A. PROGRAM DESCRIPTION
The National Space Grant College and Fellowship Program consists of 52 state-based, university-led Space Grant Consortia in each of the 50 states plus the District of Columbia and the Commonwealth of Puerto Rico. Annually, each consortium receives funds to develop and implement student fellowships and scholarships programs; interdisciplinary space-related research infrastructure, education, and public service programs; and cooperative initiatives with industry, research laboratories, and state, local, and other governments. Space Grant operates at the intersection of NASA’s interest as implemented by alignment with the Mission Directorates and the state’s interests. Although it is primarily a higher education program, Space Grant programs encompass the entire length of the education pipeline, including elementary/secondary and informal education. The Iowa Space Grant Consortium is a Designated Consortium funded at a level of $760,000 for fiscal year 2016.

B. PROGRAM GOALS
The activities of this program are designed to maximize alignment with NASA’s 2014 Strategic Plan, Space Grant goals and objectives, NASA Office of Education’s Lines of Business, and the State of Iowa’s STEM goals for education and workforce development. The overall program is divided into two elements: primary and secondary. The primary elements focus on higher education in programmatic categories of NASA Internships, Fellowships and Scholarships; Higher Education; and Research Infrastructure. The secondary elements support new STEM participants to enter the higher education pipeline in programmatic categories of Precollege and Informal Education.

PRIMARY ELEMENTS
GOAL 1: Conduct an annual competition to select students for STEM training opportunities, through fellowships and scholarships that align with Higher Education campus base programs, and internships that occur at NASA Centers or industry, to encourage and retain students in STEM fields. (National Center for Education Statistics {NCES} Table 306.6)

Objective 1a. Each year ensure that all awardees are enrolled in a NASA STEM-related research course with an ISGC research mentor, and internship awardees are engaged in NASA-related research.
Objective 1b. Each year ensure that all awardees reflect the diversity of Iowa and meet NASA requirements. For Iowa, the target objective is 40% women and 23.3% underrepresented minority (UM) participants.

Objective 1c. Each year ensure that internship, fellowship and scholarship awardees reflect the diversity of Iowa and meet NASA requirements. For Iowa, the target objective is 40% women and 23.3% UM participants.

GOAL 2: Continue to implement an annual scholarship program for outstanding precollege seniors at the State Science and Technology Fair of Iowa that positively impacts retention of students in STEM-related fields.

Objective 2a. The majority of SSTFI senior entrants are aware of the ISGC awards.

Objective 2b. Ensure that awardee retention in STEM exceeds that of the general STEM student population from a postsecondary institution.

Objective 2c. The majority of awards will go to those who participated previously in SSTFI.

GOAL 3: Continue the development of competitive, self-sustaining base programs that combine active research with student involvement on each core institution campus.

Objective 3a. Each base program will provide research-training instruction for fellowship and scholarship awardees and other student participants.

Objective 3b. Each base program will produce publications and non-ISGC proposals each year.

Objective 3c. Each base program will develop a NASA collaboration that did not exist prior to funding.

Objective 3d. Each base program will generate cash or in-kind match from non-federal funds equal to the NASA funding provided at 125% (1:1.25).

GOAL 4: Support STEM skills development through support of higher education curriculum development and student hands-on projects to align with NASA’s education goals.

Objective 4a. Each award will involve curriculum development/enhancement at academic affiliate institutions in areas of importance to the mission of NASA.

Objective 4b. Each award will involve hands-on student projects at academic affiliate institutions in areas of importance to the mission of NASA.

GOAL 5: Continue to develop research infrastructure to build a sustainable capability in the state to support NASA’s mission through support of early career faculty and research innovation projects.

Objective 5a. The Early Career Investigator Project will support awards that enable junior faculty to conduct interdisciplinary research, develop a NASA collaboration that did not previously exist, generate nonfederal cash or in-kind match to the NASA funding provided at 125% (1:1.25), and produce evidence of research.

