

V. EXTERNAL PARTNERSHIPS

1. PARTNERSHIP OBJECTIVES

The Center seeks to develop, maintain, and expand partnerships that:

- Fundamentally enhance the Center's research efforts.
- Serve the Center's educational mission.
- Positively impact knowledge and technology transfer from the Center.
- Contribute to the diversification of the information technology workforce.

Developing partnerships is a primary means for accomplishing the goals set out in the Center's four key mission areas. The Center serves as a focal point for other organizations that are interested in pursuing the development of next generation materials for information technology applications, and partnerships naturally follow from the interests and goals that are shared between Center personnel and these external organizations. A number of educational and commercial organizations are seeking to establish strong links to the STC in order to build on the world-class research and educational progress that is being demonstrated within the STC. The Center's Industrial Affiliates Program is already proving to be a key gateway for companies to become more closely involved in the research advances being made within the Center.

The Industrial Affiliates Program has established a formal relationship between the members of the Center and six companies that are keenly interested in the future development of commercial materials and devices for the information technology industry. The current group of Industrial Affiliates provides the Center with broad representation from across the commercial sector. This ranges from innovative chemical companies such as Eastman who are looking to supply the next generation of fundamental compounds, to space and aerospace innovators such as Lockheed Martin and Boeing, and computing component manufacturers such as Fujitsu. The Industrial Affiliates also serve as a valuable resource to Center personnel, providing a perspective on industry trends and future needs that helps to guide the potential applications of STC research.

Although the Industrial Affiliates program is relatively new, a number of the Affiliate companies have already increased the intensity of their interest in Center research beyond the core Affiliates Program activities. Companies such as Eastman Chemical, Boeing, and Battelle have been exploring additional partnership activities with Center personnel through site visits to Georgia Tech and the University of Washington. Battelle, Fujitsu, and Lockheed Martin are looking to evaluate Center supplied materials for potential application in their product development programs and material transfer agreements are being negotiated.

Center participants are leveraging the strength of their STC affiliations, and the collective research and education progress among the Center's Thrusts, to initiate and establish new relationships with external partners. Partnership activities that leverage the Center's research accomplishments and ever growing national and international profile include:

1. Undergraduate and graduate program design and teaching assistance, to develop and strengthen MDITR-related courses, student exchange, and degree programs.
2. Exchanges with key companies in the chemicals, materials, and devices application sectors, some of which have led to sponsored research partnerships.
3. Involvement in educational networks that help to spread the influence and impact of the Center's focus beyond its participating institutions and personnel.

4. Participation in materials and devices development programs that are funded by government agencies whose goals overlap with but are fundamentally distinct from those of the Center.

We are recording partnership activity based on the formal relationships that are being initiated, established, and further developed between Center personnel and external partners. Partnerships in development may still be informal in nature, but they are characterized by a deepening interaction between Center personnel and personnel at institutions and organizations outside of the STC which indicates that progress is being made towards the establishment of a formal relationship. As these initial interactions grow, and formal relationships are established, both new and existing partnerships between STC personnel and external organizations will be tracked.

Formalized partnerships fundamentally reflect areas in which the mission of the STC overlaps with the mission of our external collaborators. As a result, performance indicators for our partnership activities are shared in common with many of the performance goals found in sections I-IV, as these are the direct measures of our mission as a Center.

A number of the Center initiatives in the areas of education and outreach, knowledge transfer, and fundamental research serve as a base from which to develop new relationships and partnerships. The Industrial Affiliates Program, and the two way dialog that it enables with industry, also serves as a foundational part of the Center's knowledge transfer activities. It allows motivated industrial partners to gain an in-depth appreciation for cutting edge Center research and its future information technology applications.

