AGATE required a structure that was adaptable to the changing environment associated with such a technology-based program (Jreisat, 1997). As Chester Barnard said, "Cooperation...justifies itself as a means of overcoming the limitations of what individuals can do...exists when two conditions are met: accomplishment of the cooperative purpose and satisfaction of individual motives" (Jreisat, 1997, p. 96).

The cooperation between and within the work package teams was a critical part of the organization's structure. In this sense, Open Systems theory may be appropriate to analyzing the trends associated with AGATE. According to Jreisat (1997), the key criteria for organizational effectiveness include flexibility and responsiveness, continual adaptation and innovation to get resources, holistic view of unit, high risk, and common vision and values. With programs such as AGATE, a team approach is more appropriate because the project has a beginning and an end as based on the NASA program plan. As a result, they are more fluid than other organizational structures (Harrison, 2002). Therefore, a more stringent framework, such as those associated with the Rational Model or Classical Approach to organizational theory, may have stifled the innovative nature of the program. However, multiple partner organizations with flexible structure are subject to error-prone behavior such as that associated with the Space Shuttle Challenger disaster (McNeese, 1996). These types of partnerships often foster reduced information sharing and miscommunications which may lead to coordination difficulties as well as organizational/human factors failures (McNeese, 1996).

Increasingly, organizations are using teams or work groups to accomplish specific tasks. Within the context of Open Systems theory, sociotechnical systems theory focuses on key issues that affect these teams or work packages in the case of AGATE. While team use is on the rise, the dissatisfaction from this work experience is also fairly high (Hacker & Kleiner, 1996). By examining these sociotechnical issues, the quality of the work experience and performance may be improved. According to Hacker and Kleiner, little is known about the working of these groups outside of laboratory conditions. This limits the research's usefulness since, "it is only in the field where contextual variables can be adequately represented" (p. 471).

Sociotechnical research has shown that by strengthening the underlying social and technical elements of an organization the performance results will be optimized. To emphasize the social over the technical, as some recent interventions have done, would be counterproductive (Hacker & Kleiner, 1996). The social system contains the work group/package participants, their relationship with each other, and their relationship with the larger organization including members of other work groups/packages. The technical systems are made up of the rules and policies, such as the JSRA, which the participants use to convert inputs into outputs (Pasmore, 1988). This element ties in closely to performance expectations. Both elements have considerable impact on the overall performance of a work group.

AGATE has additional issues to consider since many of its work packages involved cross-functional teams. Hacker and Kleiner (1996) say evidence suggests a critical factor in these types of teams is formalizing the group processes. By establishing a formal method, decision making is improved which increases performance. In these instances, individual participants have little interest in the project outside their own realm. Since they are not accountable for knowledge involving other areas, they often do not feel responsible for sharing information (Gallaway, 1996). With no one accountable to the entire program, the quality information is compromised and the performance suffers. The organizational structure must not be allowed to be a barrier to the cross-functional flow of information. While participants may need to be jointly grouped for administrative purposes, they should not be isolated by the group designation (Harrison, 2002). By designing the structure to facilitate program strategy, participants can then adjust themselves to meet the organization's needs and their own.

RESEARCH QUESTIONS

The objective was to gain a clearer understanding behind the trends that led to the successes of this jointly funded research and development initiative. To obtain this objective, the study focused on three research questions. The resultant findings and follow-on behavior contributed to the study of policy research discussed in the previous

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section of this paper. "In many qualitative studies, the real interest is how participants make sense of what has happened, and how this perspective informs their actions, rather than determining precisely what took place" (Maxwell 1998, p. 84). With this in mind, the researcher analyzed the dataset.

1. What trends may have contributed to AGATE's successes as a research alliance?
2. Which of these successful trends may contribute to other research alliances, such as SATS?
3. Are there any common trends that illustrate where dissension may have hindered AGATE's success?

Due to the complex and multifaceted nature of this program, it was necessary to develop specific boundaries for this study. The areas the researcher chose to focus on were based on the high level of industry interest in what helped to make AGATE a success. These occurred aside from any technological advances. The transfer of this organizational structure has the potential to be helpful to other programs with similar interests, but less technological concentration. These boundaries were selected based on the time and means limits of this study to properly frame the research parameters (Miles & Huberman, 1994).

METHODLOGY

A qualitative data analysis of the AGATE program, employing an interview instrument method of inquiry, was used to identify information on trends and patterns that applied to future NASA programs such as SATS. The primary data source for this research was an AGATE-based dataset collected in summer 2001 (Scarpellini Metz, 2002). Data collection, organization, and analysis played a significant role in the process. The collection and organization depended entirely on the methods used and what the actual data consisted of, be it field notes or transcripts. The data provided interview feedback compiled about the AGATE program, based at GAPO's NASA Langley Research Center in Langley, Virginia, from its participants.