Objective 5b. Research Innovation Awards will fund projects that develop a NASA collaboration that did not previously exist, conduct research important to NASA’s mission, and generate nonfederal cash or in-kind match to the federal funding provided at 125% (1:1.25).
SECONDARY ELEMENTS

GOAL 6: Conduct statewide STEM professional development, preservice and in-service training, which serves the NASA mission and showcases NASA content, for formal and non-formal educators working in grades K-12.

**Objective 6a.** Ensure that STEM professional development workshops engage at least 400 teachers in short-term workshops and 25 to 30 in long-term workshops.

**Objective 6b.** Ensure at least four communities from tribal and/or other underserved schools will participate in STEM workshops.

**Objective 6c.** Ensure workshop participation from at least three non-formal organizations such as science museums, clubs, and homeschool groups each year.

**Objective 6d.** Ensure participants of STEM implementation workshops provide professional development to colleagues and actively engage students within year of workshop participation.

GOAL 7: Continue to promote and provide hands-on opportunities for learners to participate in STEM education engagement activities that serve the NASA mission and showcase NASA content.

**Objective 7a.** Engage between 550 and 600 precollege students in the SSTFI and at least 100 precollege students in the Iowa Junior Academy of Science in the presentation of research at a professional event.

**Objective 7b.** The majority of Iowa Junior Academy of Science senior entrants will be aware of ISGC support for the national competition.

**Objective 7c.** The majority of Iowa Junior Academy of Science winners will matriculate to study in STEM fields.

**Objective 7d.** The ISGC associate director for education will continue to provide volunteer services to the Governor’s Advisory Council.

**Objective 7e.** Support programming on Iowa Public Television (IPTV) that will reach at least 20,000 Iowans and is consistent with other ISGC education objectives which uses NASA content and meets the informal education requirements.

GOAL 8: Continue to support STEM informal education programs that enhance public awareness of NASA missions and general scientific literacy for all Iowans through opportunities to engage with NASA unique content.

**Objective 8a.** Ensure development and delivery of competitively selected informal education projects that meet NASA requirements and engages participants with NASA content from at least 5,000 elementary, middle and high school students and teachers and the Public-At-Large annually.

C. PROGRAM/PROJECT BENEFITS TO PROGRAM AREAS

- Dr. Martin Gross, Postdoc Research Associate, Food Science & Human Nutrition, College of Agriculture and Life Sciences, Collaborator with Center Director, National Center for Earth and Space Science Education students “This is an opportunity of a lifetime for our students, we are so thankful for Dr. Gross’ support for getting this ISGC grant so our students can have this trip to Iowa to perform our algae research” - Kennan Poulakos, Environmental Theme Coach, Two Rivers Magnet Middle School, 337 East River Drive, East Hartford, Connecticut
• Higher Education Student Hands-On Project, University of Iowa Robotics club: Students involved with the University of Iowa Robotics Club have sharpened numerous engineering and professional skills. Throughout the course of this project, many students have learned how to design, manufacture and test diverse engineering systems, accelerating their professional development, as well as their ability to contribute to the future of space travel. For example, over the two year period of involvement with the ISGC funded program, Abram Nothnagle and Doron Tsachor have gained significant expertise in power electronics design, and have used that experience to start their very own power electronics student business. Working together, these two students have won the Rose Francis Elevator Pitch Competition as well the JPEC business model competition for a business centered around a motor controller designed for collegiate robotics competitions. Additionally, several students are working with geology professor Ingrid Peate to develop Ramon and LIBS spectrometer devices for use on the rover which may lead to student patents in the future. Quotes: "I wouldn't have been able to start my business without the opportunities provided by the ISGC." -Doron Tsachor, University of Iowa Senior

• Higher Education Student Hands-on, Iowa State University Mars Analog Vehicle for Robotic Inspection and Construction (MAVRIC) team has benefitted immensely from this grant. We have been able to push the boundaries of what we can do as students. To be able to gain hands-on experience with machining and manufacturing our own designs, and with engineering a product from start to finish, is incredible and very applicable for learning. One example of this is our wheels. It is very difficult to find commercial wheels for our application, and for many years have fanaticized about creating our own wheels to give us greater flexibility in our tire choice. This year, we were able to literally redesign the wheel for our application. Because of Iowa Space Grant, we were able to afford the aluminum and other materials needed to manufacture the lightweight, motor covering, and terrain climbing wheels we required for tackling the rough desert terrain of our competition. – Daniel Mallek, Iowa State University Senior