Widespread recognition of the level of excellence achieved in the Center's programs is demonstrated in the extensive participation of Center personnel in program design and review activities at other institutions and agencies around the world. STC personnel have established a number of formal commitments to help develop programs that will complement the Center's activities, and a number of new partnerships are expected to grow out of these involvements. At Norfolk State University, STC personnel are serving as advisors to the Center for Research and Education in Advanced Materials, providing intensive summer lecture programs to undergraduate and graduate students and helping with the design of a doctoral program in Materials Science. An intensive summer lecture series on STC related topics will be delivered by STC personnel at Alabama A&M University and Florida International University, with follow-up student visits planned at STC research facilities. Student exchange programs are also being established between STC personnel and both Northern Arizona University and Yavapai College, allowing students to gain hands-on experience in the synthesis and characterization of new compounds, activities that are made possible through access to unique STC research facilities. An ongoing partnership with students and researchers at New Mexico Highlands University has resulted in productive student exchanges and the recent co-authorship of 5 research articles. Center personnel have also been magnifying the impact of the STC internationally through research collaborations and education efforts made possible through a Georgia Tech – CNRS partnership in France and through a developing partnership with the Chinese University of Hong Kong and input to the Academia Sinica in Taiwan.

In addition to the established relationship with our Industrial Affiliate program partners, a number of other companies have either established, or are working towards establishing, partnerships with Center research groups. Established partnerships with Intel and Lumera have resulted in sponsored research funding that has contributed to Center research over the past year. 3M is interested in accessing the unique expertise and capabilities of Center researchers, and non-

disclosure agreements are being negotiated to allow for a more formal and in-depth partnership to be considered. Initial interest in establishing a partnership relationship with Center personnel has been expressed by Dow Chemical, Dow-Corning, HP, and Brewer Science. It is hoped that these companies will enter into formal arrangements to engage in collaborative research activities with Center personnel over the coming year. Organic Lighting Technologies has applied for SBIR funding in partnership with Center personnel and STC researchers are formally linked with a number of small companies through their scientific advisory boards.

A number of complementary research programs are in place that bring together both Center and non-Center personnel in formal collaborative relationships. These programs, such as the DARPA funded "Super Molecular Photonics" (MORPH) project and the MURI funded "Smart Skins" project, provide a vehicle for Center personnel to enter into new partnerships with research groups outside of the Center. The DARPA program will also lead to the development of new industrial partnerships, further leveraging STC research efforts.

2. PARTNERSHIP PERFORMANCE AND MANAGEMENT INDICATORS

The Center has established a database to track activities and interactions that occur with its partners. Additional information is collected through the input of the Center's researchers, staff, and students. Below we highlight eight indicators that help us to describe the Center's ability and willingness to form partnerships with key individuals and organizations.

1. Number and characteristics of partners
2. Level and nature of support provided (if any)
3. Number and quality of faculty & student interaction with partners (e.g. visiting scientists, student internships)
4. Materials and technologies shared with partners
5. Number of agreements signed with external organizations to facilitate interactions
6. Use of STC facilities (e.g. SIF) by partners and vice versa
7. Number of joint publications and patent applications
8. Number of Center workshops and conferences attended by external partners

3. PARTNERSHIP PROBLEMS ENCOUNTERED

The Center's researchers typically have a number of sponsoring organizations for their research and they must maintain their obligations to all of these organizations. A balance must be maintained on an individual and group level, between participation in new partnership activities and the need to fulfill pre-existing obligations. To date, these potential constraints have not prevented the initiation of new partnership activities by Center personnel but the number of new partnerships will ultimately be limited by the need to manage the time and energy commitments of Center personnel.

4. PARTNERSHIP ACTIVITIES

Partnership Activity		Industrial Affiliates Program	
Led by		NSF-STC-MDITR	
Participants			
	Name of Organization	List Shared Resources (if any)	Use of Resources
1.	Battelle	STC personnel, material	Ongoing consultation with EO/AOS Thrust members, material to evaluate, annual meeting attendance
2.	Boeing	STC personnel	Collaborative research with EO/AOS Thrust members, annual meeting attendance
3.	Eastman Chemical	STC personnel	Site visits to Georgia Tech and UW, annual meeting attendance
4.	Ford	STC personnel	Annual meeting attendance
5.	Fujitsu	STC personnel, material	Material for evaluation
6.	Lockheed Martin	STC personnel, materials	Ongoing consultation with EO/AOS Thrust members, material for evaluation, annual meeting attendance

Goals: To provide a gateway for a focused group of key industrial partners to strengthen their involvement with Center personnel and research activities within in the STC. By establishing an ongoing dialog with the Industrial Affiliates, Center personnel are kept informed of the potential commercial applications of their research, and they are able to develop materials and devices that will best meet the needs of future industrial users.

