THE NATIONAL SPACE GRANT COLLEGE & FELLOWSHIP PROGRAM

FISCAL YEAR 2021
ANNUAL PERFORMANCE REPORT (APR)

FUNDING SOURCE:
OFFICE OF STEM ENGAGEMENT
SPACE GRANT
(CFDA) NUMBER: 43.008

MANAGING ORGANIZATION:
NASA HEADQUARTERS
OFFICE OF STEM ENGAGEMENT

TECHNICAL OFFICER:
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MICHIGAN SPACE GRANT CONSORTIUM LEAD INSTITUTION:
UNIVERSITY OF MICHIGAN

ACTIVITY TITLE:
MICHIGAN SPACE GRANT CONSORTIUM PROPOSAL FOR NATIONAL SPACE GRANT COLLEGE AND FELLOWSHIP PROGRAM - NASA STEM FY 2020 – 2024

UNIQUE ENTITY IDENTIFIER:
073133571

MICHIGAN SPACE GRANT DIRECTOR:
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COOPERATIVE AGREEMENT/GRANT NUMBER:
80NSSC20M0124

PERIOD OF PERFORMANCE:
MAY 10, 2020 – MAY 9, 2024

REPORTING PERIOD:
[MARCH 10, 2021-MARCH 9, 2022]

SUBMISSION DATE:
03/09/2022

FINAL REPORT:
NO

SIGNATURE OF SUBMITTING OFFICIAL:
[SIGNATURE]

ACTIVITY/PROGRAM DESCRIPTION: (100 – 250 words)

Michigan Space Grant Consortium's (MSGC's) strategic elements are derived from the needs of the state of Michigan, the nation, and from the guidance of Headquarters on NASA priorities. MSGC's suite of funding opportunities supports NASA's goal to develop the US STEM workforce, NASA Mission Directorates' needs, National Space Grant objectives, and Michigan's STEM strategies. Program elements that make up the MSGC portfolio include: **NASA Internships and Fellowships (NIF)** that support graduate students and faculty for research or public service activities related to the MSGC at any affiliate institution and internships at NASA Centers; **Hand-On NASA-Oriented Experiences for Student groups (HONES)** that supports active participation by student groups in hands-on learning rooted in NASA-related, STEM-focused issues; **Research Seed Grants** that support research and instructional faculty members at MSGC affiliate institutions to build research expertise; the **Community College Collaborative Program Opportunity (C3PO)** that supports partnerships with community colleges with high percentages of underserved students; **Pre-College Education** grants that support programs aimed at the pre-college level and in-service teacher professional development for individuals; and **Informal Education** grants that support education in informal settings to increase learning and to educate students, educators, and the general public on STEM content areas in order to expand the nation's future STEM workforce. **Special Initiative** augmentation grants are available to supplement funding for programs that target women, underrepresented minorities, and people with disabilities. Proposals are welcome from outreach institutions and organizations throughout the state as well as from affiliate institutions. These programs are designed to lay the seeds of STEM workforce development by focusing on our youngest students, as well as their parents, guardians, and mentors.

ACTIVITY/PROGRAM GOALS: (Bulleted list)
State the Consortium Goals and Objectives from your base proposal and augmentation proposal, if different from base proposal. The objectives should express quantitative targets when appropriate.

Michigan Space Grant Consortium goals and objectives:

1. Promote a strong STEM education base from elementary through secondary levels while providing support to teachers in these grade levels toward more effectively improving student academic outcomes.
2. Create opportunities that enable student contributions to the development of solutions addressing NASA Mission Directorate challenges.
3. Establish and maintain a national network of universities with interests and capabilities in aeronautics, space, and related fields.
4. Create cooperative programs among universities, aerospace industry, and Federal, state, and local governments to foster STEM ecosystems.
5. Encourage interdisciplinary training, research, and public service programs related to aerospace.
6. Attract, recruit, and train US citizens, especially women, underrepresented minorities (URM), and persons with disabilities, for careers in aerospace science and technology.
7. Advance aerospace knowledge and expand related activities.