D. PROGRAM ACCOMPLISHMENTS

• NASA Internships, Fellowships, and Scholarships (NIFS) (Goals 1 and 2):
  ➢ Interns: one Iowa State University undergrad was placed at the Jet Propulsion Laboratory in Fall 2016; one Iowa State University undergrad is being placed at Johnson Space Center in Summer 2017; six undergrads have pending placements at the time of this writing at Armstrong Flight Research Center, Ames Research Center, Jet Propulsion Laboratory, and Marshall Space Flight Center.
  ➢ Fellows: 16 graduate student awardees (eight at Iowa State University; and eight at University of Iowa)
  ➢ Scholars: 44 undergraduate awardees, which include 18 students with community college transfer credits and one high school senior science fair awardee (matriculated). In summary, with December 2016 and May 2017 graduations, 21 longitudinally tracked students have reached their next step: eight have graduated and are pursuing an advanced STEM degree, four have graduated and are seeking STEM employment, two are working for Aerospace contractors, six are employed in STEM non-aerospace position, and one is working in an “other” STEM academic field.
• **Higher Education projects (Goal 3):**
  - Four research base programs funded one each at academic affiliates:
    - Infection Mitigation During Space Flight: Combination Pharmacotherapy to Combat Herpes Viral Infections, Curtail Drug Resistance, and Decrease Incidence Rates of Adverse Effects, **Drake University**
    - Research and Education Integrated Program on Aircraft Icing and De-/Anti-icing Technology, **Iowa State University**
    - Countermeasures to Regain Gravity Sensing after Ear Manipulations, **University of Iowa**
    - Biogeochemical Evolution of The Atmosphere: The BETA project, **University of Northern Iowa**

In summary, four research base programs were funded, one each at our core academic affiliates. These projects provide support for NASA-related research and have produced six accepted and two submitted peer reviewed publications, six refereed conference presentations, three invited talks, and two course revisions with 115 undergraduates. There is one patent pending. The base support has led to an additional $1,552,540 in non-ISGC grants. There are presently $553,101 in pending proposals for follow-on funding. These projects involve 28 PI’s, Co-PI’s, and collaborators from three NASA Centers: Ames, Glenn and Goddard, other academic institutions, and industry. These additional collaborators are located at the National Science Foundation, five industries, Penn State University, Ohio State University, the University of Illinois at Chicago, and the Iowa Department of Aging.

The base programs involved many student participants in this active research. Progress has been shown in a variety of areas, including advancements in understanding the earth’s atmosphere, ancient, Devonian, and present; studies and outreach in aircraft icing and anti-/de-icing technology; combination experiments to determine mode of pharmacodynamic drug interaction; and research to better characterize gravity sensing in manipulated ear systems. The range of research topics stretches across the NASA Mission Directorates and provides Iowa with sound research and opportunities to actively engage students.

- **Iowa-Wide Space Flight Operations Workshop at Iowa State University:**
  - A week-long program for undergraduate students that targets enhancement of student operational thinking capability, with an intended outcome of increased competitiveness for employment opportunities in government and commercial industries, including those related to spaceflight. The workshop is open to engineering students, preservice teachers, and students from partner Historically Black Colleges to create cohorts that strengthen the learning across disciplines through varied background and perspectives from the disciplines. This workshop is lead by Clayton C. Anderson, U.S. Astronaut, Retired.