Output: Three main objectives were successfully met in this the first year of the Industrial Affiliates Program. The goal of recruiting six participating companies was met, with each of them paying a membership fee to join the program. An exclusive Industrial Affiliates section of the Center website was developed. This provides Affiliate members with up to the minute information on pending publications and provides resumes for graduate students and research associates who are interested in industrial research positions. And finally, an inaugural Industrial Affiliates Research Expo was held, allowing for a full day of personal interaction between Center personnel, students, and representatives from our Affiliate companies.

Anticipated Outcome and Impact: In the short time that the Industrial Affiliates program has been running, there has already been some real progress towards concrete outcomes. Eastman Chemical, an Affiliate company, has been visiting Center personnel and research facilities as they look at the possibility of establishing long-term research partnerships with Center personnel at multiple institutions. The integration of research capabilities across the Center institutions allows Industrial Affiliates to access the world class expertise of the STC in a “one-stop” fashion. The planned sharing of a common set of materials between the various STC institutions and Industrial Affiliates such as Battelle, Eastman, Fujitsu, and Lockheed Martin will allow for the integration of research discoveries in a variety of material and device applications in the academic and industrial settings.

Partnership Activity	Industrial research collaborations
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Led by		NSF-STC-MDITR	
<u>Participants</u>			
	Name of Organization	List Shared Resources (if any)	Use of Resources
1.	Intel	STC personnel and facilities	Technical information and collaborative research
2.	Lumera	STC Personnel and facilities	Collaborative research and material development
3.	Photonic Systems	STC Personnel and facilities	Collaborative research and device development
4.	Durel	STC Personnel and facilities	Collaborative research and material development

Goals: A number of companies have been attracted to the research being performed by Center personnel. These relationships continue to be valuable as they support and validate Center research, and they will serve as a stepping stone for new companies to join the Industrial Affiliates program.

Output: Many of the companies that were early proponents of Center research and supported it directly with research funding continue to provide their support to STC personnel. This serves as an ongoing validation of the progress being made in research and technology development within the Center.

Outcome and Impact: Research sponsors help to leverage the support provided to the STC. Research partners such as Lumera and Photonic Systems serve a critical role in moving the fundamental research discoveries of the Center into real world production methods and prototype devices. In the future, network-ready product prototypes incorporating material and device configurations originating from the STC should be ready for evaluation by potential end users in the information technology industry.

Partnership Activity		Development and delivery of educational and training programs at non-STC institutions and agencies	
Led by		NSF-STC-MDITR	
<u>Participants</u>			
	Name of Organization	List Shared Resources (if any)	Use of Resources
1.	Alabama A&M University	STC personnel	Collaborative research and education.
2.	Norfolk State	STC Personnel	Collaborative research, education, and program development.

Goals: To advance the research and educational activities at STC and partner institutions through the sharing of resources and intellectual exchange. An additional goal is the anticipated increase in the diversity at STC institutions and ultimately in the technology workforce that will result from these partnerships by promoting student involvement from under-represented groups in Center research.

Output: A partnership is being developed with Alabama A&M University, building on the complimentary goals of the STC and their Ph.D. Physics program in Optics and Materials Science. The initial activities in this collaboration are focused on strengthening this Ph.D. program through an instructional collaboration. An ongoing and expanding partnership is in place with Norfolk State University. Instructional, curricular, and program design input is being provided by STC personnel for their M.S. Materials Science program. An initiative to extend this

M.S. program to the Ph.D. level is underway and those efforts are benefiting from the extensive input and support provided by STC personnel.

Outcome and Impact: The delivery of STC focused content at summer education programs for undergraduate and graduate students at Alabama A&M and Norfolk State University is leading to the increased interest in STC research among students in those institutions. STC personnel have hosted students from Alabama A&M at Center research facilities. It is hoped that new educational programs that are tied into the mission of the Center, such as the Ph.D. program in Materials Science at Norfolk State University, will be approved over the next few years and will serve as a tangible impact of the Center's activities.

