C.U.I.T.S

Columbia University InTo Space
Software Proposal for NASA SUITS 2024 Design Challenge

COLUMBIA
SPACE INITIATIVE

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Michael J. Massimino
Professor of Professional Practice

Contents

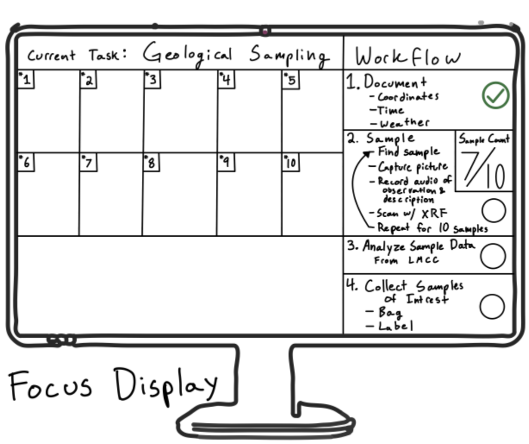
I. Technical Section

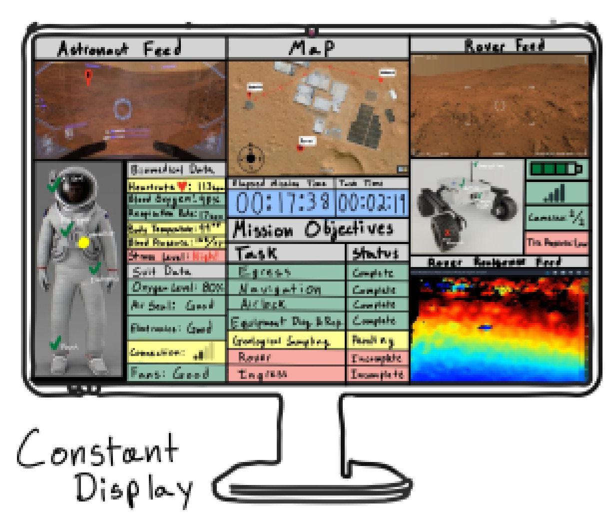
a. Abstract

The road to long-term human spaceflight inhabitation requires rapid assessment and response of and to extraterrestrial environments, typically more stressful than earth environments. Astronauts in low earth-orbit experience a wide variety of health-related stresses, including muscle atrophy, neuro-ocular damage, and spaceflight-induced anemia. Key environment factors include atmospheric composition, geographical coordinates, and local environmental features. Engineers and scientists are partnering within a broad range of disciplines to develop systems to simultaneously monitor all of these factors, whether by measuring biological factors within astronaut urine or collecting environment statistics on rovers, which will likely be sent before and along with the first human astronauts to Mars. Our goal for this project is to create a software interface for an astronaut productivity optimization headset that integrates data in a findable, accessible, interoperable, and reproducible manner, presenting it visually in an elegant and functional way. We divide the interface into two core components: an intuitive UI that would be displayed on an astronaut's headset during Extra Vehicular Activity, and a dual monitor display that serves as a localized mission control center to make crews far from Earth more independent. Within the LMCC 's dual monitor display we will have a constant screen, monitoring crucial factors that are important at all times during the mission, and the mission-specific focus screen, mediated by place,time, and current mission. We plan to incrementally develop throughout the first half of the upcoming year and utilize members of our team as primary testers, with peers and friends outside of the team as secondary testers to test how intuitive our designs are to others not familiar with the mission. Ultimately, our project will empower the astronauts to make informed decisions with regard to the environment and their health, improving the sustainability of long-term space travel, making humanity an interplanetary species.

b. Software-Hardware Design Description

Localized Mission Control Center (LMCC)

