**Award Specific Terms and Conditions for the EEC-0812348 / 1159199, "NSF Engineering Research Center for Revolutionizing Metallic Biomaterials", North Carolina Agricultural and Technical State University Cooperative Agreement**

The terms and conditions stated herein are the minimum requirements to fulfill the responsibilities to achieve the goals expected under ERC solicitation NSF 07-521. All referenced documents including websites are made a part of this Cooperative Agreement. The absence of a compelling strategy for achieving demonstrable impact in and of the key features of a Gen-3 ERC incorporated in this agreement and described in full details in NSF 07-521 is sufficient reason to deny continued funding.

The following includes revisions to the generic ERC terms and conditions that impact all ERCs since NSF 07-521 was issued.

## 1. Project Description:

The ERC is developing the fundamental knowledge and technology needed to advance biocompatible and biodegradable metal-based (especially Mg) implantable systems with feedback control for reconstruction and regeneration. The ERC will educate the next-generation workforce needed to implement biodegradable implantable systems.

## 2. Project Governance and Governing Responsibilities:

The Awardee will ensure that an efficient and effective project governing structure is in place throughout the award period to support all critical significant project activities. The awardee will also ensure efficient and effective performance of all project responsibilities by the governing components throughout the award period.

## 3. Key Personnel:

The following positions are considered Key Personnel and are essential to the work of this ERC. Any contemplated changes in Key Personnel for these positions should be discussed with the NSF Program Officer. Written approval from the NSF Program Officer must be secured before any change is implemented. Any anticipated change in the people serving as the Center Director or the Deputy Director to be effective within the next performance year must be disclosed in the ERC's annual report, and a succession plan must be provided in the report.

Center Director - Jagannathan Sankar, NCAT
Deputy Directors - William R. Wagner, University of Pittsburgh
Mark J. Schulz, University of Cincinnati
Administrative Director – Lois Dalton Deve
Executive Director – Harvey Borovetz
Education and Outreach Director - Devdas M. Pai
Industrial Collaboration and Innovation Director - Peter R. Seoane
Global Site Coordinator – Frank Witte

In the case of the departure of the Center Director, the lead university and the affected university, in consultation with NSF, will find a replacement suitable to NSF. Before a change is implemented within the lead university, written approval from the NSF Program Officer must be secured. In the case of the departure of (a) the Center Director from the lead university, or (b) one of the PIs from a core partner university, and NSF does not find the person recommended by the Center to be suitable, the Foundation reserves the right to recommend termination of the ERC or the core partner's affiliation with the ERC.

**4. Lead and Core Partner Universities:**

The NSF Engineering Research Center for Revolutionizing Metallic Biomaterials is configured as follows: North Carolina Agricultural & Technical State University (NCAT) is the lead university, with the University of Pittsburgh and University of Cincinnati as core partner universities. In the case of inadequate performance at the lead university or at the core partner universities, the National Science Foundation reserves the right to recommend termination of, respectively, the ERC or the core partner.

**5. Requirements for the Implementation of the Key Features:**

a. Strategic Research Planning and the Research Program:

(1) Support for the Research Experiences for Undergraduates Program (REU) program, at a minimum of $42K per year, will be provided using ERC base budget funds. The ERC may seek an REU site award under the REU Program Solicitation to augment these funds. The ERC also may augment base REU Program support through a combination of REU supplemental awards to individual ERC faculty as long as those students have an interdisciplinary ERC experience with exposure to industry.