Partnership Activity		Exchange of personnel, materials, and training resources between STC and minority institutions	
Led by		NSF-STC-MDITR	
<u>Participants</u>			
	Name of Organization	List Shared Resources (if any)	Use of Resources
1.	NMHU	STC research facilities & personnel	Collaborative research and education
2.	Yavapai College	STC research facilities & personnel	Collaborative research and education
3.	Northern Arizona University	STC research facilities & personnel	Collaborative research and education
4.	Clark Atlanta University	STC personnel	Collaborative education
5.	Florida International University	STC personnel	Collaborative education

Goals: To create a broad network of partner institutions that can benefit from the opportunities provided by being linked to the STC, at the undergraduate, graduate, and post-graduate levels. By developing formal links that persist over time, an impact on the curriculum and research focus at the partner institutions is expected. An increased interest in and awareness of Center research activities will provide a source of motivated students, and as a consequence motivated and highly skilled future employees, which will be required to execute the mission of the STC. By targeting partnerships with smaller, minority focused institutions, Center personnel are having a proportionally large impact on the nature of the research and education that students are exposed to.

Output: A partnership with New Mexico Highlands University has led to ongoing student exchanges and research collaborations, resulting in a number of high impact publications being co-authored with Center personnel. Students at Yavapai College are synthesizing compounds that are being characterized and further integrated into device designs by STC research personnel. Northern Arizona University, Florida International University and Clark Atlanta University have established student exchange and education programs with Center personnel.

Outcome and Impact: The five recently co-authored publications that have resulted from collaborations with New Mexico Highlands University have provided additional motivation to broaden the level of interaction and the development of partnerships with other non-STC institutions. The number of new educational partnerships that are being developed with minority institutions follows from the success of previously established partnerships.

Partnership Activity		Development of airborne applications for Center materials	
Led by		Air Force Office of Scientific Research	
<u>Participants</u>			
	Name of Organization	List Shared Resources (if any)	Use of Resources
1	Naval Weapons Laboratory, China Lake	STC personnel, materials	Collaborative research
2.	Boeing-DOD	STC personnel, materials and device design expertise	Collaborative research and student training

Goals: The development of new chip scale wavelength division multiplexing and optical gyroscope devices for airborne applications.

Output: Device prototypes have been successfully developed within the Boeing project. This is the result of an ongoing, integrated effort between Boeing engineers and Center personnel supplying material and device expertise.

Outcome and Impact: The project with Boeing, an Industrial Affiliate of the Center, has demonstrated how the integration of efforts between an industrial partner and Center personnel at multiple institutions can lead to successful results. This will encourage future project work that integrates expertise across the Center with our industrial partners.

Partnership Activity		Development of materials and devices for defense applications	
Led by		Department of Defense agencies	
<u>Participants</u>			
	Name of Organization	List Shared Resources (if any)	Use of Resources
	DARPA-MORPH	STC personnel and research facilities	Material design and synthesis
	MURI-AFOSR	STC personnel and research facilities	Material and device design
	NRO	STC personnel and research facilities	Material and device design

Goals: To develop new materials for sensing and data transmission in a variety of applications, including airborne and space applications.

Output: Lightweight, highly flexible device prototypes resulting from the integration of research across the Center have been demonstrated.

Outcome and Impact: Widespread application of new device designs resulting from Center research is anticipated. Lightweight, compact, and highly efficient devices should be appearing in airborne and space vehicles in the coming years.

Partnership Activity		International programs	
Led by		STC	
Participants			
	Name of Organization	List Shared Resources (if any)	Use of Resources
1.	GTL-CNRS	STC personnel	Collaborative research and education
2.	Academia Sinica	STC personnel	Program review and oversight
3.	Chinese University of Hong Kong	STC personnel, materials	Program design, collaborative research

Goals: To establish strong international networks that will strengthen the work being done by Center personnel. The success of Center research into new technologies will be dependent on the global adoption of the materials and devices being created through Center research.

