



Section 7E Infrastructure

1. Institutional Configuration and the ERC Management Challenge

The technical challenges outlined in our program are significant and overcoming the underlying research barriers will require fundamentally new approaches. The Gordon-CenSSIS management team is comprised of faculty and staff from the four core partners (NU, BU, RPI, and UPRM) and strategic affiliates (INL, LLNL, MGH, MSKCC, WHOI). The management team is augmented by our partnership with companies and government agencies. Effectively managing this complex enterprise presents a challenge equal to the basic research challenges. We understand that each entity within the Center must maintain its own unique charter and work environment. To ensure coherence, we have created Academic and Industrial Partnership Agreements that define respective roles (see Appendix II). These documents describe critical issues ranging from membership on the Board of Directors to Intellectual Property, and the responsibilities and authority vested in the Center's leadership.

2A. Organization, Management Systems, and University Support for the ERC Culture

Gordon-CenSSIS is managed by experienced personnel with proven records of accomplishment. Professor Michael Silevitch directs the Center. As Director, he has full management responsibility, including budgeting funds, resource allocation, risk identification and mitigation, and management progress tracking and reporting. Professor Silevitch's sole responsibility is to direct the Center's operation. As a leader in both electromagnetic research and K-12 education reform, Professor Silevitch has 22 years of experience in the leadership and management of large, multi-institution, multitask, high-stakes initiatives similar to the ERC. Professor Bahaa Saleh is the Gordon-CenSSIS Deputy Director. He is internationally recognized for his research contributions in the areas of photonic sensors and physics-based image processing – key disciplines of the ERC.

Each core institution is represented by an Associate Director: Professors David Castañon (BU), Miguel Vélez-Reyes (UPRM), Badri Roysam (RPI), and Carey Rappaport (NU). Over the past eight years, the aggregate amount of non-core research funding supervised by this team of Associate Directors has exceeded \$15 million. Other senior management team members are David Kaeli (NU), R3 Thrust Leader, Steve McKnight (NU), Education Leader, and Carol Warner (NU), S1 Domain Co-Leader. Members of this "Executive Committee" also lead the Center's three Research Thrusts:

- **R1** Subsurface Sensing and Modeling — Bahaa Saleh and Carey Rappaport
- **R2** Physics-Based Signal Processing and Image Understanding — David Castañon, Miguel Vélez-Reyes, and Badri Roysam
- **R3** Image and Data Information Management — David Kaeli

Because of the critical importance of the I-PLUS process and the unifying framework, Professors Silevitch and Saleh provide overall leadership for this area. This is augmented by Gordon-CenSSIS researchers and domain experts who provide leadership for the testbeds and system-level.

In addition to the program leaders, John Beaty is responsible for Center administration and the development of R&D programs, Dr. Philip Cheney is the Senior Consultant for Corporate and Government Partnerships, Dr. Paula Leventman is the Diversity Coordinator, Kristin Hicks is the Partnership and Outreach Services Coordinator, and Claire Duggan is the K-12 Co-Coordinator, Anne Magrath is the Director of Finance & Research Contracts Administrations Operations and Deanna Beirne is the Computer Systems Manager & Web Developer. Figure 7E-1 shows the Center's organization chart. Gordon-CenSSIS is organized to address both the unique and different interests of the four academic part-