(2) U.S. Student Involvement at Foreign University Partners: If there is a large number of U.S. ERC students who work in the foreign partner university(ies)' laboratories resulting in a large accrual of materials costs, the ERC may provide a subaward to that foreign partner to cover those costs.

b. University Education Program:

(1) The ERC's university education program will function with a governing hypothesis of how to develop creative, innovative, and globally competitive engineers, will implement a set of activities and experiences designed to impart those characteristics to students, and will assess the impact of the program in achieving the desired characteristics in the impacted students.

c. Pre-college Education Program:

(1) Support for the RET Program, at a minimum of $42K per year, will be provided using ERC base budget funds. The ERC may seek an RET site award under the Program Solicitation to augment these funds. The ERC also may augment base RET Program support through a combination of RET supplemental awards to individual ERC faculty as long as those teachers work in ERC laboratories and have an interdisciplinary ERC experience. A short-term workshop designed only to inform pre-college teachers about engineering concepts may also be carried out but not in lieu of the required RET program.

d. ERC Innovation Ecosystem:

(1) The ERC's industrial/practitioner partnership program will be governed by an ERC-wide membership agreement, including a uniform IP policy for ERC-generated IP at the lead and each of the ERC's partner universities. The membership agreement defines the scope and function of the ERC's partnership with industry/practitioner organizations, the types of membership such as full, affiliate, contributing, etc., the respective membership fees, and the ERC's Intellectual Property (IP) policy. The ERC will develop an IP policy that facilitates the roles of industrial partners in Gen-3 ERCs and be flexible in recognizing IP jointly developed by faculty in different universities or that developed by joint industry and university research.

(2) Foreign firms may be members of the ERC as long as they participate in accordance with the same membership agreement as U.S. firms do, provided they are in compliance with their domestic laws governing intellectual property. Domestic and foreign member firms/practitioner organizations will contribute financially to the ERC and will have first rights of refusal for ERC-generated Intellectual property (IP) if they are full members.

(3) The ERC will function with an Industrial Advisory Board (IAB) involving all of its Industry/practitioner members. The IAB will meet at least twice a year, carry out an annual analysis of the ERC's

strengths, weaknesses, opportunities and threats to survival (a SWOT analysis), and participate in the annual NSF review of the ERC's performance and plans. During the meeting with the NSF site visit team, the Chair of the IAB will present the IAB's SWOT analysis to the review team and discuss the findings. The SWOT will be updated annually and progress of the ERC in addressing the SWOT will be discussed with the NSF site visit team as well. The Chair and the IAB members also will discuss the annual SWOT analysis with the ERC Director and the ERC Leadership team to determine appropriate future strategies to deal with the weaknesses and threats.

(4) Industrial consortia may join the ERC, but benefits of membership do not accrue to firms that are consortia members, unless they are also paying membership fees to the ERC as members separate from the consortia.

(5) Throughout the course of the ERC's funding by NSF, the Center shall continue to develop and refine its technology transfer and innovation strategy and its Intellectual Property policy, the latter in accordance with NSF's Intellectual Property guidelines (NSF Award and Administration Guide, Chapter VI.D., "Intellectual Property") and the Awardee's policies.

(6) Industrial membership fees are treated as Program Income, and must be allocated for use for Center purposes. Industrial membership fees that are not expended in the year in which they are received must be placed in a Center account and reported to NSF and industry as 'unexpended funds' that are held in reserve for future use. Progress reports on the expenditure of these funds should be included in the Center's annual report and reported to IAB during the IAB meetings. Industrial members may provide additional support for activities such as sponsored research projects, equipment donations, intellectual property donations, or educational grants.

(7) Costs for organizing meetings with industry members will be borne by the ERC or the participants through a registration fee, as deemed appropriate. Costs for attending these meetings by industry members will be borne by their organizations.

(8) All ERCs will have member firms engaged in translational research through sponsored projects, and small firms carrying out translational research supported by funds from the ERC Program's Translational Research Fund or other non-ERC, non-member, non-university sources for ERC-generated Intellectual Property (IP) that member firms do not license.