POLICY RESEARCH CONSTRUCT APPLICATION

In conducting policy research, such as that associated with AGATE and SATS, the levels of inquiry needed to remain open. Policy research is a "multi-dimensional, empirico-inductive, malleability-oriented, reciprocating and communicating process" (Majchrzak in Bowen and Lu, 2002, p. 2). As such, the data-collection tool required added flexibility and was not rigidly designed. Multifaceted themes were revealed through a blended approach such as interview and field research. Bowen and Lu (2002) presented a policy research construct that attended to the interests of the public and public need through the policy-making mechanism of aviation. They examined the instrumental reasoning used as the basis of policy making and challenged the use of applied statistics to address social problems such as those associated with an over-burdened interstate highway system and a restrictive hub-and-spoke airway system (Bowen, Holmes & Hansen, 2000). The application of the policy research construct provided a manner to operationalize the patterns found in the data analysis stage of this research. By viewing the patterns in this context, the researcher could offer recommendations about possible policy modification that may better enable SATS to achieve its goals. Additionally, comparison of the results allowed the researcher to strengthen the validity and possible reliability of the study.

Sampling

The focused nonprobability sampling was employed in this study to expose a confined relationship at greater depth (Berg, 2001; Miles & Huberman, 1994). By using this focused framework, in conjunction with purposive or judgmental sampling, it was easier to make educated guesses and detect trends within the larger group. The sampling lent itself to determining attributes of background and processes. The focused sampling pertained to the system of choosing conditions that provided descriptive illustrations or that offered suitable investigation of a theory (de Vaus, 2001).

In this case it was appropriate for the sample of interview subjects to be selected based on the researcher's knowledge of the population, the recommendations of field experts, and the nature of the intended research (Babbie, 1999; Berg, 2001). Only a small subset of the AGATE population was chosen to take part in the interview process. However, this was a representative group that demonstrated the basic elements of the entire program population. The participant pool included a combination 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 those who worked with the program from outside the inner circle. The intent was to interview someone from each of the eight work packages. Additional interviews were conducted to gain better depth

and to include participants from the three areas of involvement—government, industry, and academia. A representative group that showed the basic elements of the population was interviewed. These participants fell within each of the eight work packages AGATE and were divided into a combination of the three organizational types.

A limited amount of snowball sampling was also employed to ensure that key individuals were not unintentionally excluded from the process. Snowballing, also referred to as accidental sampling, was useful when it was difficult to locate members of the population (Babbie, 1999). In this case, members of the target population were asked for information to help in locating other members. Since this was a fairly close-knit group, snowball sampling was only necessary on a limited basis.

Demographically, the participant group clearly represented the larger population of AGATE. The vast majority of this population was white males ranging from 25 to 70 years in age. There were no females holding key positions and very few minorities. As a result, the sampling consisted of 30 white males and 3 nonwhite males. Of five possible interview subjects who were not able to complete the study, prior to the September 11, 2001 cutoff or due to other time limitations, they all fit the primary demographic.

Interview Process for Dataset Construction

The transcripts were based on interviews that consisted of five multi-part open-ended questions (See Table 1). These questions were selected from a larger pool of questions to focus on specific areas of AGATE that might be helpful to a future multi-institutional partnership such as the newly launched SATS that is currently under GAPO's guidance. Key GAPO administrators were involved in the selection process to support the internal validity of the findings. The interview questions were developed from a comprehensive review of materials and literature about the program (Fink, 1995). They were consolidated, constructed, and validated through expert analysis that included NASA administrators and academic authorities. This review enhanced the validity of the questions and strengthened their reliability in the context of the study (GAO, 1991). Due to the exploratory nature of the research questions, these interview questions were appropriate for gathering the perceptions of the AGATE participants.

Table 1. Interview Questions for Existing Dataset

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?*

Source: Scarpellini Metz, 2002

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The information from this dataset took into consideration the limitations of the less than optimum interview setting. Five broad, open-ended questions were used to allow the interview subjects to respond fully to the issues under consideration. They offered the interviewees the opportunity to answer with as much or as little information as they personally desired. None of the participants were aware of this research project or possibility of being interviewed until they were contacted to set a time for the interview. 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 Experimental Aircraft Association AirVenture in Oshkosh, Wisconsin to minimize travel time. The interviewer then traveled to NASA Langley Research Center in Hampton, Virginia to complete the remainder of the interviews with the NASA participants.

Using a combination of face-to-face and phone interviews, the interviews were recorded on microcassettes that were later transcribed. Due to technological limitations, only one of the four phone interviews could be recorded. The transcripts from these remaining three interviews were prepared from the researcher's notes.

The 33 interviews provided a representative sample of the AGATE 72 participant organizations. As a result, 46% of participant organizations took part in the study. More interviews were scheduled, but the events of September 11, 2001 ended the interview phase of the study to maintain a sense of continuity within the dataset and to bound the study. The sampling was based on a cross-section of all three-partner groups: government, industry, and academia. The primary researcher, a doctoral research assistant, conducted the interviews.

During the course of this study, all participants were contacted. At this time, they were allowed to review their interview transcripts and make any changes they believed were necessary in clarifying their position. Of the 33 participants, 8 responded with minor clarifications and 2 offered more significant exposition of their interviews.

Validity and Reliability

The validity of this dataset was verified by internal and external factors (Scarpellini Metz, 2002). The majority of participants took a genuine interest in the successful completion of the study and offered suggestions on possible key interview subjects. Research based on this dataset addressed the research questions of this study. While the interviews were open, the transcripts were deemed confidential to enhance the response rate of the participants. Some feared the loss of funding if less than favorable comments were reported to NASA. By ensuring confidentiality, the study was able to obtain more reliable results.