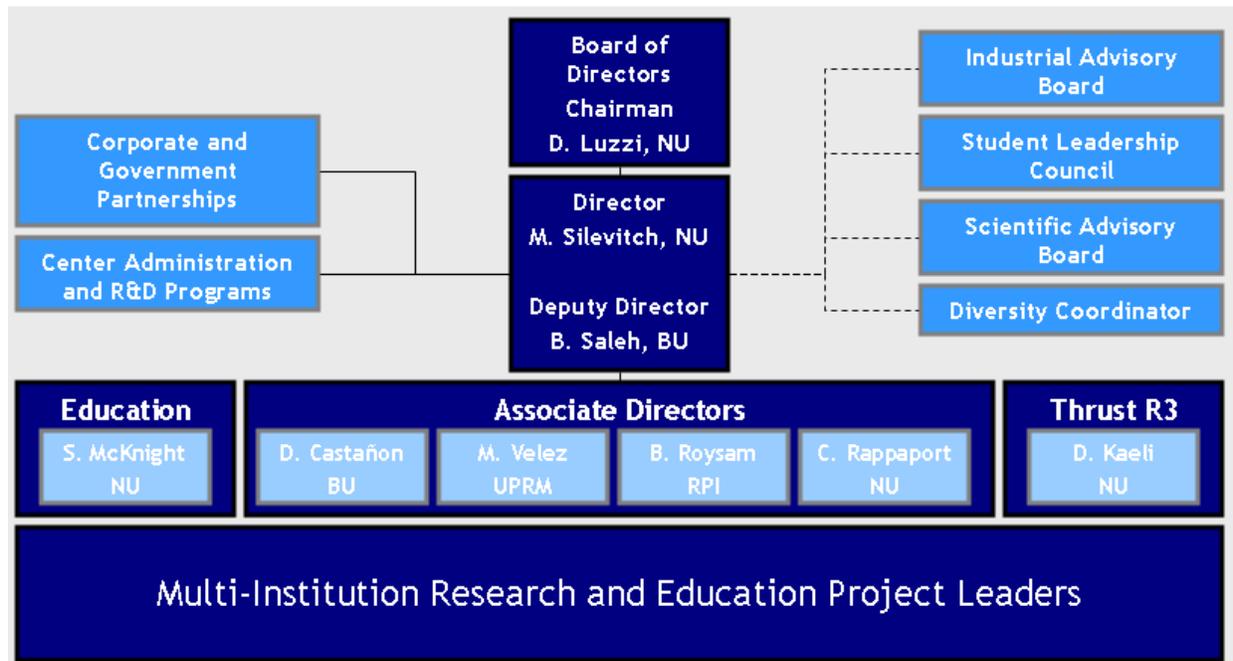


Figure 7E-1. Gordon-CenSSIS Organization Chart

ners, as well as the collective, team-based focus of the inter-institutional partnership.

We also recognize the importance of including ‘line officers’ (i.e. Deans and Department Chairmen) of the partners in the center management, which is manifested in the composition of the Board of Directors, as shown in Figure 7E-2. The function of this Board is defined in our Academic Partnership Agreement (Appendix IIC). The Board meets several times per year. Policies and procedures are in place to deal with issues such as the sharing of educational programs and Intellectual Property. Every year the Board conducts an analysis of the Center’s Strengths, Weaknesses, Opportunities and Threats (SWOT).

The Board of Directors (BOD) is comprised of senior-level administrators at the level of Dean or above. In our first eight years of operation, we have found that this composition cements the ownership of the Gordon-CenSSIS mission by the academic partners. The NU Dean of Engineering, David Luzzi, is Chair of the BOD.

This composition also emphasizes the necessity of aligning the partnership goals with those of the individual institutions. This is virtually impossible unless the line officers of the various institutions are directly involved with the man-

agement of the partnership itself. The institution’s line officers make faculty assignments, recruit, tenure, promote, and allocate space for laboratories and research.

The Industrial Advisory Board (IAB) is comprised of all companies supporting Gordon-CenSSIS, with membership and voting rights as described in Section 7D. This Board provides strategic guidance to the Center in areas such as new sensor developments, educational needs, and system testbed applications. The Chair of this Board is also a voting member of the Gordon-CenSSIS Board of Directors. Emel Bulat, Director of Technology and Business Strategy at Textron Systems, and John Pearson, Manager of Government Programs at Siemens Corporate Research, are co-Chairs of the IAB. Each year the IAB conducts a SWOT Analysis of the Center. This was discussed in Section 7D-1.

During its first two years of operation the Center did not convene a formal Scientific Advisory Board (SAB). We had discussed this decision with NSF because we felt that our strategic affiliates could provide the critical domain knowledge needed to guide the overall directions of our research and system testbeds. In the Center’s third year, we created and convened an SAB because we now need external oversight beyond