(9) In addition, the ERC will develop and nurture the innovation ecosystem for the purposes of accelerating the translation of knowledge into innovation, by:

(i) Stimulating member firms to support sponsored projects for the purposes of translating center-generated IP to commercialization,

(ii) Forming collaborations with small firms for the purpose of translating ERC-generated IP to the marketplace, if member firms do not license the IP - (This should be done via licensing IP, knowledge transfer to the firm, and/or securing translational research funds to accelerate commercialization of the technology by the small business in partnership with the ERC. Translational research funds could be secured from the ERC Translational Research Fund and/or from funding from other non-ERC/non-member/non-university sources);

(iii) Building partnerships with federal, state, or local government programs designed to develop entrepreneurs, support start-up firms, and otherwise speed the translation of ERC-generated knowledge and technology into practice and products; and

(iv) Leveraging technology commercialization opportunities offered by the federal Small Business Innovation Research (SBIR)/Small Business Technology Transfer Research (STTR) programs. The ERC will include analyses to determine the most effective methodologies to use to achieve these innovation goals through these types of partnerships.

(v) In reference to 9(ii) above, ERCs will classify their IP generated from research under the scope of the ERC's strategic plan as core IP (IP resulting from center-controlled unrestricted funds) and Project IP (IP resulting from restricted funds that flow through the center or flow directly to a PI). For Core IP and Project IP, the full member firms/practitioner organizations or the sponsoring firm/ practitioner organization, respectively, will be offered the first option to negotiate a license. If there is no license forthcoming in either case, the IP can be offered to a non-member small firm and a partnership formed between that firm and ERC faculty to carry out translational research to accelerate product development. Support for a translational research project to accelerate product development can be sought from NSF through the ERC Translational Research Fund; in that case, the small firm would be the submitting organization, with a subaward to the ERC faculty. In

addition, in that case, the university must screen the project for ERC faculty, Industrial Liaison Officers (ILO) and/or ERC Executive Management personnel conflicts of interest. When conflicts are disclosed for any of the above three categories of personnel, the university impacted must develop a conflict management plan for each disclosure.

(vi) In the case of a conflict, there will be a conflict of interest management plan. Progress and impacts of the project would be reported in the ERC's annual report. Because NSF would support such a project as an associated project outside the center's core funds, any additional IP developed from that project would not revert to the university or member firms.

e. Student Leadership Council. The SLC is responsible for organizing student activities to achieve the ERC's goals for research and education. The SLC will be comprised of undergraduate and graduate students and will have a Chair and a Co-Chair. The Chair will serve as a member of the ERC's Leadership Team. The SLC also is responsible for carrying out a SWOT analysis of the ERC and communicating the results to the ERC Director, the ERC's leadership team, and the NSF site visit team.

**6. Programmatic Activity Requirements:**

a. Joint NSF-Awardee Activities:

(1) The ERC will participate in evaluation and other types of studies of the ERC Program initiated by NSF. Such studies include but are not limited to the outcomes and impacts of the ERC Program. The ERC will also participate in workshops organized by NSF to study various issues common to the system of centers. Costs for attending these meetings must be included in the budget submitted to NSF

b. Electronic Access: The Awardee shall establish and maintain an electronic access capability via the Internet to transfer the quantitative and qualitative data to an NSF database. The access to this electronic information will be protected and only NSF will have and grant access. The Center will establish a WWW "Home Page" containing some elements with public access to make available any information about the Center's goals, activities, and accomplishments. The Center will develop and use an identifying logo that is consistent with the Awardee's policies and procedures and approved by the Awardee as a graphic identity to be used on brochures, newsletters, on the Center's WWW "Home Page," etc.

## 7. NSF Ongoing Project Oversight:

The Awardee will ensure full commitment and cooperation among the governing structure components, and all project staff during ongoing NSF project management and oversight activities. The awardee will ensure availability of all key institutional partners during any desk or on-site review as well as timely access to all project documentation. As a minimum requirement, the Center Director will meet annually at NSF with the NSF ERC Program Officer assigned to the ERC for oversight to discuss progress and other issues. The timing of the visit is to be determined by mutual agreement between the Center Director and ERC Program Officer.