By examining the dataset that contained a variety of perspectives, including primary and peripheral participants, the researcher elucidated trends that may be useful to the operation of future multi-institutional, private, and publicly funded programs. To facilitate and group the findings, interview transcripts were examined in the context of the three research questions. Each area reflected a compilation of the 33 interviews. The findings focused on the consensus view as well as any notable outliers to illustrate the overall trends that revealed themselves through the interviews.

The inclusion or exclusion of content occurred with reference to the criteria of selection. These criteria must be exhaustive to interpret the divergence of message content and exercised consistently (Berg, 2001). As an intended result, other researchers looking at the same communication will achieve the same or equivalent results. "This may be considered a kind of reliability of measures, and a validation of eventual findings" (p. 241). The initial data analysis occurred manually. Future analysis included the NVivo software to enhance some conventional aspects of data maintenance. NVivo also permitted the researcher to substantially transform the data. The increased ease of replicability strengthened qualitative data analysis in terms of validity (Este et al;, 1998). This study confirmed many of the original findings thus strengthening the overall validity of the results.

The dataset was developed based on the input of established experts in the field of interview research and program development. "A design is internally valid if it is free from nonrandom error or bias" (Fink, 1995, p. 56). The sample was based on the configuration of the AGATE work packages. Participants were selected based on their organization's role in AGATE in order to collect a representative grouping. This research examined the dataset based on individual affiliation that was predetermined and mutually agreed upon before the onset of AGATE. The dataset's content validity was based on its ability to include the meaningful scope attended to within the concept (Babbie, 1999). Questions were limited to

enable the interviewee to respond as fully as desired. Specific information was not sought, but rather behavioral trends. Participants were well-versed on their organization's involvement in AGATE. As the direct point of contact, they were in the position to offer the most useful and valid data. Conducting a cross-comparison between research notes and the findings from the NVivo qualitative software further validated the study. Coding was reviewed and revised to maintain the integrity of the study.

Since an existing dataset was used for this study, the question of reliability was a fundamental guideline. To be useful, according to Baker (1999), the data must survey what they claim to and these standards must be pertinent to the present study's variables. The dataset was selected in accordance with the following considerations for secondary analyses: "(1) the quality of the data-gathering organization, (2) the purpose of the original researcher, and (3) the extent to which the dataset contains indicators that will enable you to test your research problem" (Baker, 1999, p. 292). The participants and the dataset were selected based on their representation of the sample and resulting generalizeability. Trying to reevaluate the data produced better knowledge of their significance. This reliability was tested by the repeatability of the evaluation to maintain consistent results in previous studies, as well as current and future analysis (Babbie, 1999). The analysis conducted via qualitative software was compared to previous manual analysis which was able enhance and more clearly define the trends and patterns.

Limitations

The limitations of this study involved several areas. The researcher assumed the dataset, based on interviews with AGATE participants, consisted of a representative cross section that could fully reveal the program's significant patterns. Secondly, it was assumed that the scope of research questions was sufficient in terms of meeting research objectives. Based on review by content experts, it was estimated that the questions were a reliable qualitative assessment to obtain information in accordance with research objectives. Also, the research was limited by the researcher's ability to interpret and code the dataset using the NVivo software. Additionally, useful patterns may not have been identified. Working within these limitations the researcher attempted to successfully compile the data in a constructive and valuable format. Particular observation was given to the subjects' intent and in determining the underlying message (Berg, 2001). The textual material was classified in order to abstract the relevant and applicable data without infringing on any ethical considerations.

These possible limitations were taken into consideration when preparing the research questions and in their analysis. This study's theoretical framework was used to derive the constructs. Additionally, while it was not possible to assess all trends, the data collected were believed to be a good representation of the issues recognized in the literature.

DATA ANALYSIS PLAN

Through data analysis the researcher intended to organize, reduce and structure the data so as to construe meaning and trends from the dataset. 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 and analyzed with reference to this study's research questions. According to Wolcott (1994 in Este, Sippert & Barksy, 1998), analysis applied to the classification of fundamental elements and the systematic portrayal of interrelationships between the observations and narration. This process is illustrated through Components of Data Analysis: Interactive Model designed by Huberman and Miles (1994) (Figure 1). In this design, the "analysis is sequential and interactive" (p. 433). Data analysis involved data reduction, display, and conclusions/verification (Berg, 2001, p. 35). To facilitate a richer analysis, the qualitative data analysis software was employed to "perform repetitive analysis functions more efficiently, but also to enhance the process of theory building and testing as well" (Este et al., 1998, p. 2).