Gordon-CenSSIS Board of Directors David Luzzi, Northeastern University, Chair	
Organization	Name
Boston University	Kenneth Lutchen, Dean, College of Engineering
	Selim Ünlü, Associate Dean, College of Engineering
Northeastern University	David Luzzi, Dean, College of Engineering
	James R. Stellar, Dean, College of Arts & Sciences
Raytheon Corporation	Stephen R. Olive, Vice President of Information Technology and Chief Information Officer
	Mark Russell, Vice President for Engineering (alternate)
Rensselaer Polytechnic Institute	Alan W. Cramb, Dean, School of Engineering
	Joseph H. Chow, Associate Dean of Research & Graduate Programs, School of Engineering
Siemens Corporate Research	John Pearson, Manager, Government Programs
Textron Systems Corporation	Emel S. Bulat, Director, Technology and Business Strategy
University of Puerto Rico at San Juan	Manuel Gómez, Director, Resource Center for Science and Engineering
University of Puerto Rico at Mayagüez	Ramón Vásquez-Espinosa, Dean, College of Engineering

Figure 7E-2. Board of Directors Organization

the expertise of the strategic affiliates. A listing of the current SAB members is provided in Section 4. It is to be noted that because of their domain expertise, several representatives of our strategic affiliates serve on the SAB.

NSF Tables 6, 6 a-c, and 7 a-f summarize various institutions executing the ERC's program and demographic information for ERC personnel in the past year. These tables are located at the end of this section.

2B. Lessons Learned over Eight Years

During the first eight years, we have refined our management and organizational systems to address the challenges of creating an ERC driven by its strategic plan and goals. The following represents some important lessons learned:

1. Weekly management team meetings are critical for maintaining the shared ERC vision across the distributed partnership. These meetings are teleconferenced and typically involve over 20 people spread across the core partners and strategic affiliates. Participants include the senior management team as well as key thrust and education leaders. At these meetings both adminis-

trative and research issues are discussed. Minutes are kept and disseminated; there is a weekly agenda. All meetings are kept to a strict one-hour period for efficient use of time.

2. An Executive Committee was formed in Year Two as a result of the need to make tough strategic program decisions. This nine-person body is composed of the Director, Deputy Director, Associate Directors, the Thrust Leaders, a biomedical domain Leader, and the Education Leader. (The Deputy Director and two Associate Directors have Thrust-Leadership responsibilities.)
3. The administrative requirements of the ERC are significant. Faculty time must be used as efficiently as possible. If this is not done there is a danger of losing the 'buy-in' of the research leaders.
4. An ERC needs to continually refine its strategic plan as described in Section 7B-1. We have found that the yearly retreats are essential to maintain our focus on 10-year outcomes. In Year Two the retreat was held near UPRM in Mayagüez, Puerto Rico. While there, we fo-

cused on clarifying the nature of I-PLUS. After the Lake George, New York retreat in Year Three, we expanded the responsibilities of the Executive Committee to incorporate oversight of the system application areas described in Sections **7B-1** and **7B-2** of this report. Additional faculty leaders and domain experts were also asked to provide leadership of the system-level areas. The Year Four retreat at Woods Hole highlighted the need to better define the feedback mechanisms between the three levels of the Gordon-CenSSIS strategic plan. An important outcome of the Year Five retreat at Puerto Rico was the need to create Center-wide engagement in the development of the unifying framework. Also the Intro to SSI textbook was enthusiastically endorsed as an important educational deliverable. The Year Six retreat in Puerto Rico focused on the issues of sustainability and the legacy of both the research and educational components of the Center. The Year Seven retreat also focused on sustainability, including the role of the Gordon gift. The Year Eight retreat again focused on legacy and sustainability. This will be discussed in the next section.

3. Sustainability Plan for the Center

In this section, we lay out the elements of the Center's plan for sustainability after the NSF funding runs out. The major pieces of the plan are to:

- A. Sustain the Center's R&D and educational infrastructure through resources available within the Gordon gift;
- B. Identify core research and education "Glue" proposal opportunities and grow them over the remaining two years of NSF support;
- C. Write collaborative R&D proposals with the Center's industrial partners, and;
- D. Commercialize emerging Center technologies through patents and licensing.

3A. The Gordon Gift

In August 2006, Northeastern University received a \$20 million gift from the Gordon Foundation. This gift helps to both sustain the

R&D infrastructure of the Center and to launch programs to foster the development of engineering leaders. The gift is not an endowment, but will be provided in yearly increments over a 12-year period, beginning last year. As a result of this gift, the Center was renamed in honor of Bernard M. Gordon at its 2006 Research and Industrial Collaboration Conference (RICC).