a. Annual Review: NSF will carry out annual site visits to review the progress and plans of the Center. Renewal reviews will be carried out in years three and six. Based on the performance of the ERC, and in consultation with the ERC Director, the NSF Program Officer may determine that an annual site review is not necessary. In that case, the Center Director and a team of key individuals may visit NSF to update the NSF Program Officer and other NSF staff on progress and plans of the Center. For the purpose of the annual review, site visits will be conducted a minimum of six weeks prior to the anniversary date of the award to review performance and to provide advice to the ERC. The level of continued NSF support will be negotiated with the Awardee annually and will depend upon a review of progress through the annual site review or other means, the performance metrics, the industrial support level, and the Program Officer's assessment of progress, and the availability of funds for the program.

b. Renewal Proposal Review: If a renewal proposal is submitted during the sixth year of the Center's operation, the ERC will be evaluated in the manner described above to determine whether NSF will continue to support full ERC operations or provide decreased funding to phase out NSF support of the ERC over Years 7 and 8 of the Center's operation. If NSF decides to continue full ERC operations, a new level of funding support will be negotiated for years 7 and 8 and two years will be added to the agreement to extend it through year 10. If the Awardee chooses not to submit a renewal proposal, NSF support to the ERC will be phased down over the two-year period covering Years 7 and 8 of the Center's operation.

c. NSF will specify the format of the progress report/renewal proposal, the review process, and review criteria approximately six months before the date agreed upon for submission.

d. Termination of the Cooperative Agreement. NSF’s agreement with a Center might be terminated as a result of an annual review indicating insufficient progress in organizing the ERC to achieve its vision, or not addressing one or more key features of the Center. In the case of termination, NSF support to the Center will be phased down over the next

one or two years.

e. NSF may carry out a summative site visit at the end of the 10th year of support to determine the long-term value added by the ERC.

f. After the end of the Cooperative Agreement with NSF, NSF expects the ERC to continue in a self-sufficient mode, maintaining the ERC culture with support from funds outside the ERC Program. Under no circumstances will the ERC receive ERC Program support to continue its full center operations after the Cooperative Agreement expires, although it may receive ERC Program support through subawards from other ERCs or through special purpose awards designed to capitalize on past ERC Program investments.

**8. Reporting Requirements:**

Awardee will provide *ad hoc* and regular reports as designated by the NSF cognizant Program Official, with content, format, and submission time line established by the NSF cognizant Program Official. The Awardee will submit all required reports via FastLane using the appropriate reporting category; for any type of report not specifically mentioned in FastLane, the Awardee will use the "Interim Reporting" function to submit reports.

a. Annual Report. The Awardee shall submit an Annual Report which will contain specific information including, but not limited to, the following: the progress and plans of the ERC in all areas in achieving its vision with supporting data developed from the data submitted to the ERC Program's data base of indicators of progress and impact, information on revenues and expenditures, and proposed budgets. The annual report should also include plans, quantitative information on performance and the ERC's impact on diversity. The annual report is due at least five weeks prior to the annual site visit and at least 11 weeks prior to the anniversary date of the award. The annual report must be prepared according to the online document "Guidelines for Preparing ERC Annual Reports and Renewal Proposals," which is available at: https://www.erc-reports.org

b. Data Tables: NSF maintains a database, ERCWeb, to collect and report quantitative and qualitative data for all of the ERCs. Each center is required to enter data into the database annually as instructed the "Guidelines for Preparing ERC Annual Reports and Renewal Proposals" and the "Guidelines for ERCWeb Data Entry." Both documents can be found at the website https://www.erc-reports.org. Many of the data tables required in the Annual Report are produced from the data submitted to the ERC database. The Center will print these tables directly from the database website and use them in their respective Annual Reports. Details, data collection requirements and procedures for entering data are

available in the “Guidelines for ERCWeb Data Entry” document.

c. Renewal Proposal. In lieu of the sixth-year annual report, the Awardee may submit a renewal proposal that contains a cumulative progress report covering the period from the beginning of the fourth year to the date of submission of the renewal proposal, a request for support for years seven through ten, and plans for center activities during that last four-year period of this Cooperative Agreement. The progress report/renewal proposal is due at NSF by a date agreed upon between NSF and the Awardee. If the Awardee chooses not to submit a renewal proposal, NSF support to the Center will be phased down over the two years remaining in the period of support provided by this Cooperative Agreement.