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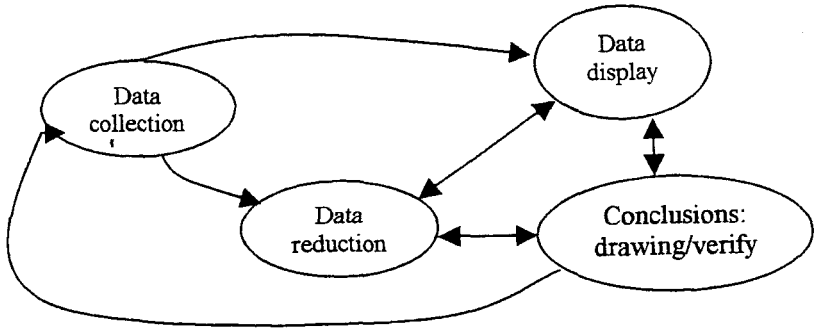

Figure 1. Components of Data Analysis: Interactive Model . Source: Huberman & Miles, 1994, p. 429.

Within the research community, there is concern about the potential for technology to transcend the path of inquiry. This translates into the consideration that researchers may exchange concentrated analyses for large-scale analysis associated with quantitative research, and that the computer technology boundaries will become the study's boundaries (Hesser-Biber, 1995, in Este, et al., 1998). To avoid this, the researcher remained aware of the underlying methodology that forms the software in order for the resultant study's process to be free from this influence. The use of such software was intricately related to qualitative research's theoretical and methodological basis (Morison & Moir, 1998). To maintain the integrity of qualitative research, the researcher attempted to remain neutral to the analysis process.

Since the study could not contain everything concerning the AGATE program, it focused on patterns of ideological perceptions and themes while being thoroughly grounded in the data. As a retrospective qualitative study, this research included information that references AGATE's program period. According to de Vaus (2001), "the goal is to build up a clear and reasonably detailed picture of the sequence in which events took place and of the context in which they occurred" (p. 228). In order to achieve this analysis the dataset was examined in detail with potential variables focused in areas of possible causal factors that may influence future programs as well as common trends of items that led to the program's success and dissension.

Unit of Analysis

For the purpose of this exploratory study, the unit of analysis was based at the individual level as determined by analyzing the dataset in terms of the participant's AGATE work package affiliation. According to de Vaus (2001), the unit of analysis was the entity from which the data was collected and the conclusions formulated. By clearly defining the unit of analysis, the researcher was better able to create the boundaries necessary to limit the study (Reichardt & Mark, 1998).

The individual participants were the direct contact people involved personally in the work packages as opposed to a media representative from the representative organizations. They were selected for the dataset building interview based on accessibility and ability to respond to their organization's involvement in the AGATE program. Using the individual as the unit of analysis, the aim of the findings was able to reveal the social dynamics operating within the AGATE population. The perceptions were

analyzed based on AGATE's influence on the individual and vice versa. The participants were the AGATE point of contact person within the organization. They were actively involved in AGATE and tended to be their organization's primary decision maker in terms of AGATE.

Data Analysis Software Application

By employing data analysis via the qualitative software, the researcher intended to obtain an objective vantage point of the existing dataset. The software helped to reduce the human factor that has the potential to introduce unnecessary bias to the analysis. The use of predetermined variables and attributes enabled the researcher to scan the data and detect any trends. Additional variables were also included when a trend became apparent. The predetermined definitions may have limited some of the options for discovery by not taking into consideration particular working or phraseology that may not have originally occurred to the researcher.

To operationalize the study, the entire dataset was imported into NVivo Qualitative Research software. Each transcript document or node was given a specific value and perhaps a range of values depending on the attribute. Each transcript was coded based on the time in AGATE, work package affiliation, organization type, and race of participant. Where applicable three null values of Unassigned, Unknown, and Not Applicable were specified. This allowed for a more rigorous analysis. The data were then organized, linked, categorized, questioned, shaped, and synthesized by manipulating the NVivo software (Richards, 1999). The same attributes applied to all transcript documents, while the values differed where appropriate. The applied values were used consistently by the software.

Coding was the primary categorizing strategy in qualitative research. The goal of coding was to split the data and reconstruct them into categories that expedited correlation between items in the corresponding category and amid categories (Maxwell, 1998). Coding reflected key words and phrases. The codes were created with reference to the research questions and interview questions. Tree nodes developed as relationships between responses were detected. The nodes were under a constant stage of development throughout the analysis to ensure that critical information was not ignored for failing to fit into a predetermined node. Several free nodes were created, as necessary, to address changing needs of the data. As the analysis continued, nodes were grouped according to revealed affiliations. Some nodes that originally seemed important were later merged with other nodes as no pattern developed supporting their existence.

The data analysis linked to NVivo software was well situated to accomplish this task. Each transcript was thoroughly engaged in the coding process. In the process of analyzing the data, codes were refined and additional codes were added where necessary. As such, "a careful balance must be struck between efficiency considerations and design flexibility" (Marshall & Rossman, 1999, p. 151).

FINDINGS

The findings for this study centered on the 33 interviews carried out during the 2001 summer. The research notes from each interview were analyzed to distinguish trends in terms of the three research questions. The organization of the findings section correlates to these research questions. The lessons learned were linked to the current SATS program. Specific observations were condensed and integrated throughout the findings. Any identifying information was removed to maintain the confidentiality of the participants' comments as guaranteed during the initial interview. According to Marshall & Rossman (1999), the structural framework of this study was revealed through data analysis in the context of the participants' perspectives. The series of phases involved in the management of data is expressed in Figure 2. Original findings were based primarily on interview questions. As the nodes and coding system developed the results revealed the underlying themes expressed in the transcripts.