ACTIVITY/PROGRAM CONTRIBUTIONS TO PERFORMANCE GOALS (PG) AND SUCCESS CRITERIA

List appropriate FY 2021 PGs and Success Criteria, and write a brief description of the project activity's contribution to each.

NIF, HONES, Research SEED Grant, C3PO SMART GOALS
NASA Candidate Performance Goal 3.3.5 "Enabling contributions to NASA's work"

- **Goal:** Improve the quality of applications received for Internships and Fellowships.
  Measurement – Based on average reviewer scores.
- **Goal:** Increase the number of students applying for NASA Internships.
  Measurement – Compare the number of students from year-to-year.
- **Goal:** Increase the number of presentations/ papers reported by students and faculty awardees
  Measurement – Compare the number of presentations/ papers reported by students and faculty awardees from year-to-year.

NASA Candidate Performance Goal 3.3.3 "Building a diverse, skilled future STEM workforce"

- **Goal:** Increase the % direct significant awards to underrepresented minority (URM) and women
  Measurement - Compare the number of applications from year-to-year
- **Goal:** Increase the number of applications each year from URM and women.
  Measurement - 22.7 URM and 53% women
- **Goal**: Increase the number of NIF applicants from MSGC affiliated (non-lead) universities
  Measurement - Compare the number of applicants from MSGC affiliates from year-to-year.

Pre-College Education, Informal Education, and Augmentation SMART GOALS
NASA Candidate Performance Goal 3.3.5 "Enabling contributions to NASA's work"

- **Goal:** Improve the quality of applications received.
  Measurement – Based on average reviewer scores

NASA Candidate Performance Goal 3.3.3 "Building a diverse, skilled future STEM workforce"

- **Goal:** Increase the # of educational programs that either (i) apply for augmentation or (ii) are continuing augmented programs, increasing target # of direct participants.
  Measurement - Compare the number of applications from year-to-year

All Programs combined SMART GOALS
NASA Candidate Performance Goal 3.3.3 "Building a diverse, skilled future STEM workforce"

- **Goal:** Increase the number of collaborations with industry partners
  Measurement - Compare the number of applications from year-to-year

PG 3.3.3: Provide opportunities for students to engage with NASA's aeronautics, space, and science people, content, and facilities in support of a diverse future NASA and aerospace industry workforce.

> **PG 3.3.3 Success Criteria:** Meet or exceed the national average in two of the four categories of student diversity for NASA STEM enrollees in internships, fellowships, or other student engagement opportunities. Diversity Categories: (1) students across all institutional categories and levels (as defined by the U.S. Department of Education), (2) racially or ethnically underrepresented students (Hispanics and Latinos, African Americans, American Indians, Alaska Native, Native Hawaiians and Pacific Islanders), (3) women, and (4) persons with disabilities at percentages that meet or exceed national averages for science and engineering enrollees, as determined by the most recent, publicly available data from the U.S. Department of Education's National Center for Education Statistics.

Response to PG 3.3.3 and PG 3.3.3 Success Criteria goes here:

NIF, HONES, Research Seed Grants C3PO

MSGC uses three metrics to measure the increase in diversity of aerospace science and technology workforce from activity derived from Fellowship, Internships and faculty applications and awards. The first metric includes the percent of significant, direct awards for URM and women. The target is to meet or exceed the percentage enrollment of those populations in higher education institutions in Michigan, reported by DoE, NCES. A second metric includes the number of applications each year from URM and women. The target is to increase that number each year. Thirdly, MSGC's efforts to build a broad, skilled future STEM workforce is measured by the number of applicants from MSGC affiliated (non-lead) universities. The target will be to increase that number each year.

Benchmarks for diversity within the MSGC Fellowship and Internship Programs have consistently been met. Historically, approximately 40% of fellowship and internship, award recipients were women and 20% were underrepresented minority students. MSGC's new goal is to secure at least 53% women and 22.7% underrepresented minority students.

Pre-College Education, Informal Education and Augmentation

To measure the increase in diversity of aerospace science and technology workforce from activity derived from **Pre-College Education, Informal Education and Augmentation** MSGC will compare the number of proposals that either (i) apply for augmentation or (ii) are continuing augmented programs, increasing target # of direct participants. The target is to increase that number each year.

