

**THE SMALL AIRCRAFT TRANSPORTATION SYSTEM (SATS):
RESEARCH COLLABORATIONS WITH THE NASA LANGLEY RESEARCH CENTER**

A NASA Nebraska Space Grant & EPSCoR Sponsored Research Endeavor

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Abstract

The aviation industry is an integral part of the world's economy. Travelers have consistently chosen aviation as their mode of transportation as it is reliable, time efficient and safe. The outdated Hub and Spoke system, coupled with high demand, has led to delays, cancellations and gridlock. NASA is developing innovative solutions to these and other air transportation problems. This research is being conducted through partnerships with federal agencies, industry stakeholders, and academia, specifically the University of Nebraska at Omaha. Each collaborator is pursuing the NASA General Aviation Roadmap through their involvement in the expansion of the Small Aircraft Transportation System (SATS). SATS will utilize technologically advanced small aircraft to transport travelers to and from rural and isolated communities. Additionally, this system will provide a safe alternative to the hub and spoke system, giving more time to more people through high-speed mobility and increased accessibility.

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(White Paper)**

An Overview of Capabilities

Rationale

The aviation industry is an integral part of the world's economy. Travelers have consistently chosen aviation as their mode of transportation as it is reliable, time efficient and safe. They are encouraged to use aviation in its varied forms for both business and personal purposes. However, commercial airlines are required to follow routes that have been designated by the out-dated Hub and Spoke system. This, coupled with high demand, has led to delays, cancellations and gridlock.

The need for efficient options for business and personal travel is anticipated to increase steadily. Yet even as the airline hubs become more and more crowded, there seems to be no immediate answer to the problem. This system emphasizes large airports and large aircraft, and requires travelers to fly long distances through metropolitan areas to be advantageous. Airline management will find their customers becoming increasingly frustrated by increases in both safety and congestion problems. The decrease in customer satisfaction and overall efficiency will lead to loss of revenue, opportunities and time.

Those passengers who are repeatedly disappointed by what is currently available will seek other avenues of travel. Perhaps consumers will look to the five thousand small airports throughout the United States to alleviate their transportation problems. Unfortunately, travelers will find that no business strategies have been created and no federal funding has been delivered to address the air transport needs of rural and isolated communities. Even the Federal Aviation Administration lacks the budget to deliver the efficiencies that the aviation industry demands. Without additional business, these small airports will remain underutilized.

The SATS Concept

The National Aeronautics and Space Administration (NASA) is developing innovative solutions to these and other air transportation problems. This research is being conducted through partnerships with federal agencies, industry stakeholders, and academia, specifically the University of Nebraska at Omaha. Each collaborator is pursuing the NASA General Aviation Roadmap through their involvement in the expansion of the Small Aircraft Transportation System (SATS).

SATS is intended to utilize technologically advanced small aircraft to transport travelers to and from rural and isolated communities. Additionally, this system will provide a safe alternative to the hub and spoke system, giving more time to more people through high-speed mobility and increased accessibility. The benefits of SATS include, but are not limited to, economic development, intermodal connectivity and a revolution in exportable transportation.

Those who created this concept recognized the importance of time and remained sensitive to how long the execution of this system would take. Therefore, the SATS researchers set a goal in 1999 to reduce public travel time by half in ten years and two-thirds in 25 years. Additionally, this would be completed at equivalent highway system costs, increasing mobility for all of the nation's communities through advanced on-demand air transportation. The envisioned outcome is to increase "connectivity" between remote communities and transportation centers in urban areas by utilizing the nation's 5,400 public-use general aviation airports. This allows isolated communities to receive safe, affordable and timely transportation. Those working on the development of this project have remained faithful to this timeline and fully expect this goal to be accomplished.

Nebraska SATS Collaborative Research Team (CRT)

The Small Aircraft Transportation System Collaborative Research Team (SATS CRT) is highly productive in its research endeavors. This CRT develops and implements a research agenda to support SATS research activities at NASA's Langley Research Center (LaRC). Although the SATS CRT work clearly focuses on SATS, it is not confined to a single discipline or topical area. Research projects undertaken by CRT members include systems engineering and decision support analysis, policy analysis, network development research, and financial analysis. In each case, the SATS team is progressing towards its larger objective of conducting research that is both credible and useful to decision makers within and outside NASA. The SATS CRT has produced a number of research outcomes related to its work in Year 1. The SATS CRT has secured non-EPSCoR funding through its participation in the North Carolina – Upper Great Plains SATSLab team, which is led by the Research Triangle Institute.