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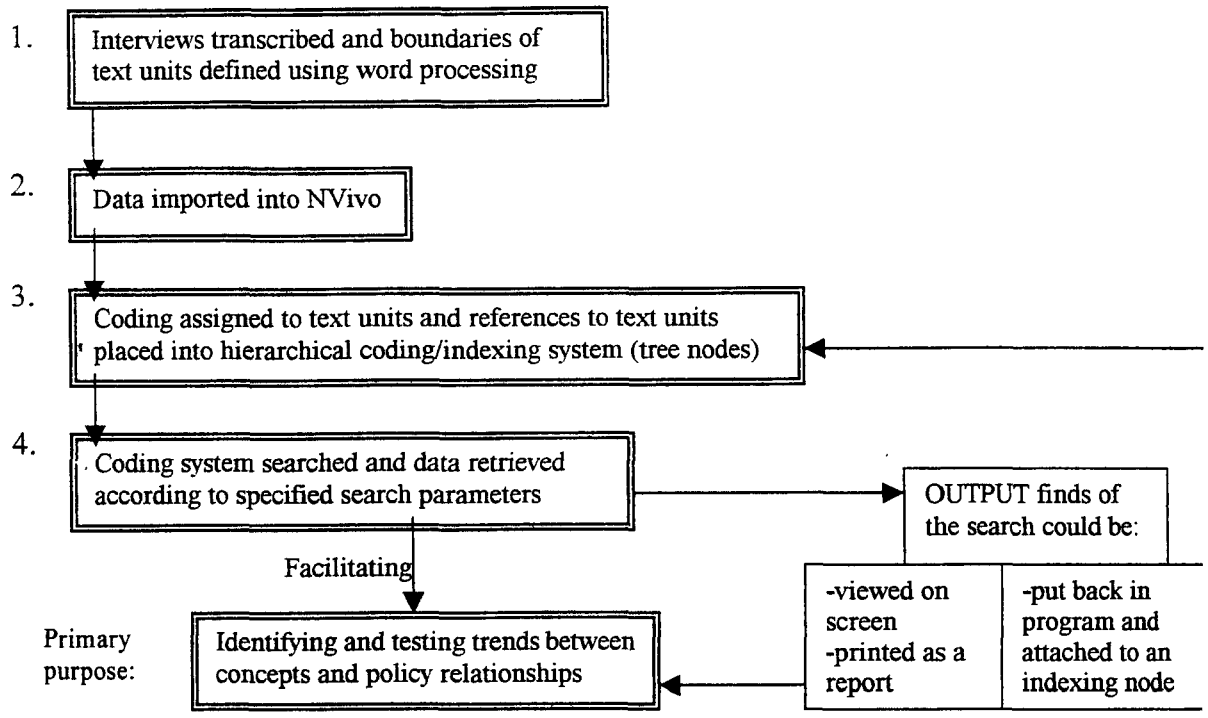

Figure 2. Flow Diagram Illustrating Data Management Source: Adapted from Morison and Moir, 1997.

As the coding system was searched and data retrieved, additional codes were created and some codes were merged based on the output. Through careful coding and recoding, the qualitative data analysis enhanced the investigation of transcripts that revealed general statements leading to the connection between categories of data. The initial coding system contained over 100 free nodes. Through analysis and searching, the nodes were linked and merged to create a workable design reflecting the trends of the key research questions. Some of the trends were expressed as tree nodes with representative branches. This method of data management facilitated the researcher's primary purpose of identifying and testing trends between concepts and possible policy relationships.

What trends may have contributed to AGATE's successes as a research alliance?

There are several trends that revealed themselves as a result of the data analysis concerning this question. The subject of AGATE's successes showed the most agreement of all the research questions. Participants agreed that AGATE initiated an effective new business approach. The most notable success was the joining together of organizations within the industry from various situations. Ultimately these separate organizations worked as a collective unit for the common good. In addition to producing tangible outputs such as specific technological products and certification procedures, AGATE also fostered less tangible sociotechnical outputs such as cooperation and relationship building. Of the 33 participants, 18 considered this development of industry-wide focus to be one of AGATE's most significant successes. This occurred by reducing the risks typically associated with similar collaborations. In the end, through common collaboration, work packages produced products that could get to market. The NVivo model illustrating AGATE's successes based on nodes attributed to the interview transcripts is illustrated in Figure 3.