In terms of sustainability, the gift will stabilize elements of the Center located at Northeastern, such as the industrial liaison, financial and R&D operations, education outreach, IT support, and administration. Clearly, this is a major impact in terms of keeping the core of the Center's operations intact. In addition to this, the Gordon gift will help to stabilize collaboration between the academic partners (BU, RPI and UPRM). The detailed process for this is still being worked out, but the aim is to make targeted resources (as well as inter-institutional cost sharing) available for 7 years after the end of NSF support. This strategy has been approved by the Board of Directors. This later element is critical in that it will preserve the Academic Partnership Agreement beyond NSF support. Inherent in this agreement is the "distributed university" concept that has been so successful in terms of the Center's education, diversity and outreach elements.

As mentioned at the beginning of this section, the Gordon gift has two elements associated with it. The first, as just discussed, concerns the ERC infrastructure. The second element is the development of NU-based programs to enhance engineering leadership. These programs are not directly relevant to the annual progress of the Center and so will not be discussed in this report.

3B. Core Research and Education "Glue" Proposals

To maintain our identity as a Center, we have been aggressively seeking outside support for continuation of our multi-partner and multidisciplinary fundamental science research and education efforts. At the Year 7 retreat, it was

decided that we need to develop 4 or 5 large, multi-year grants of about \$1 million each per year. It was estimated that it takes about 3 years to nurture and grow winning “Glue” Proposals of this magnitude. This meshes well with the time available before the NSF funding ends. Ideally a “Glue” Proposal would involve at least two Center partners and would leverage the strengths and the three-level strategic planning processes that have been built up over the years of NSF support. With that in mind, we have been looking for themes that can be channeled towards relevant funding sources. Examples of proposals that were submitted or funded in the past year include:

1. A Department of Homeland Security-oriented basic research initiative that would provide a coherent approach to the sensing and imaging challenges faced by DHS. In July 2007, the four Gordon-CenSSIS academic partners, augmented by Texas Tech University, University of Missouri at Rolla, and Washington State University, submitted a proposal to DHS in response to the solicitation for a Center of Excellence for explosives detection, mitigation and response. In February 2008, the NU-led team was awarded a four-year period. It is anticipated that the total award period will be ten years. This mechanism is similar to that of an ERC. More details on the award will be available at the NSF Year 8 Site Visit in April 2008.
2. Resubmission of a National Institutes of Health (NIH) Quantum proposal on multi-mode breast imaging. In Year 8, a consortium of MGH, NU, RPI and Tufts submitted an R-01 entitled “Tri-Mode Clinical Breast Imaging for Cancer Detection and Evaluation” to the National Cancer Institute. The long term goal of this project is to develop and evaluate a new instrument that will improve the diagnosis and treatment of breast cancer. In aggregate this proposal will fund 1-2 months of release time each for six researchers, resources to accrue 300 normal and 300 disease subjects, multiyear support

for 2 RAs, and multiyear support for 4 post-doctoral fellows.

3. In September 2007, NU and UPRM were awarded a \$3 million, 5-year IGERT grant on civil infrastructure diagnostics. This grant, a collaboration with Gordon-CenSSIS industrial partners TransTech and GSSI, will create a joint education and research site to produce diagnostic engineers who can successfully apply multidisciplinary skills to address technical, societal and political challenges associated with aging infrastructure and damage due to natural and man-made disasters. Gordon-CenSSIS researcher Sara Wadia-Fascetti is PI of the project and Ingrid Padilla and Carey Rappaport are co-PIs.

Currently we are working on a P42 grant proposal to NIH for a comprehensive program to examine the implications of contamination in Superfund sites to public health issues such as low birth weight. This program will be entitled “PRoTECT” (Puerto Rico Testsite to Explore Contamination Threats). The partners on this proposal are NU (lead), UPRM, University of Michigan, and the University of Puerto Rico School of Public Health. Camp Dresser and McKee, a potential industrial partner, is also very interested in participating. The deadline for the submission is April 15, 2008. Funding will be requested at the level of ~\$1.5 million per year over 5 years. Akram Alshawabkeh (NU) and Ingrid Padilla (UPRM) are co-PIs of this proposal.