Scott Tarry has replaced Russell Smith and is working to coordinate the activities of the CRT so they are both responsive to the various needs expressed by the NASA SATS team at LaRC and part of a coherent and complementary research agenda. Tarry maintains regular contact with SATS officials at LaRC and executes regular meetings of UNO SATS researchers and support staff. Tarry met with Bruce Holmes, who replaced Mike Durham as Technical Monitor in January at the Transportation Research Board Meetings in Washington, DC. In addition to these administrative functions, Tarry oversees three projects. The first examines SATS as a policy alternative to Essential Air Service, which is the government subsidized program that provides air service to small communities. Understanding whether small communities and national policy makers will accept SATS as credible and reliable for small community air service will determine whether it will succeed as a transportation system for ordinary Americans. The second project focuses on insurance and endeavors to determine whether insurance costs associated with SATS aircraft and operational characteristics will present a critical barrier to the successful implementation of the system. Finally, Tarry is supervising the work of Patrick O'Neil, a PhD student in Public Administration. O'Neil has prepared an annotated bibliography on technologies that are relevant to flight operations in the SATS program. O'Neil met with NASA Langley researchers in the initial stages of his project. The bibliography was submitted to LaRC for use by researchers at NASA in SATSLab teams that are engaged in the flight demonstration projects.

The SATS CRT's focus is on the implementation of a transportation system that will enhance economic development opportunities for the people of Nebraska, especially those living in small communities and rural areas where air transportation services are inadequate or nonexistent. Working with the Nebraska Department of Aeronautics and other relevant state officials, the CRT believes its research will have a real and significant impact on the quantity and quality of air transportation services in the state.

Individual Contributions to the SATS Project

Massoum Moussavi aids in LaRC's on-going effort to develop a computer-based decision support system/model for SATS implementation. The focus of Moussavi's research is the implementation of this model for managing SATS planning, design, and operation within the State of Nebraska. A direct outcome from these efforts is the Master's thesis by Moussavi's student, Jaime Vargas, who received his MS in Civil Engineering in May 2002. Vargas developed important sub-models for the more comprehensive decision support model. His sub-models of demand forecasting, airfield, terminal, and ground transportation provide a solid foundation for the larger project. Moussavi continues his own efforts to develop a number of other sub-models, including mobility, accessibility, and travel time. Moussavi also contributes to the SATS assessment and analysis work conducted at LaRC and is in regular contact with Jerry Hefner and Stuart Cooke, Jr., who lead that effort for NASA's SATS team. Moussavi coordinates research conducted by other team members, so that the team's diverse research projects contribute to the decision support model development efforts in Nebraska and at the national level.

Brent Bowen is contributing to the SATS team through his efforts on two projects. First, he oversees the CRT's analysis of security issues related to general aviation. It is clear that security issues are of increased operational and political importance in the current environment. Second, Bowen continues to coordinate research on SATS policy issues, which include papers in process regarding a critical review of SATS program development and recommendations for future direction and evaluation. Bowen is also exploring the organizational transition from AGATE to SATS in an effort to understand lessons that can be learned from the AGATE experience and integrated into the successful development of the SATS Consortium, which will consist of government, industry, and academic partners. This work is facilitated by a research fellowship awarded to Nanette Scarpellini-Metz. Metz visited LaRC in the summer of 2001 where she interviewed key participants in AGATE and SATS and collected archival data related to the development of AGATE and the transition to SATS.

John Bartle continues his work on financial issues related to SATS implementation. Bartle's work is important for the successful development of the decision support model noted above, since financial constraints appear to be among the most critical barriers to implementation of SATS in rural and isolated communities, where SATS is especially relevant for Nebraska and the Great Plains region. Bartle's work relies on the Nebraska State Aviation System Plan (NSASP), which is in the final stages of revision. The NSASP will allow Bartle to match the financing options he has been evaluating with the specific needs of airports and communities in the Nebraska aviation system. This work has been slowed by the delayed official release of the

NSASP, but promises to be a real and credible contribution to understanding important implementation issues in Nebraska and around the nation.