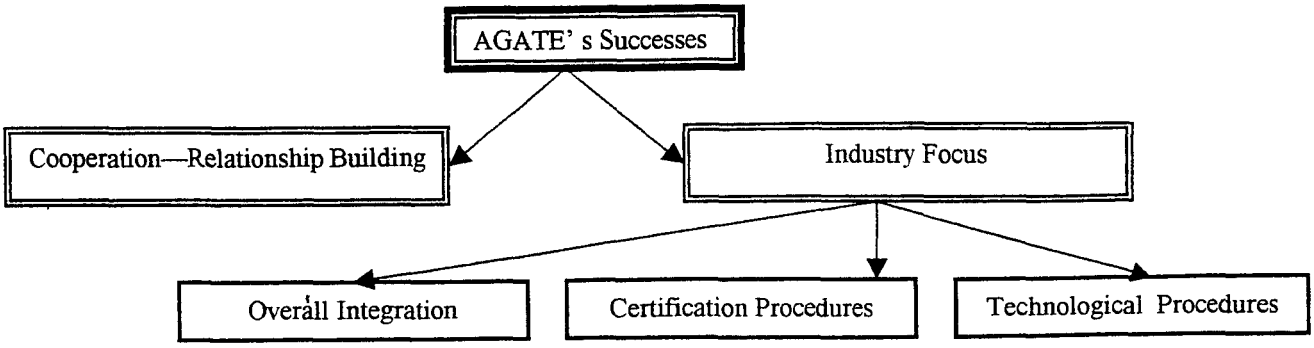

Figure 3. AGATE Successes Tree Node

There was a general consensus among participants that this collaboration between various counterparts would not have occurred without AGATE. At the very least, it would have been a long way out. By working together, overhead costs decreased for everyone. Smaller companies were not limited by their financial resources. Therefore they were free to explore technology more aggressively. This careful, protected cooperation, which created overall integration, was one the greatest successes of AGATE. The participants' perception was that AGATE allowed more companies to become actively involved in general aviation. While there was still division along company lines, the participants found the level of teamwork to be a critical example of the success of AGATE with 17 participants noting its significance.

Many participants considered AGATE to be instrumental in addressing certification issues that previously were too time-consuming and expensive. According to seven participants, AGATE changed the way materials are certified. They saw the program as having a profound effect on aircraft over the next five to ten years. Due to AGATE's efforts, it became possible to certify materials faster, safer and cheaper than before. This change may expedite the development and certification of composite aircraft. Also, there has been a tremendous improvement in the area of production where standard methods have been established for certifying material. Four participants noted superb cooperation between FAA and NASA in certification. They see the industry impact extending 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 were concrete independent markers that signify the success of some of the AGATE partnerships.

The technological advances generated by AGATE were significant in considering the program a success. The improvements in crashworthiness illustrated notable safety advancements as a result of testing collaboration. Additionally, guidelines were established for bringing advanced technology into the cockpit of small aircraft. This changed the way airplanes are flown. According to the participants, a low cost and high value technology with a profit potential was the recipe for a healthy industry. AGATE showed that small aircraft represented real proving ground for technology. Exciting new advancements were made with small aircraft at much less expense than associated with larger aircraft. More importantly, a tremendous synergy developed between the companies that worked together. 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. This provided a simple demonstration that the government's cost-sharing and risk-sharing accelerated product development. This developing synergy is consistent with the sociotechnical systems theory associated with team evolution when allowed to occur within an open organizational system.

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Which of these successful trends may contribute to other research alliances, such as SATS?

The trends that emerged in this area were more diverse. Participants recognized that the way the groups have operated within AGATE might not be appropriate for a program such as SATS. There were several areas that appeared relevant to this discussion, most notably in the areas of goal definition, federal management and leadership (Figure 4).