All Program Combined

MSGC aims to grow strategic partnerships with industry to enhance and extend the impact of NASA's efforts in STEM engagement. The number of collaborations will measure success from year to year.

PG 3.3.5: Provide opportunities for students to contribute to NASA's aeronautics, space, and science missions and work in exploration and discovery.

PG 3.3.5 Success Criteria: Number of paper presentations and peer-reviewed research publications (and beginning in FY2021 to include student proposed solutions and products) resulting from STEM engagement investments.

Response to PG 3.3.5 and PG 3.3.5 Success Criteria goes here:

NIF, HONES, Research Seed Grants C3PO

MSGC has three metrics under this criterion. The first metric for applications submitted in response internships and fellowships opportunities includes increasing the quality of applications measured by the average reviewers' scores on applications. The second metric includes increasing the number of students applying to MSGC for NASA internships, measured by number of applications received from year to year. The third metric includes increasing the numbers of papers/presentations and award demographics gathered through both applications and annual reports.

Pre-College Education, Informal Education, and Augmentation

The single metric under this criterion for applications submitted in response to Pre-College Education, Informal Education, and Augmentation funding includes increasing the quality of applications received measured by the average reviewers' scores. The target will be to increase the quality each year.

ACTIVITY/PROGRAM ACCOMPLISHMENTS: ***(250 – 500 words)***

NIF, HONES, Research Seed, C3PO
NASA Candidate Performance Goal **3.3.5 "Enabling contributions to NASA's work"**

- **Goal -** Improve the quality of applications received for Internships and Fellowships.
  Measurement – Based on average reviewer scores.
  Approach – Create opportunities for additional guidance and mentorship at the affiliate and lead institution level prior to proposal submission and provide an administrative review of proposals upon receipt, prior to sending to reviewers; ensuring proposals include all of the required components; such as matching funds and letters of support.
  Accomplishment –In year 1, 58 out of 87 applications or 67% received a score of 80% or higher. 20 applications or 23% received a score of 90% or above. In year two, 59 out of 106 applications or 56% received a score of 80% or higher. 16 applications or 15% received a score of 90% or above. The reduction in performance may be linked to the increased number of applications received. .The number of high scoring proposals was essentially unchanged, but the percentage of high scoring proposals went down due to increasing numbers of submissions.

- **Goal -** Increase the number of students applying for NASA Internships.
  Measurement – Compare the number of students from year-to-year.
  Approach - Provide marketing materials to all MSGC affiliate representatives to supplement the other ways (newsletter, website, postings, and e-mails) in which we announce the MSGC Internship opportunities.
  Accomplishment – In Year 1, NASA received approx. 275 applications from MSGC's 11 affiliate institutions. This year, applications submitted to NASA for internships have not been made available for comparison due to the migration to a new system limiting access by the consortium to the database containing the submitted applications.

- **Goal -** Increase the number of presentations/ papers reported by students and faculty awardees
  Measurement – Compare the number of presentations/ papers reported by students and faculty awardees from year-to-year.
  Approach – Increase visibility around this goal; highlighting the expectation in Notices of Awards and Reporting Requirements documents; providing our Acknowledgement Statement with grant number for easy reference on our website and MSGC signature lines, etc.
  Accomplishment – Year two saw the first reportable outcomes from year one's funding. There were 74 publications reported in year one including 49 Paper Presentation and 25 Peer Reviewed Manuscripts.

NIF, HONES, Research Seed, C3PO
NASA Candidate Performance Goal **3.3.3 "Building a diverse, skilled future STEM workforce**"

- **Goal -** Increase the number of applications each year from URM and women.
  Approach - Provide marketing materials (newsletter, website, postings, and e-mails) announcing augmented support for those proposals that target underrepresented minorities and women. To be considered for augmented support, applicants are required to submit an additional page describing in detail why additional funds are necessary to assure the success of program targeting underrepresented minorities and/or women.
  Measurement – Target indicated in our proposal was (22.7 URM and 53% women)
  Accomplishment – In year 2, women represent 46% of the applications received; whereas, URM represented 20%, just 2.7% shy of our goal. Year two saw an increase of URM's from year 1, which only accounted for ~ 16% previously.