d. Summative Report. If NSF decides to carry out a summative review of the long-term impact of the ERC, a summative preliminary final report covering the period from the beginning of the Center to the anniversary date shall be submitted to NSF at least five weeks prior to the final 10th year summative site visit. More details are available at https://www.erc-reports.org on the “ERC Library” link.

e. Final Report: A final report prepared according to guidelines provided by the ERC will be due within 90 days of the expiration date of this Cooperative Agreement. Guidelines for the ERC final report are available on the following site: https://www.erc-reports.org on the “ERC Library” link.

In addition, to assist NSF in evaluating the ERC programs, the PI must also respond to the request for information about project outcomes following the end of the award period. These include the project's impact on workforce needs, awards and other measures of the quality of the project's products, including project technology transfer results not reported in prior years, but due to the ERC investment of prior years. NSF will provide guidelines for the collection and reporting of data and project information.

**9. Diversity Strategic Planning:**

The leadership, faculty, and students involved in an ERC shall be diverse in gender, race, ethnicity and persons with disabilities at levels that are benchmarked against the academic engineering-wide national averages. The faculty and staff of the ERC and the administrations of lead and partner universities receiving NSF funding shall devote the time and effort required to ensure that the diversity of the Centers' leadership teams, faculty, and students at all levels serves as a model for diversity within each institution and for the nation as a whole. The ERC will prepare and execute diversity strategic plans in collaboration with the home departments of the ERC-affiliated faculty. These plans shall articulate the ERC's diversity goals and intended actions but need not specify quantitative targets. The ERC also will be multicultural through the involvement of faculty and students from other countries by virtue of their role as faculty or students

in the ERC's institutions and, through the involvement of faculty and students from the foreign partner universities. The involvement of foreign faculty and students also is expected to be diverse, representing a broad spectrum of cultures and countries. In fulfilling its obligations under the agreement and in compliance with the requirements of federal law, no university receiving federal funds will employ quotas or set-asides based on race.

Each ERC will:

a. Demonstrate the existence of a partnership among the affiliated Deans of Engineering, other Deans, and the chairs of departments of the affiliated ERC faculty to increase the diversity of the Center's leadership team, faculty, undergraduate and graduate students, and graduates over the duration of NSF's support.

b. Include as the lead or one of the domestic partner universities a university that serves large numbers of students predominantly underrepresented in engineering in the U.S. (i.e. women, African Americans, Pacific Islanders, Native Americans, Hispanic Americans, or persons with disabilities). The ERC may also develop non-core partner outreach connections with the same types of institutions.

c. Develop and strengthen long-term core or outreach partnerships with predominantly female, African-American, Native-American, and Hispanic-American serving institutions and/or institutions serving large number of these underrepresented students who are majoring in engineering and science programs.

d. The ERC may also, but is not required to, develop outreach connections with NSF programs focused specifically on increasing diversity of engineering students and faculty through the involvement of women, underrepresented racial minorities, and Hispanic-American students. This may include connections with one of the NSF's Louis Stokes Alliance for Minority Participation (LSAMP), and/or with one or more of the NSF-sponsored awardees focused on diversity such as the NSF Alliances for Graduate Education and the Professoriate (AGEP), Colleges and Universities that serve predominantly Native American Populations, and other ongoing NSF programs serving underrepresented groups.

e. Focus the Research Experiences for Undergraduates (REU) and Research Experiences for Teachers (RET) programs on increasing diversity.