Areas that we are looking to submit proposals on include:

1. A multi-altitude, multispectral environmental information gathering and assessment program that would be applied to the tactical needs of agencies like the Air Force or National Geospatial-Intelligence Agency. The DoD MURI program would be the right vehicle for this effort.
2. A multi-partner approach to single molecule imaging and microscopy that would be appropriate for the new National Insti-

tute of Health P50 Request for Proposal (RFP) or perhaps even an ERC in two years' time. This would include both the engineering disciplines as well as the chemical and biological ones. The P50 deadline is in the summer and it repeats every year.

3. A program built around intensive real-time computation through the use of advanced processing elements like GPUs. An initial focus would be biomedical applications.
4. Multi-partner educational initiatives like the NSF IGERT program. It would be interesting to create an IGERT proposal involving all four of the academic partners. Biomicroscopy or breast cancer detection are possible themes for this effort.

3C. Collaborative R&D Proposals with Industry

In a similar vein to the core research and education "Glue" proposals, we will develop several large proposals that leverage our connections with industry. Even though actual research support in those proposals may be limited, it is important to demonstrate transfer of our research results to the end user. Moreover, these proposals help the Center maintain a high level of relevance to its industrial partners. Examples include:

1. Suicide Bomber Detection Program (Bom-Detec). This \$1.7 million, 12-month Phase I effort, a collaboration between NU (lead), RPI, Raytheon, Siemens, American Science & Engineering and PPT, will end in September 2008. John Beaty, Gordon-CenSSIS Director of Technology Programs, is currently leading a Phase II, ~\$5 million proposal effort that would develop a prototype.
2. Advanced Spectroscopic High Energy Radiation Detector (ASHERD). This \$4.9 million, 1-year prototype demonstration project was funded in 2005-06 by DHS. NU (lead) and Bubble Technologies Industries (BTI) were collaborators on this intense proof-of-concept effort to demonstrate a capability to detect hidden threatening nuclear material concealed inside metal containers. As a re-

sult of this project, DHS awarded a million production contract to Raytheon in collaboration with BTI. The effort was for the development and manufacture of a fieldable "Advanced Spectroscopic Portal" (ASP). Raytheon's participation and leadership in this major program was facilitated by the Center's industrial liaison officer, Philip Cheney.

Other examples include SBIR and STTR Phase I and II successful proposals with industrial collaborators TransTech, Interactive Supercomputing, Acentech and Lucid Technologies.

3D. Commercialization of Center Technologies and Spin-Off Companies

One of the mandates of the Gordon gift is to enhance the development of commercial products that emanate from the Center's technologies. This had not previously been an emphasis of the Center. Mr. Gordon, however, has indicated his willingness to mentor and foster this activity. As reported in Year 7, the center launched its first spin-off company, DualAlign LLC. Founded by RPI Professor Charles Stewart, DualAlign is a Gordon-CenSSIS industrial partner. DualAlign's technology is based on the multiple applications of the Dual Bootstrap registration algorithm that was developed partially under Center support (see Project Report **R2-B** in Volume II). As a result of this support, the Center will receive 30% of all licensing revenue from the intellectual property (IP) associated with the Dual Bootstrap technology.

Other technologies within the Center with commercial potential include: the ACT-4 Electrical Impedance Tomography Imager for breast cancer diagnosis, developed at RPI; the non-invasive cell-counting algorithm for IVF used to determine embryo viability, initiated at NU; the cost-effective SeaBED Autonomous Underwater Vehicle (AUV), developed by WHOI; the high-resolution cardio-vascular imaging technique, created by BU and MGH; the advanced hyperspectral

classification tools, developed at UPRM; and the list goes on. All of these examples are protected with either patents or provisional patents. The key is to take the next step and translate these intellectual properties into the marketplace.

In summary, it is anticipated that, after Year 10, the total level of the key multi-partner associated “Glue” proposals will be ~ \$6 million per year. The industrial membership fees and collaborative R&D proposals will be ~ \$2.5 million per year. Commercialization income is harder to estimate but very conservatively it could be ~ \$400k per year by Year 12 and much greater after that. These sources of revenue coupled with the stabilizing force of the Gordon gift and the ALERT COE award will provide a sound basis of sustainability for the ERC well beyond the period of NSF funding.