- **Goal -** Increase the % direct significant awards to underrepresented minority (URM) and women
  Approach – If we succeed at our first goal to increase the number of applications received each from URM and women, the % of direct significant awards should follow.
  Measurement - Compare the number of applications from year-to-year. Year 1 set the baseline that subsequent years will be compared against. 16% URM and 49% females.
  Accomplishment – in year 1**,** females represented 49% of the significant awards and URMs 16%. In year 2, females represented 45% of the direct significant awards and awards to URM's represented 27%. We grew in URM support in year 2 but was down in our numbers for female awards from Year 1.

- **Goal** - Increase the number of NIF applicants from MSGC affiliated (non-lead) universities
  Approach - Provide marketing materials to all MSGC affiliate representatives to supplement the other ways (newsletter, website, postings, and e-mails) in which we announce the MSGC Fellowship and Internship opportunities.
  Measurement - Compare the number of applicants from MSGC affiliates from year-to-year.
  Accomplishment – The number of MSGC affiliated (non-lead) universities proposals submitted by NIF applicants in year two was 82, up by 16 from year 1; including (0 Calvin, 3 EMU, 11 GVSU, 19 Hope, 11 MSU, 23 MTU, 3 Oakland, 1 SVSU, 1 UM, 4 WSU & 6 WMU). Calvin saw a transition in Affiliate leadership this year.

Pre-College Education, Informal Education, and Augmentation
NASA Candidate Performance Goal **3.3.5 "Enabling contributions to NASA's work**"

- **Goal -** Improve the quality of applications received.
  Measurement – Based on average reviewer scores
  Approach - Create opportunities for additional guidance and mentorship prior to proposal submission.
  Accomplishment - Year 1 sets the baseline that subsequent years will be compared against. In year one, 6 out of 18 applications or 33% received a score of 80% or higher. 3 applications or 16% received a score of 90% or above. In year two, 9 out of 20 applications or 45% received, a score of 80% with 2 applications or 10% receiving a score of 90% or above. Overall, year two saw an increase in quality of applications submitted from 50% in year one to 55% in year two.

Pre-College Education, Informal Education, and Augmentation
NASA Candidate Performance Goal **3.3.3 "Building a diverse, skilled future STEM workforce**"

- **Goal -** Increase the # of educational programs that either (i) apply for augmentation or (ii) are continuing augmented programs, increasing target # of direct participants.
  Measurement - Compare the number of applications from year-to-year
  Approach – No longer, require 1:1 match for the augmentation portion of the budget. Provide marketing materials (newsletter, website, postings, and e-mails) announcing augmented support for those proposals that target underrepresented minorities. To be considered for augmented support, applicants are required to submit an additional page describing in detail why additional funds are necessary to assure the success of program targeting underrepresented minorities and/or women.
  Accomplishment –Twelve educational program proposals out of a total of twenty (60%) applied for augmentation or continuing augmented programs in year 2, up 4% from year 1.

All Programs combined
NASA Candidate Performance Goal **3.3.3 "Building a diverse, skilled future STEM workforce**"

- **Goal -** Increase the number of collaborations with industry partners
  Measurement - Compare the number of applications from year-to-year
  Approach - Reach out to industry partners who are seeking collaborations to provide internships opportunities for our audience; pre-college and college age students from our network of non-profit community partners and our affiliates.
  Accomplishment –this summer six undergraduate and one graduate student received virtual Internships as part of a recent collaboration between MSGC and Orbital Effects, a small satellite startup focused on addressing critical U.S. national security challenges using its cutting-edge radar satellite technologies. Efforts to secure additional collaborations with industry partners are planned for year 3.