Scott Tarry is also overseeing the development of an educational web site, known as SATS 101, which is designed to provide information about SATS that can be used by students, policy makers, and the general public. Russell Smith continues to develop the survey instrument he will use to study the prospects for the development of regional organizations that could enhance the coherent development of SATS as a regional transportation system. John Bartle continues to explore airport funding issues as they relate to the implementation of SATS. The release of the recently completed Nebraska State Aviation System Plan will provide important inputs for Bartle's study. Brent Bowen oversees the work of Todd Bonkiewicz, UNO graduate student, who is exploring the issue of general aviation security with the objective of providing a foundation of knowledge from which the security implications for SATS can be more carefully assessed and understood. Scott Tarry is overseeing the work of Pat O'Neil, a PhD student who has compiled an annotated bibliography of flight technology research relevant to SATS.

Progress of the SATS CRT is currently monitored through group and individual meetings. These meetings allow members of the SATS team to compare their progress with the expectations and objectives established in the CRT's original proposal. Evaluations are based on the quality and quantity of research outcomes, such as conference papers and published manuscripts.

Collaborative Efforts

The SATS CRT has partnered with a variety of academic institutions and organizations supporting the aerospace industry. Specific collaboration has been established and continues to flourish between the SATS CRT and the Aviation Institute and the School of Public Administration, which are both housed on the University of Nebraska at Omaha campus. Additionally, Massoum Moussavi maintains collaboration by representing the University of Nebraska at Lincoln's College of Engineering. A mutually beneficial relationship has also been established with Shelly Avery of the Nebraska Indian Community College in Macy, Nebraska.

On a national level, collaboration has been established with NASA's Langley Research Center in Hampton, Virginia. The SATS CRT recognizes the importance of maintaining continuous contact with NASA, and specifically with NASA Langley Research Center (LaRC), in Hampton, Virginia. Jerry N. Hefner, Manager of SATS Transportation Systems Analysis and Assessment, has become the SATS CRT primary contact at LaRC, while Stuart Cooke, Jr. has provided guidance regarding systems engineering. The SATS CRT is working to be responsive to needs of the SATS team at NASA LaRC. Continued emphasis will be placed on policy, finance, and systems assessment, although specific research objectives may change. Such changes will be coordinated with the SATS team at NASA LaRC.

Collaboration has also been maintained with the NASA Nebraska Space Grant Consortium (NSGC). The NSGC provides additional funding for support of SATS CRT researchers and staff. Additionally, the Nebraska Department of Aeronautics' Director, Kent

Penney, and State Airport Engineer, Diane Hofer, assist the SATS CRT with data and other research materials related to the Nebraska Aviation System Plan and aeronautics issues in the state.

Community and Educational Outreach

UNO SATS research is designed to provide support to the SATS concept through extensions of research activities. With new technologies and available information, the World Wide Web can play a greater role in communicating SATS information. The Nebraska SATS website (www.unomaha.edu/~unoai/sats/) educates system users, provides support to academic classroom activities, and serves as a discussion forum for all parties or stakeholders. Additionally, this support component encompasses public appearances to interested parties, hosting information booths, participating in national and regional conferences, and developing an on-line SATS course.

Personnel from this component are developing a SATS educational outreach pilot program. This consists of workshops and hands-on experiences for Native Americans and other minorities in cooperation with the NSGC Nebraska Native American Outreach Program's (NNAOP) Family Science Initiative. The SATS CRT will continue to work with UNO's NNAOP personnel, led by Dr. Hank Lehrer, Principal Investigator. The NNAOP has established a variety of on-going, successful programs for Nebraska's Native American populations. SATS CRT members have established a SATS related curriculum for integration into the NNAOP Family Science Initiative. Members of the team are planning visits to Nebraska's Native American public schools to introduce SATS to tribal children and their families.

Efforts for educational outreach in the first year evolved from a state mission to a regional mission. Nebraska now plans for national level involvement with a national SATS symposium. Nebraska program staff work closely with Dr. Thomas Pinelli and Mr. Roger Hathaway in the Office of Education at NASA LaRC to ensure that the most up-to-date information is available for program effectiveness. All published material on SATS will be provided to the National Transportation Library for on-line dissemination, archived at the University of Nebraska at Omaha Library, and abstracted in key international databases.