**10. Key Features:**

a. Vision of the ERC:

The vision of the Engineering Research Center (ERC) is to revolutionize metallic biomaterials and underlying technologies leading to engineered systems that will interface with the human body to prolong and improve quality of life. The Center will also develop a creative, innovative and globally competitive diverse workforce for the U.S. biomedical implant industry.

b. ERC's Strategic Goals:

The ERC will use the ERC Program's 3-plane strategic planning chart to display its strategic goals and the integration of its research program, accompanied by a milestone chart depicting the major deliverables through time and their interdependencies.

c. ERC's Research Goals:

The ERC's strategic research plan has three thrusts (three engineered systems) that will be driven by four enabling technologies. The engineered systems initially will include Craniofacial and Orthopedic Applications (ES-I), Cardiovascular Devices (ES II), and Responsive Biosensors for Implants (ES III). The team will rely on four Enabling Technology Tracks (ETT) to deliver the necessary capabilities, which will support and enhance these systems. The basic research areas of multi-scale materials synthesis, bio-interfacial science, biomechanics, and clinical pathophysiology will be performed in the ETTs, which will drive the three engineered systems (ES) testbeds described below.

ES-I. Craniofacial and Orthopedic Applications: Fundamental research challenges and science issues to be addressed in ES-I, will be related to the development of materials systems and design. The goal of this Engineering System will be to identify biodegradable metallic systems that are biocompatible and exhibit controlled resorption characteristics without eliciting any toxic response. Fundamental research challenges will be related to the processing of non-porous and porous structures of metallic alloys. Basic science issues will include identification of stable alloys under electrochemical environments similar to human physiological conditions, which will then be processed into novel porous structures using 3-D ink-jet printing techniques in an inert atmosphere. Further research challenges will include the processing and surface engineering of functional coatings. Fundamental science to be addressed will include determining the synthesis conditions, the effect of particle size and structure on the binding of proteins, growth factors, and plasmid DNA

(pDNA), as well as the interfacial strength of the coatings to the underlying metallic surface.

ES-II. Cardiovascular Devices: Fundamental research challenges and science issues to be addressed in ES-II will include making non- and anti-thrombogenic surface coatings that effectively allow the reduction in anticoagulation requirements with metallic, blood-contacting medical devices. The research will address a key limitation to clinical cardiovascular device design since increased blood-contacting surface areas, larger surface area to volume ratios, and thrombogenic surfaces require more pharmacologic inhibition of blood coagulation and platelet activation pathways. Fundamental science issues that will be tackled include identifying and developing biochemical moieties that will act to prevent or inactivate prothrombotic reactions with the metallic surface. Chemical-metallic coupling strategies will be identified that will build off of the metal oxide layer in an efficient and high density fashion. Fundamental science issues that will be addressed include maximizing alloy elasticity and processing into wire or scaffold formats that will enable low-profile vascular delivery systems. These alloys will be designed from first principles of structure-property-function relationships.

ES-III. Responsive Biosensors for Implants: Fundamental research will be focused on developing responsive biosensors that can sense and use the feedback to adjust the sensor or to regulate a process. Responsive biosensors are tools that will be developed to aid in the design of metal-based implants that have excellent biocompatibility, controlled dissolution, and no toxicity. The fundamental research challenges to be addressed will include: (1) to develop responsive biosensors; and (2) to miniaturize the sensor. The goal will be to develop sensors to monitor "what is happening" at the interface between the implant and tissue, initially for in vitro studies. The research also will result in a wireless sensor that is resistant to biofouling so that it can monitor "what is happening" at the interface between the implant and tissue for in vivo animal studies. Eventually, the plan will be to explore the functionality of these sensors in patients under non-NSF support. Responsive biosensors will be developed using nanomaterials such as, long carbon nanotubes and biodegradable Mg nanowires. A corrosion control system will be developed to control the rate of corrosion of the implant. Fundamental science issues that will be addressed are the synthesis of high quality, biocompatible carbon nanotube arrays, which will be modified, and functionalized through plasma chemistry and post-processing so that the sensor is highly sensitive but non-toxic. The research will be cognizant of state-of-the-art results regarding the use of nanomaterials in vivo.

d. ERC's Specific Education Goals:

(1) Specifics of the University Education Program: The ERC's educational hypothesis is: If EMB students are trained in research in a multidisciplinary setting in partnership with industry and clinicians in a culture that values diversity, innovation and entrepreneurship they will be better prepared as creative, innovative and adaptive engineers. The goal of the ERC's university education programs is to prepare a highly diverse and globally experienced and innovative engineering workforce for the U.S. biomedical implant industry and university faculty in engineering and medicine. The approach will integrate traditional and emerging engineering disciplines with industrial experience, experience with medicine along with exposure to social, regulatory, ethical and economic issues involved in innovation in a medical context. In collaboration with its innovation partners, the ERC will develop curricular materials to train engineering students in the art and science of fostering research innovation, and will enable them to work alongside teams engaged in medical implant innovation in Europe and India to provide them with globally competitive entrepreneurial skills. Students from the lead and two partner universities, and two outreach institutions: California State University, Los Angeles and Edmonds Community College, Seattle, WA, will benefit from these education programs as well. Undergraduate students from universities outside the ERC's partners will be involved in the ERC through a Research Experiences for Undergraduates (REU) Program.

One of the major foundations of the ERC's education program is the initiation of a new department of bioengineering at NCAT, which will offer new B.S., M.S. and Ph.D. programs. The curricular materials developed by the ERC will be a foundation for this department's curriculum. The ERCs educational materials will be derived from their research but they will also build on the bioengineering model curricular materials developed by the faculty of the University of Pittsburgh's highly-ranked undergraduate and graduate programs in bioengineering. The ERC will also form an Educational Advisory Board (EAB) to propel the synergetic activities between the ERC and NCAT's bioengineering programs.

(2) Specifics of the Pre-college Education Program:

i) The pre-college educational partnership will be built on partnerships in communities in North Carolina. The program will integrate experiences for students in Grades 6-12 by providing curricular materials that include a "palette" of

devices capable of being understood by non-technical persons and children and to strengthen their understanding of the science and technology principles underlying bioengineering applications. There will be workshops for guidance counselors at regional middle and high schools and the ERC will provide information for parents and students on careers in engineering and life sciences, and on the secondary courses needed to prepare for engineering admission.

ii) The NCAT team will increase teacher expertise in bioengineering through a Research Experiences for Teachers (RET) program, where the ERC will offer research experiences every summer, with stipends for at least two teachers from each participating middle and high school. They will develop inquiry-based materials to interest students in bioengineering, which address national and state (NC/PA/OH) standards for science education. The ERC will offer a three-week curriculum development workshop for multidisciplinary (drawn from science, technology and math) teacher teams.

iii) High school students (Young Scholars) will develop Web-based lab experiments and video-based materials and materials for class projects, illustrating fundamental scientific and engineering principles. The ERC plans to extend the geographical reach of these initiatives through a traveling display (van-based) and an extensive cyberinfrastructure.

e. Specifics of the Innovation Ecosystem Program:

(1) The ERC will develop membership partnership with small-, medium- and large-scale firms. The member firms will represent sensors/electronics, coatings and materials manufacture and medical implants and other sectors relevant to the ERC's research. The ERC initially will form its industrial partnership with the firms committed to membership in the proposal and will expand the membership to include more firms. The members will be engaged in the research, education, and technology transfer/innovation efforts of the ERC through participation in the Industrial Advisory Board

(2) The ERC will include the proposed local and state government organizations devoted to entrepreneurship and innovation in North Carolina that are partners with the ERC. These organizations will help spur the development of start-up firms in North Carolina based on the research and will provide input to the development of courses and other educational experiences, designed to give students knowledge about innovation and development of small, high technology firms.

(3) The ERC will partner with small firms for translational research per ERC program policy.

f. Facilities and Headquarters

NCAT will continue to provide 600 square feet of space for the ERC Headquarters and Operations Center.

g. Faculty Hires

(1) The NCAT administration will add a Program Manager to the team who has experience in managing complex projects to assist Dr. Sankar in the day-to-day operations of the ERC.
(2) Dr. Sankar will focus his efforts on fulfilling the proposed goal of the ERC and will be relieved of other duties as appropriate to facilitate his success.