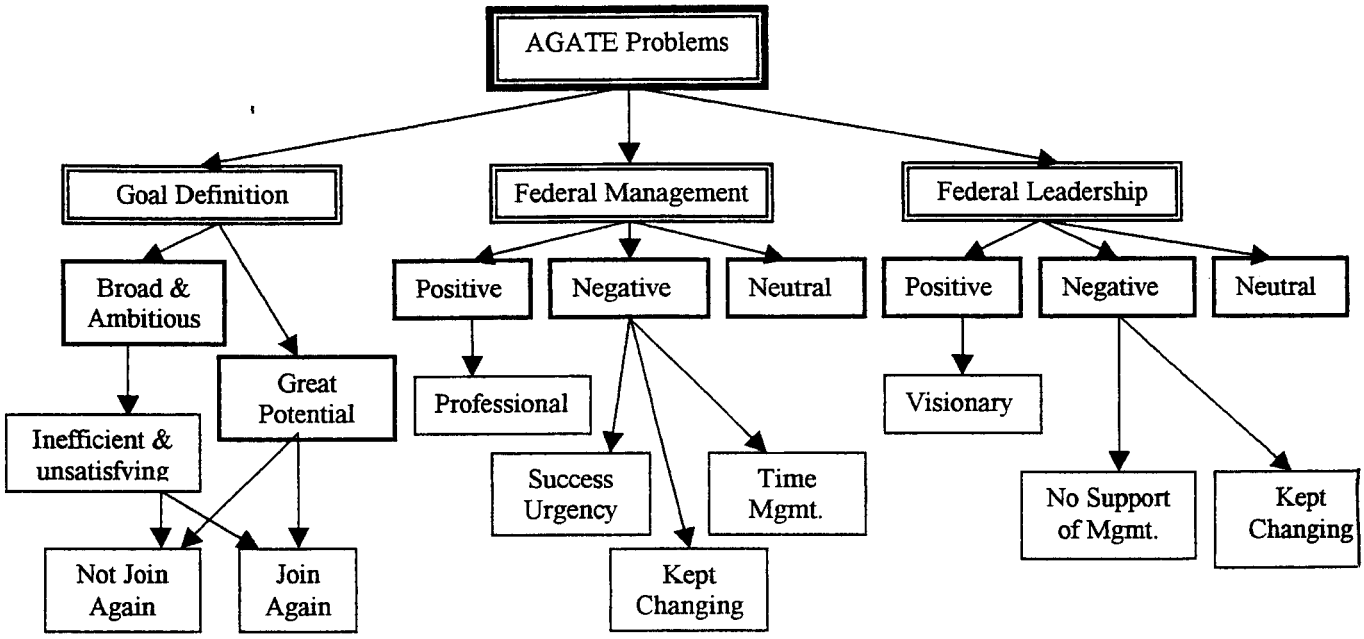

Figure 4. AGATE Problems Expressed by Tree Nodes

Overall, the participants agreed AGATE achieved a great deal, but it did not fulfill its original goal—a fully automated aircraft. To some of the participants, AGATE was a fantastic program, but in the end, eight participants found it to be inefficient and unsatisfying. This was due in part to a lack of project direction according to six participants. 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. In the end, five participants said NASA should have realized that if a goal was not reachable in life of a project, it should not set that goal. While most participants expressed concern for the program, 32 would gladly join AGATE again.

In terms of management and leadership, the participants varied considerably, but there was an overall division that revealed some basic trends (Table 2). Many noted 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. Participants acknowledged that every organization has its 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 four members' opinion of the federal government. It was mentioned that there were many innovative and dedicated people to work with in the FAA and NASA.

Original analysis of the area focused on the overwhelming positive response rate for the leadership. However, while 14 participants were quick to point out the visionary nature of the leadership, it was sometimes lacking in the day-to-day operations of AGATE. By offering too broad of goals and no support of management, the management's effectiveness decreased and as a result hampered the overall success of the program.

Table 2. Participant Perception to Federal Leadership and Management of **AGATE**

	Positive	Negative	Neutral
Leadership	21	12	11
Management	14	8	11

N = 33

Note: Participants' responses were permitted more than one response.

The majority of the participants were impressed by NASA's leadership at the top as exhibited by NASA Administrator Bruce Holmes. Many participants said some work packages changed leadership too often. This limited their progress and influenced their perception. A key problem was the government perspective that the companies would be happy to work together. They did not realize that the partners still had to make money. 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. These individual factors affected the perception of leadership and management overall and may continue to be an issue for other programs like SATS.

Are there any common trends that illustrate where dissension may have hindered AGATE's success?

Throughout the analysis of the interviews, the researcher discovered several trends that illustrated where dissension, open or concealed, may have limited AGATE's success. These same trends may appear in future alliances of this type. It was difficult to discern if these trends were the cause or merely the result of some underlying problem. The analysis highlighted three key areas: program and goal structure formation, communication division between large and small industry members, and lack of federal government support. These issues were especially prevalent during the section of the transcripts where the participants were asked if they had any advice to give future

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partnerships of a similar nature, such as in the SATS program. The recommendations coded from this section were closely tied to trends that revealed concerns and problems with the AGATE program (Figure 5).

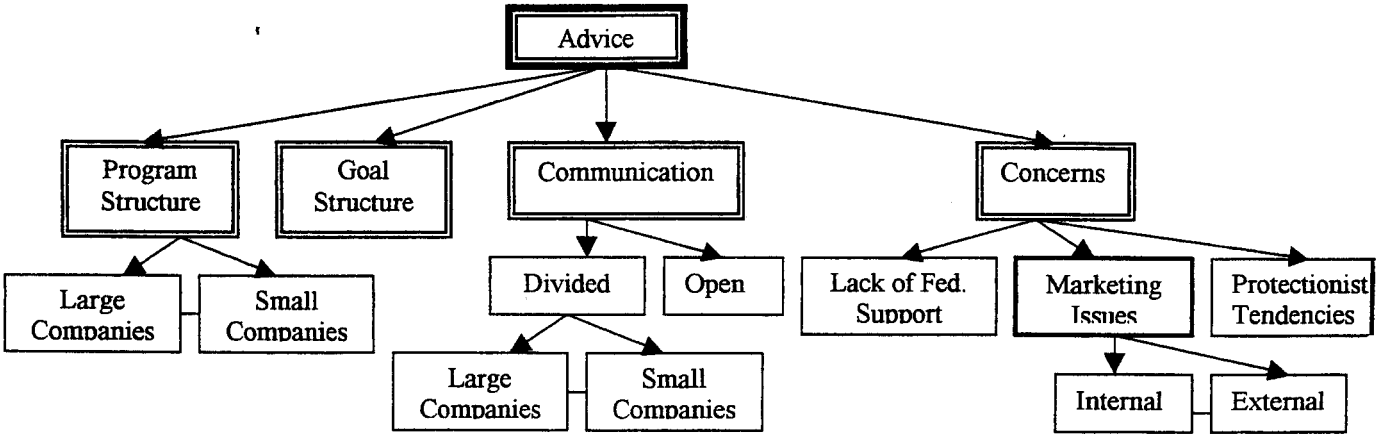

Figure 5. Advice for Future Partnerships Tree Node

According to 11 participants, there was considerable apprehension over which companies were going to be part of AGATE as the program structure was established. This often caused a battle between the larger and smaller companies. Some of the smaller companies had difficulty gaining acceptance. Once the groups were established, the problems did not stop. The division between large and small companies had a greater impact than the battle between competing interests. Eleven of the participants saw an even bigger problem in learning how to work together. The in-fighting was mainly the result of a 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 the 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. This muddled the process and made working together difficult.