Public outreach and education has been a priority for the SATS team. CRT members have presented SATS related work to a number of different audiences in Nebraska and around the nation. The CRT is also preparing a web-based instructional curriculum (SATS 101), which can be used by educators interested in teaching about air transport and SATS or by members of the general public who are interested in learning more about the project.

Technological Efforts

The SATS CRT continues to maintain a website related to its research projects and outcomes. A variety of proposal and symposium materials are available on this website as well. The CRT also publicizes its SATS research and the SATS program generally through the distribution of CDs, NASA EPSCoR brochures, other SATS images and logos.

The SATS CRT is in the process of developing an educational and informational web site called SATS 101. Graduate and faculty researchers are drawing from their various SATS research projects to present relevant information to the public in an interesting and accessible format. It is anticipated that this website will be up and running by May 1, 2003.

Diversity Initiatives

Conscious efforts have been made to ensure the participation of underrepresented groups in the SATS CRT. Women are represented at all levels of the CRT, including staff researchers, graduate assistants, and faculty researchers. Michaela Schaaf, Research Associate and Instructor, is being mentored by Brent Bowen. Minority groups, Hispanics and Native Americans, are represented as well. Efforts to identify and recruit additional CRT members from underrepresented groups is a priority of this research program.

SATS CRT Outcomes

The CRT is seeking to develop roles for two new junior faculty members. Mike Larson of the UNO Aviation Institute and Kenneth Kriz, who was recently hired to join the UNO Department of Public Administration, are being groomed for these positions.

The SATS CRT is participating in the North Carolina / Upper Great Plains (NC/UGP) SATSLab Team that was awarded a contract from NASA to pursue research related to the demonstration and implementation of SATS technologies. Scott Tarry, representing the UNO Aviation Institute, is serving as principal investigator on a \$100,000 sub-contract from team lead Research Triangle Institute. The purpose of the sub-contract is to fund initial studies related to systems assessment and analysis. The research will continue throughout 2002 as NASA has extended the deadline for this work. The SATS CRT plans to continue its participation in the NC/UGP SATSLab Team as NASA's SATS demonstration project expands towards its ultimate 2003 flight test objective.

The SATS CRT's work has been publicized in both UNO and UNO press releases and has received coverage in the Omaha World Herald. The CRT's work has also been reported in various trade publications and newsletters. The CRT will continue its efforts to publicize its research findings and disseminate its results globally. A complete listing of SATS CRT Team Outcomes can be found in Appendix A.

Aviation Safety

The Nebraska SATS initiative has begun to explore aviation safety components affected by comprehensive systemic change. This initial investigation is coordinated with the NASA LaRC SATS Program and in consultation with Mike Durham, NASA LaRC Aviation Safety Program liaison to SATS. Candidate areas of focus include, but are not limited to, areas such as bio-medical and human factors, maintenance, manufacturing, support systems, airport environment, pilot education and regulatory issues impacting safety. Nebraska, as co-lead for

the NASA Space Grant/EPSCoR Aeronautics Program, will seek to engage other space grant and EPSCoR states in this area of inquiry.

Conclusion

The implementation of SATS would be a dream come true for communities that urgently need air service and medical air transport. This system is a clear concept, made credible by extensive research. Although SATS is not an additional system for commercial airlines, it should be viewed as a component of aviation, which will help alleviate congestion at airline hubs to allow for increased customer satisfaction. This safe travel alternative will free both passengers and products from transportation system delays. SATS will better serve existing markets and extend air service to communities currently neglected by the airline industry. This will be accomplished through the use of advanced small aircraft, new innovations in navigation and communication technologies, and new business models.

SATS has the potential to dramatically improve access to small and isolated communities while developing over 5000 general aviation airports into operational business centers. New consumers and producers will be linked to the global economy rather than being confined to their immediately surrounding areas. Time is of the essence in the SATS endeavor. The opportunity to educate the public is upon us. When this phase of implementation is complete, travelers will be more knowledgeable of their transportation options and more able to actively participate in saving the future of transportation.