- **Five curriculum development grants awarded (Goal 4):**
  - Using Wireless Human Physiological Monitoring Systems in an Undergraduate Medical Physiology Course at **Drake University**
  - Developing Capacity of Science Faculty Members in Design and Implement Research-Based Science Curriculum at **Drake University**
Using post-consumer recycled polymers education to meet NASA weight-specific mission objectives. at Iowa State University

Developing Online STEM Masters Courses at the University of Iowa at the University of Iowa

3D: Discover, Design, Develop Workshop Pilot at University of Northern Iowa

These projects are in two distinct categories: courses for students pursuing STEM degrees, and courses for STEM education improvement. These projects provided students and inservice teachers at the four core academic affiliates novel and improved courses based on the ISGC-funded curriculum development and course revisions. The curriculum included traditional STEM courses that focused on recycling polymers during long-duration space missions, exercise testing and physiology, and STEM teaching and learning. One project helped provide a foundation for working with science faculty on improving their understanding of effective teaching and their curriculum. A participant mentioned how the one on one format has helped her to see the connections between educational research and her own teaching. The student participant stated, "This project has provided useful experience running a project from beginning to end, being intimately involved in all aspects of the initial research, data collection, and eventually, presenting findings and implications.” The polymer course development had a side benefit for the students involved in the process as co-creators. Throughout the investigation the students developed literature review research skills, fundamental knowledge of instrumental analysis, and technical writing abilities. Each student devoted between 90 and 100 hours to the investigation of the synthesis, processing, application and re-purposing ability of currently available polymeric materials. The “flipped” nature of the curriculum development process came about as a result of identifying where the gaps in understanding were for engineering students that had not specialized in learning about polymeric materials.

Eleven team projects funded under student hands-on competitions (Goal 4b) seven at Iowa State University (ISU), and four at University of Iowa (UI):

- 2017 University Rover Challenge – UI Robotics Club
- Effect of Mitochondrial CaMKII Inhibition on Radiation-induced Endothelial Dysfunction, UI
- Halo-Sat Cube-Sat, UI
- Space Grant Midwest High-Power Rocket Competition – 2016-2017: UI AIAA
- Space Flight Operations Workshop – ISU
- NASA Robotic Mining Competition – ISU Cyclone Space Mining team
- 2017 World Solar Challenge ISU Solar Car organization: PrISUm
- Value-Based Model of Fixed Wing UAS in Civil Applications – ISU
- “Make to Innovate” (M:2:I) lab support for three projects at ISU:
  - AIAA Design/Build/Fly – ISU
  - 2017 University Rover Challenge MAVRIC (Mars Analog Vehicle for Robotic Inspection and Construction) – ISU
  - NASA University Student Launch Initiative – ISU CySLI team

In summary, these hands-on student projects are creating opportunities for a wide range of students across different colleges and majors to engage with NASA-related
STEM activities and competitions. The teams’ reports indicate the members learned critical lessons related to the engineering process, as well as team communication and the complexity of systems integration for a final product. The teams are active in outreach events, including efforts that also support ISGC goals for precollege and informal education. Numbers of direct and indirect participants from these events will be included in the final report for FY2016.

- **Research Infrastructure projects (Goal 5):**
  In summary, the ISGC funded two projects which are quite different but impacted the development of research capacity and collaborations. Dr. Anupam Sharma, Assistant Professor, Aerospace Engineering had one peer-reviewed paper with 3 pending, four refereed conference presentations, and three other professional presentations. He revised a course in aeroacoustics, and was awarded 92M CPU hours from NSF and DOE. Sharma’s ISGC grant was instrumental in securing the NSF Career award. He and his team were able to secure a barn owl wing specimen, scan it, build 3D models and perform some numerical simulations. They also developed a computational aeroacoustics framework, which was used to analyze model geometries representative of the serrations found at the leading edge of an owl wing. The team was able to demonstrate that the serrations can significantly make the owl quiet in flight; such serrations can be optimized for use in UAVs, aircraft engines, and wind turbines. A number of graduate and undergraduate students have been supported by this grant, either directly or indirectly.

- Dr. Martin Gross, Postdoc Research Associate, Food Science & Human Nutrition, College of Agriculture and Life Sciences was able to develop a collaboration with students who developed a project for submission to fly on ISS through the National Center for Earth and Space Science Education’s Student Spaceflight Experiments Program. This project created a unique collaboration between middle school teachers and students and the ISGC-supported team at Iowa State University. This was an opportunity of a lifetime for these students and teachers to work with the Iowa team to perform algae research. The PI’s of this proposal have performed validation experiments for the methods to prepare the algae for spaceflight. This will ensure the experiment has the best chance of success when it flies on the ISS.