NCAS AND SPACE GRANT PILOT ACCOMPLISMENTS (If applicable): ***(250 – 500 words)***

Not Applicable

BIG Idea FY2021 ACCOMPLISHMENTS (If applicable): ***(250 – 500 words)***

After winning the BIG Idea 2020 challenge and receiving the Artemis Award, we have continued testing and developing the technology. Based on the T-REX rover and the superconducting cable for power transfer technology we tested for the BIG Idea competition, we completed a much more in-depth analysis and participated in the NASA Watts on the Moon challenge. We were awarded the Grand Prize ($100,000.- prize money) for Scenario 2: a 1 km, max 10 kW power transfer from a power plant to a water extraction factory. We have written a journal paper (second round of review currently) about T-REX and several conference papers. Preparations to participate in phase 2 of the Watts on the Moon challenge are underway. We also proposed a PRISM 2 tether deployment demo mission while characterizing the lunar environment but were not encouraged to submit for phase 2 due it being too much of a tech demo. We are still continuing to further develop this technology and in the mean time have been busy developing subsequent lunar surface technologies through several funded grants such as one of the inaugural LuSTR grants ($1.9M) and we are also part of a GCD grant to look at lunar regolith transport into a molten regolith electrolysis reactor.

FIRST NATIONS LAUNCH (If applicable): ***(250 – 500 words)***

Not Applicable

ACTIVITY/PROGRAM IMPROVEMENTS MADE IN THE PAST YEAR:
(*e.g., activity management, cost efficiencies) (100 – 250 words)*

At MSGC's summer board retreat, this August, the board agreed to increase the funding amount for Faculty Led Undergraduate Fellowship awards from $3K to $4K and eliminate the requirement to include matching funds on requests for supplement funding, up to $5K, on proposals that target women, underrepresented minorities and applicants with disabilities.

Two years in the making, and for the first time ever, this year's annual Fall Conference for MSGC awardees was held face to face, on location at one of MSGC's affiliate campuses - Calvin College in Grand Rapids, MI. It included keynote, Deanna van Dijk, former MSGC awardee from Calvin College, as well as 18 oral presentations and 38 posters, more than 100 attendees turned out to network and share their efforts from 2021. The schedule included on-site tour of Professor Deanna van Dijk's, Perseverance Dune project, a docent guided tour of the Dice Mineralogical Museum, and the opportunity to explore Ecosystem Preserve & Nature Gardens, a one of a kind oasis is the city of Grand Rapids, MI. Those who were unable to attend in person were invited to submit an optional pre-recorded five-minute video presentation of their project for upload to MSGC's YouTube channel and website

We are also excited to announce that our collaboration with the Michigan Science Teachers Association (MSTA) will provide an opportunity for twenty-two K-12 teachers from the state of Michigan to attend MSTA's annual professional development workshop this March.

Additional K-12 commitments, new in FY2021, included support for the MiSTEM Greater West Michigan Region's STEM Mini-Grants Program that supports educators in the teaching and learning of STEM in K-12 classrooms. As well as 100 5-8 graders from Perry Innovation Center, of the Grand Blanc Community School District, in Grand Blanc, MI who submitted more than 30 flight experiments to the Student Spaceflight Experiments Program's (SSEP) Mission 16 to the International Space

Station (ISS). One experiment submitted by a team of 8th graders entitled, "Microbial Solutions for Food Waste in Space" was selected. Also new in 2021, MSGC supported ten teams comprised of 146 students from four Title 1 Schools from across the state of Michigan to take part in this spring's Plant The Moon/Mars Challenge. Hosted by Competition Sciences, participants in the Plant the Moon/Mars Challenge join a global science experiment and research challenge to examine how vegetable crops can grow in lunar or Martian soil.

In addition, MSGC continues to establish and expand our non-profit STEM educational collaborations and industry partners. This summer, six undergraduate and one graduate student received virtual internships as part of a new collaboration between MSGC and Orbital Effects, a small satellite startup focused on addressing critical U.S. national security challenges using its cutting-edge radar satellite technologies.

Efforts to secure additional non-profit STEM community collaborations and industry partners is ongoing.

ACTIVITY/PROGRAM PARTNERS AND ROLE OF PARTNERS IN ACTIVITY EXECUTION:

Bulleted list or table. May include a brief description of how partners were involved in the project activity.