Recent Activities

1. Development of a research agenda to support SATS research activities at NASA's Langley Research Center (LaRC).
2. Research projects undertaken by CRT members include systems engineering and decision support analysis, policy analysis, network development research, and financial analysis.
3. The SATS CRT has secured non-EPSCoR funding through its participation in the North Carolina – Upper Great Plains SATSLab team, which is led by the Research Triangle Institute.
4. Tarry maintains regular contact with SATS officials at LaRC and executes regular meetings of UNO SATS researchers and support staff.
5. Tarry met with Bruce Holmes, who replaced Mike Durham as Technical Monitor in January 2002
6. Tarry oversees three projects:
 - a. SATS is examined as a policy alternative to Essential Air Service.
 - b. Insurance and insurance costs associated with SATS aircraft and operational characteristics are examined.
 - c. Preparation of an annotated bibliography on technologies that are relevant to flight operations in the SATS program.
7. Moussavi has developed a computer-based decision support system/model for SATS implementation.

8. Vargas has developed important sub-models of demand forecasting, airfield, terminal, and ground transportation provide a solid foundation for the larger project.
 9. Moussavi is in regular contact with Jerry Hefner and Stuart Cooke, Jr.
 10. Brent Bowen oversees the CRT's analysis of security issues related to general aviation.
 11. Bowen continues policy research initiatives, which include papers in process regarding a critical review of SATS program development and recommendations for future direction and evaluation.
 12. Bowen is exploring the organizational transition from AGATE to SATS to understand lessons that can be learned from the AGATE experience and integrated into the successful development of the SATS Consortium.
 13. John Bartle continues his work on financial issues related to SATS implementation.
 14. Russell Smith is developing a survey instrument utilizing Delphi techniques in preparation for his study of regional network development as it relates to air transportation in Nebraska and the Great Plains.
 15. Smith continues to work with the Nebraska Department of Aeronautics Director, Kent Penney, to identify state and university collaborations on the SATS project.
 16. CRT members have presented SATS related work to a number of different audiences in Nebraska and around the nation.
 17. The CRT is preparing a web-based instructional curriculum (SATS 101), which can be used by educators interested in teaching about air transport and SATS or by members of the general public who are interested in learning more about the project.
 18. Collaborations are maintained with Shelly Avery at the Nebraska Indian Community College.
 19. Collaborations are maintained with Bruce Holmes in the General Aviation Program Office at Langley Research Center.
 20. Collaborations are maintained with Stuart Cooke in the Systems Engineering Department at Langley Research Center.
- A proposal for \$37,000 has been submitted to NASA via the Research Triangle Institute.

Further Information

If you would like further information regarding the Small Aircraft Transportation System, or would like to collaborate with the Nebraska CRT, please contact:

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This overview was prepared and regularly updated by Dr. Scott Tarry, Dr. Brent Bowen and, Mrs. Jocelyn Nickerson, with contributions by various SATS CRT members.

SATS Personnel

Principal Investigator:

Dr. Scott Tarry

- Associate Professor at the University of Nebraska at Omaha Aviation Institute

Faculty Investigators:

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- Director and Professor at the University of Nebraska at Omaha Aviation Institute
- Director of the NASA Nebraska Space Grant & EPSCoR
- Principal Investigator of the primary funding source, the NASA Nebraska EPSCoR Program

Dr. John Bartle

- University of Nebraska at Omaha - Associate Professor, School of Public Administration

Dr. Hank Lehrer

- Professor at the University of Nebraska at Omaha Aviation Institute

Dr. Massoum Moussavi

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Mrs. Michaela Schaaf

- Co-Director at the University of Nebraska at Omaha Aviation Institute

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- Geospatial Extension and Research Specialist, University of Nebraska at Omaha

Mr. Scott Vlasek

- Technology Manager at the University of Nebraska at Omaha Aviation Institute

Appendix A

Team Outcomes

Development of two new junior faculty members; Mike Larson of the UNO Aviation Institute and Kenneth Kriz of the UNO School of Public Administration.

The SATS CRT is participating in the North Carolina / Upper Great Plains (NC/UGP) SATSLab Team that was awarded a contract from NASA to pursue research related to the demonstration and implementation of SATS technologies.

Scott Tarry is serving as principal investigator on a \$100,000 sub-contract from team lead Research Triangle Institute.

Continued SATS SRT participation in the NC/UGP SATSLab Team as NASA's SATS demonstration project expands towards its ultimate 2003 flight test objective.

Master's thesis by Jaime Vargas who received his MS in Civil Engineering in May 2002.

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