- **Precollege projects (Goals 6-7):**
  a. This year, the ISGC provided NASA professional development for ten ISGC Partner School Program educators with travel and lodging to Marshall Space Flight Center (MSFC) and United States Space and Rocket Center (USSRC) in Huntsville, Alabama for educational professional development conducted at MSFC and USSRC, February 8-11, 2017. The cohort of 10 educators included K-4, 5-8, and 9-12 educators as well as an ISU Extension and Outreach 4-H Youth educator. The educators will use these new materials and knowledge to conduct professional development for other Iowa colleagues and provide learning opportunities for Iowa youth based on this NASA PD. The 4-H educator is planning a series of day-camps for youth to learn about the sun, our solar system, NASA missions, and the solar eclipse on August 21, 2017. Most Iowa schools are not in session on the 21st so the 4-H program under her leadership can fill the void for this experience.
b. Long-term professional development for precollege partner schools focusing on improving teacher skills for STEM education and supportive NASA curriculum. The program included STEM, math, language arts, and special education teachers at the middle school level. The professional development included two days during the summer with a focus on content, pedagogy, and implementation planning and six days during the school year for classroom visits for coaching and additional training in partnership with the Iowa regional education supporters.

c. Ongoing leadership and support for the State Science and Technology Fair of Iowa (SSTFI) continues to support ISGC precollege efforts. The ISGC Associate Director managed the fair for FY2017 at Iowa State University on March 30-31, 2017 with approximately 700 students.

d. The Iowa Junior Academy of Science (IJAS) promotes and supports precollege student research with process, funding, and conference attendance opportunities. Forty proposals were submitted for review and funding. Projects will be presented at the Iowa Academy of Science Junior Academy poster session and two will advance to the American Junior Academy of Science annual meeting. The IJAS project continues to support student engagement in STEM through support of their work from proposal through poster presentation.

e. Continued support for the Iowa Governor’s STEM Advisory Council’s efforts. ISGC Associate Director serves on two working groups and collaborates with the group to improve STEM learning in Iowa.

- **Informal Education projects (Goal 8):**
  a. The ISGC supported the Science Center of Iowa’s (SCI) Star Tours Project that developed “Enter the Universe” for school-day programming and “Star Tours” star parties. The SCI staff conducted seven of these events in targeted communities that had high underserved populations. The program linked the mythology of the universe starting with the ancient greeks to the science of today. The astronomical interactions inspired engagement with the night sky and our universe. Jeff Hendred, Principal at Wilson Elementary School in Ottumwa Iowa writes, “Thank you for providing our families and school the opportunity to gaze at the stars with the telescopes and the Starlab. Our community was so excited to work with the Science Center staff. The SCI provided a great host and tour guide during the Starlab. We hope to partner with you again.”

  b. The ISGC is again sponsoring Earth Day celebrations in April 2017 with free or subsidized admission to the general public at two outreach affiliates: National Mississippi River Museum and Aquarium, and the Science Center of Iowa. Attendees will learn about NASA STEM at the events.

E. **PROGRAM CONTRIBUTIONS TO NASA EDUCATION PERFORMANCE GOALS**

- **Diversity:**

  Seven of 11 executive committee and administrative team members from our core academic affiliates are women. Fellowship and scholarship activities supported 43 students, and the higher education projects supported 52 students. Females total 39 (41.1%), with 22 from UM populations (23.2%) including a military veteran. Our goals are
40% women and 23.3% UM students, per the National Center for Education Statistics (NCES) 2013 data table 306.6.

- **Minority Serving Institution Collaborations:**
  Iowa has no minority serving institutions.