The clash between open and closed organizational systems was strongest within this area. This illustrated also the inconsistency between individual organizational goals and those of AGATE. The lack of a definitive program structure that could adapt to the changing needs and parameters of the program emerged as a significant trend

that may affect future partnerships. When combined with goal structural issues, the two were capable of having a debilitating effect on AGATE and any future partnerships.

The lack of structure had several results. A principal limitation was its restriction on information sharing. According to seven participants, this unstable structural nature further contributed to security consciousness that restricted collaboration. While AGATE enabled companies to work toward common goals, it took three years before the sharing really started in some of the work packages. By then, most of them realized they could work together and survive and even thrive. The ones who did not reach this realization usually quit. Six participants also noted planning failures and project delays as impeding 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.

Communication was another key area that will be a factor in future programs. Open communication, though much desired, was seldom realized throughout the life of the AGATE program. While this initially seemed to be one of the larger problems, the division between the large and small companies and problems with the goal structure eclipsed it in the data analysis. Eleven participants expressed frustration with the loose arrangement between the participants who allowed the poor communication to continue without repercussion. Some of the communication issues were caused by the top down when reports and requests for updates were not responded to in a timely fashion. Many 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. Participants said that there should be careful and prompt communication between work package leaders and participants. Establishing a trust factor and relationship building upfront, will set the tone for future collaboration and sharing that has to happen. Much of the communication failure was attributed to shortcomings in the federal support as indicated by its leadership and management. These areas are examined more closely within the confines of the Concerns node.

The primary concern, outside of communication and structural issues, focused primarily on the questionable support of the federal government. Lesser concerns included missed marketing efforts and the limitations associated with the protectionist mindset of many of the participants. While this mindset did ease throughout the course of the program, the inconsistent support from the government continued to plague the program and goal structures. Leadership and management were not able to maintain positive control of the program due to a variety of events often beyond the control of the individual representative. Budget cuts and personnel changes were symptoms of the problem. Also of concern, marketing was viewed as a missed opportunity. Many participants said this would have been an ideal time to begin gaining support not only from other professional in related industry, but also in beginning to educate and ease the general public into an appreciation for general aviation. By not taking on the role of a marketer, AGATE failed to address an audience that would continue to be more prevalent with follow-on programs like SATS. These concerns weighed heavily in the participants' recommendations and advice for future partnerships. They suggested by recognizing and addressing these concerns, future programs would be able to gain more solid ground in achieving their goals.

CONCLUSION

The findings revealed a shared sense of discovery. As the coding emerged, the results were evaluated within the context of the policy research construct to help determine applicable patterns and behavioral trends. This additional review enabled the researcher to better define the patterns and trends in terms of specific actions and possible future application. Both NVivo and the policy research construct allow for continued evaluation and feedback as the nuances of the data are explored.

Most participants were satisfied with their involvement, but some believed the government bureaucracy limited their effectiveness and drove good partners away. The forming of relationships was a lengthy process, usually taking about two years, before the participants were able to trust each other. This delay reduced the power of AGATE. By the time the relationships were formed, the program was one-third complete. With only one exception, the participants would gladly join AGATE again. Granted, the majority would apply the lessons learned over the last seven years to avoid some of the pitfalls and stalemates that divided the various work packages at different stages. 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. Strengthening the underlying social and technical elements of each work package would have helped to alleviate some of the initial tensions and increased the resulting performance results.

This study showed the connection among the diverse perceptions expressed during the interview portion of the data collection. The identification of policy issues and the subsequent acquisition of data facilitated the analysis. By producing analytic findings, the researcher was able to contribute possible policy change results and

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recommendations. Further analysis of the similar and dissimilar reaction in terms of the policy research construct, showed how the connection of participant observations rendered various valuable trends of this partnership alliance. These trends may be applied to other programs with similar partnership orientations that may be a consequence of this foundational group as well as for partnerships not yet considered. This use of instrumental reasoning allowed the researcher to better discern the significant trends that offered context to future programs.

Even as AGATE was declared a success by its program literature and numerous participants, the majority of participants acknowledged that the program's promise failed to be fully realized. To ensure the success of program of this nature, the appropriate structure must be established prior to it commencing. Likewise, the federal government and each participant, regardless of affiliation, must be completely and explicitly dedicated to the program goals. According to the study's findings, for SATS to flourish, it should employ AGATE's hard-learned lessons and not seek to recreate a new course of action.

A stronger emphasis on the elements addressed by the sociotechnical systems theory during the program development would have helped to eliminate many of the obstacles the participants encountered at the onset of the program. By addressing at the onset the barriers associated with competitors collaborating, as well as the formation of groups to include such diverse participants, the AGATE program may have been more effective in achieving its performance goals. Greater attention to the sociotechnical elements influencing its operation would likely have alleviated some of the earlier tensions, increased communication, and bridged the way for more rapidly achieving its goals.✈

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