The MSGC Executive Board consists of the campus representatives at the following member institutions; as well as board members representing local K-12 and Teacher Training Programs. Campus representatives have the same general role within MSGC, achieving ultra-high equity among the board members. The campus representatives further MSGC's mission and vision on their campus, helping students and ensuring that administrative procedures are followed during the application process. They evaluate and advise MSGC leadership on policies and procedures. They review individual funding applications; their varied individual expertise provides the ability to evaluate applications across a broad spectrum of subject areas. The Board also meets in February to arrive at final decisions on our annual program awards.

Calvin University • Private four-year liberal arts college: Dr. Larry Molnar is an Assistant Professor of Physics and Astronomy with research in the field of globular star clusters.

Ann Arbor Public Schools • Tom Pachera is the STEAM Coordinator for Ann Arbor Public Schools, has also joined the MSGC executive board this year as an expert in K-12 education. He has taught Technology Education for 29 years and currently teaches Introduction to Engineering Design, and Engineering Design & Development courses for Skyline High School. Key figure in evaluation of Precollege programs.

Eastern Michigan University • Public Ph.D.-granting university: Dr. Roxanne Katus is a Professor of Mathematics and Statistics.

Eastern Michigan University • Public Ph.D.-granting university: Dr. James Sheerin is a Professor of Physics and Astronomy. Key figure in evaluation of Precollege programs.

Grand Valley State University • Public Master's-granting university: Dr. Bopaiah Biddanda is an Aquatic Microbial Ecologist interested in the Carbon Biogeochemistry of natural waters.

Hope College • Private four-year liberal arts college: Dr. Peter Gonthier is an astronomer and Professor of Physics. 2021 Deputy Campus Representative, Dr. Brian Yurk, will replace Dr. Gonthier in 2022. Assistant Professor, Yurk, has been teaching in the department of Mathematics at Hope College since 2009 and is a former MSGC awardee.

Michigan State University • Public Ph.D. granting university: Dr. Virginia Ayers is a Professor of Electrical and Computer Engineering at Michigan State University. Her research investigates both inorganic and organic nanostructures.

Michigan Technological University • Public Ph.D. granting university: Dr. Will Cantrell, is the Associate Provost and Dean of the Graduate School at Michigan Technological University, as well as a professor of physics. His research includes atmospheric science, cloud and aerosol physics and chemistry as well as nucleation.

Oakland University • Public Ph.D. granting university: Dr. Laila Guessous is an Associate Professor of Mechanical Engineering with research in the field of computational fluid dynamics and computational heat transfer.

Saginaw Valley State University • Public Master's-granting University: Dr. Khandaker Abir Rahman is the Chair and Associate Professor of Computer Science & Information Systems.

University of Michigan (lead institution) • Public Ph.D. granting university: Dr. Mark Moldwin is the MSGC director, Arthur F. Thurnau Professor of Climate and Space Sciences and Engineering within the University of Michigan's College of Engineering. He is also Faculty Director of UM's M-STEM's M-Engin program, and Past-President of the American Geophysical Union's (AGU) Education Section.

Wayne State University • Public Ph.D. granting university: Dr. Ed Cackett is a professor of Physics and Astronomy.

Western Michigan University • Public Ph.D. granting university: Dr. Massood Atashbar is Professor of Electrical and Computer Engineering and the director of Advanced Smart Sensors and Structures and the Sensor Technology Laboratory.

CURRENT AND PROJECTED CHALLENGES:

Identify any current or projected challenges in the implementation or execution of activities. Explain how the management team is working to address the challenges identified and/or how National Program Staff can assist.

The evolving landscape due COVID-19 and associated restrictions is the projected challenge for 2022. However, MSGC's network of affiliates and community partners proved resilient and determined in 2021. Identifying creative ways to stay connected and involved, they overcame unanticipated obstacles due to limited face-to-face interactions and restricted travel; getting the research, community engagement and learning objectives accomplished in spite of being in the middle of a global pandemic. Based on the success of this last year, we remain encouraged and are optimistic that MSGC will successful meet or exceed all of its funding and collaboration goals planned for 2022.