- **Office of Education Annual Performance Indicators:**
  - API 2.4.1: ED-16-1 22 (Number of NIFS to racially or ethnically underrepresented students, women, persons with disabilities, and U.S. veterans)
  - API 2.4.2: ED-16-2 58 (Number of educators)
  - API 2.4.4: ED-16-4 7 (Number of informal education events) Events are scheduled between this writing and June 21, 2017.
  - API 2.4.5: ED-16-5 329 (Number of K-12 students)

**F. IMPROVEMENTS MADE IN THE PAST YEAR**

- Three new affiliates were added. Two new academic affiliates were added to the Consortium. These were the first academic affiliates added since 1996. Loras College is a four-year private college that has an engineering program. Des Moines Area Community College was added as the first community college affiliate. The Iowa 4-H Youth program was added as an affiliate to improve collaborations between the two organizations for precollege outreach. With the addition of two new “academic affiliates” we are adjusting our language to refer to our “core institutions” to cover our executive committee member universities.
  - ISGC created a new website that focuses on better communications for students to access ISGC programs. The website also includes success stories of ISGC-supported students and educators to promote the impact of the consortium on STEM.
  - ISGC hosted the first annual Student Celebration Conference. The conference included invited presentations and a poster session for ISGC supported undergraduates. There were 34 posters and eight invited oral presentations. Mentors, parents, and ISGC faculty attended the event to celebrate the accomplishments of these students.

**G. CURRENT AND PROJECTED CHALLENGES**

- Working with executive committee to develop an adapted structure to best incorporate new academic affiliates to ensure fair and equitable operations that satisfy existing and new affiliates
  - Orient three new executive committee members at two of our four core institutions (academic affiliates)
  - Managing and tracking increasing numbers of student awards for NIFS and hands-on projects.
  - Working with faculty to improve application processes and support mechanisms for scholarships and fellowships.

**H. PROGRAM PARTNERS AND ROLE OF PARTNERS IN PROJECT EXECUTION**

The participation of partners varies as research topics and themes vary from year-to-year. Specific involvement in the current program year is listed in italics below.

1. Aerodyne Laboratories (industry) *support through annual membership fee to the ISGC*
2. Ames Laboratory of the U.S. Department of Energy (federal lab) advisor for DOE alignment
3. Drake University (private four-year university) - Executive Committee member, base program, curriculum development, scholarships, scholarship mentor program, precollege program
4. Grout Museum District (science museum) - Informal education competition participant
5. Iowa Academy of Science (nonprofit organization) - IJAS poster competition
6. Iowa Aviation Promotion Group (nonprofit organization) - Informal education competition participant
7. Iowa Department of Education (state government) - Partner Schools program, State Science and Technology Fair of Iowa
8. Iowa Department of Natural Resources - Iowa Geological & Water Survey (state government) advisor for alignment to jurisdiction
9. Iowa Department of Transportation, Office of Aviation (state government) advisor for alignment to jurisdiction
10. Iowa State University (public Ph.D.-granting university) - Lead institution, Executive Committee member, base program, curriculum development, internships, scholarships and fellowships, scholarship mentor program, early career investigator research program, research innovation, State Science and Technology Fair of Iowa, precollege program
11. United States Department of Agriculture (USDA) National Lab for Agriculture & the Environment (federal lab) advisor for USDA alignment
12. National Mississippi River Museum & Aquarium (science museum) - Informal education competition participant; Earth Day activity collaboration and funding
13. Putnam Museum (science museum) - Informal education competition participant
14. Rockwell Collins (industry) support through annual membership fee to the ISGC, aerospace industry advisor
15. Science Center of Iowa (science museum) - Informal education competition winner; Earth Day activity collaboration and funding
16. Softronics Limited (industry) annual membership fee to the ISGC, aerospace industry advisor
17. University of Iowa (public Ph.D.-granting university) - Executive Committee member, base program, curriculum development, scholarships and fellowships, scholarship mentor program
18. University of Northern Iowa (public comprehensive university) - Executive Committee member, base program, curriculum development, scholarships and fellowships, scholarship mentor program, precollege program
19. Loras College (private college) - scholarships, student hands-on, precollege program, collaborations
20. Des Moines Area Community College (public community college) – Collaborations, students hands-on, precollege
21. Iowa State University Extension and Outreach 4-H Youth program – Dual appointment of Associate Director, precollege outreach programming, ISGC Partner School Partner