Output: Center personnel have been focusing a number of their international interactions and partnerships on Center-related projects. Advising administration and students at international programs and directing research at satellite institutions is allowing STC personnel to have a direct influence on research being done outside of the US.

Outcome and Impact: The success that has been realized by Center personnel through their involvement in partnerships such as the GTL-CNRS program has led to the development of more ambitious programs. Center personnel are currently leading efforts to develop more extensive international partnership programs, including a proposed NSF-IGERT funded project and an NSF-International Materials Institute proposal.

Partnership Activity		Center for Technology Entrepreneurship	
Led by		UW School of Business	
Participants			
	Name of Organization	List Shared Resources (if any)	Use of Resources
	CTE	STC personnel, Business School faculty	Collaborative education in technology commercialization

Goals: To advance the commercialization potential of STC research and the business knowledge of Center personnel by interacting with business educators and leaders. By maintaining an ongoing dialog with CTE program participants, Center personnel are able to provide a technology context for their business studies and enhance their awareness of the future applications of Center research. STC students are able to participate in a number of programs that allow them to explore the business aspects of research and technology commercialization.

Output: Center students have been involved with the New Venture Creation Laboratory where the commercial prospects for technology originating in the STC has been evaluated and presented. Graduate students in the STC are pursuing the course based Technology Entrepreneurship Certificate offered through the CTE. Center students are also using their Center research as the basis for entries into the CTE annual business plan competition.

Outcome and Impact: The involvement of Center research personnel and graduate students in the activities of the CTE are leading to two key outcomes. One, the field of technology being discussed within the Business School includes Center research, exposing both Business

students and faculty, and external business people involved with the activities of the CTE, to the promise of Center research. Second, the graduate students within the Center that participate in CTE activities are augmenting their technical training with strong business skills, giving them a set of tools to further advance the commercial applications of Center research into the industrial community.

5. OTHER OUTCOMES AND IMPACTS

Partnership activities run like a thread through all of the core areas of the Center, as a means of achieving Center goals. Additionally, the Center is reaching a stage of maturity in which partnerships are being initiated at a higher level, with partnerships going beyond strictly serving as a mechanism to achieve individual goals and instead serving to advance the mission and vision of the Center in the broadest sense.

These higher level partnerships have been visualized, initiated, and actively developed in year-2, and this will continue in the coming year. Because of the support that the Center-wide mode of operation provides, participants are able to envision large-scale partnerships that leverage the collective expertise and experience of all Center personnel. The ability for the Center to catalyze significant new partnership activities on a number of fronts in years 3, 4, and 5 will serve as one of the legacies of this STC.

6. PLANS FOR NEXT REPORTING PERIOD

Center participants have made substantial investments of time and energy over year-2 to lay the ground work for a number of potential partnership initiatives. It is anticipated that over the upcoming year, partnerships will be further strengthened and formalized on a number of fronts. Ongoing efforts to develop new educational, industrial, and research partnerships will be intensified during year-3.

A number of exciting educational initiatives have been developed, and many of these potential partnerships are currently waiting for funding decisions and other approvals. It is hoped that a number of these national and international projects will begin receiving approval in year-3, allowing Center personnel to integrate these broader educational partnership activities with the Center's educational mission.

The potential commercial impact of our Center technologies is becoming more apparent to potential industrial partners. It is hoped that over the coming year we will be able to leverage the year-2 interactions between Center personnel and key companies in the IT sector to create formal partnerships, expand the number of companies showing a high level of interest in Center research, and increase the magnitude of the relationship with existing partners.

The Center has developed a unique research infrastructure, including both specialized equipment and facilities and expert personnel. As the internal Center programs are now well established and producing excellent results, Center resources will be increasingly available for new projects with external research partners. New partnership initiatives in year-2, where Center expert personnel and specialized facilities were available to outside research collaborators, will be expanded further, and strengthened into new partnerships, in year-3.

The Applied Physics Laboratory (APL) at the University of Washington has initiated a focused research effort in information technology based on interaction with the MDITR STC. In the coming year, we propose to strengthen this interaction and a previously initiated interaction with

the Washington Technology Center. Such collaborative interactions should strengthen our research, education, and knowledge transfer efforts.