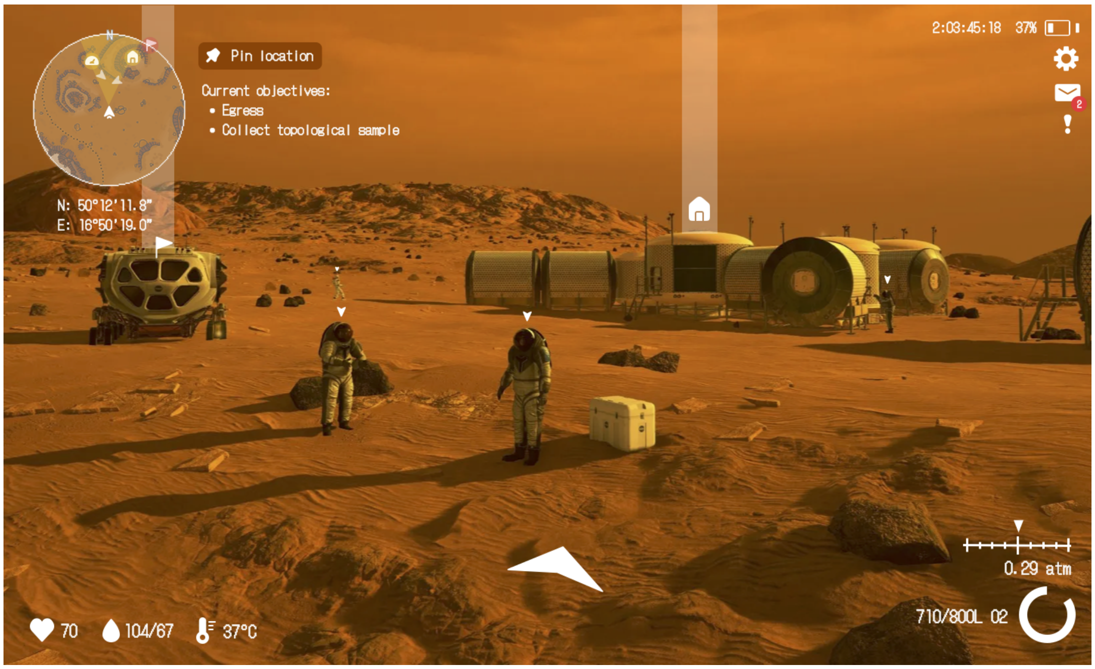




Design Mockup for LMCC Constant Display

The LMCC program will host two monitors with different purposes: One **focused display** will give a high level overview of the current mission objectives, and the other **constant display** will give a comprehensive overview of all necessary information. Both will be interactive, allowing for changes to names, statuses, pins, and other variables relevant to the mission.

Head-Mounted Device (HMD)

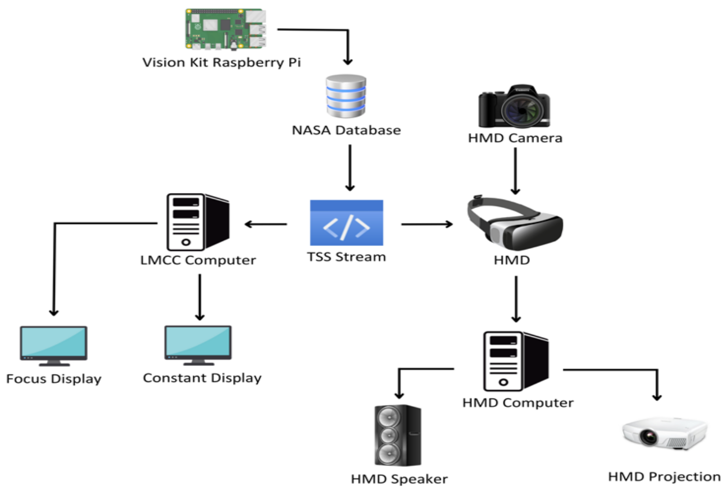


A mockup for the base use-case display of the HMD (head-mounted device).

Geographical Markers: Users can view marked beams of light indicating points of interest, which are designated by either mission control or pinned themselves.
Minimap: The minimap displays all points of interest within the user's radius in yellow, and has a constant directional marker for the current objective in *red*, indicating its location. The map also shows the locations of other crewmates within the radius. Current coordinates are displayed in GeoJSON. The map may be expanded to take up the full view, where coordinates can be seen for all arbitrary points of interest.
Objectives list: Truncated list of current objectives are listed beside minimap, but can be expanded to edit/view all.
Biomedical data: User biomedical data is displayed in the bottom left, suit O_2 and pressure levels are in the bottom right.
Messages and Warnings: Users can send and receive messages with a messaging feature, located in the top right. Messages can be sent between crewmates and to/from mission control.
Miscellaneous: Current elapsed mission time is in the top right, alongside battery levels and settings.

Proposed Network Diagram

Network diagram showing potential input sources and peripherals



Algorithms for Specific Design Objectives

Egress

For the egress and ingress tasks, we plan to develop an algorithm that takes in current UIA states from the Telemetry Stream Server (TSS) and the HMD camera feed, and return a step-by-step checklist to the DE's field of view as well as recognizing specific highlights sent by the LMCC which outline what action must be taken. For instance, if 'Switch X' is off, but needs to be on, the algorithm will gather the camera feed and the switch state in order to return a checklist item stating "Flip Switch X to on" and highlighting 'Switch X' on the DE's field of view. Additionally, the algorithm will check for hazards in the UIA states and return error messages if necessary.

Navigation

For the constantly displayed minimap, multiple algorithms will be necessary for refreshing, updating, and navigating. First, a constantly looping algorithm will take the inputs of the GPS position for each person, rover, and checkpoint on the field, returning a cartesian location on the minimap for each. Second, an update algorithm will take in a new GPS location or cartesian coordinates, and update the displayed location on the minimap. There will also be algorithms to update variable names and icons. Lastly, we will create an algorithm that takes in a start location, a goal location, and points of caution in order to return a navigation route to the HMD and minimaps.

During navigation, the camera feed from the HMD will be analyzed by an image recognition library and potential hazards (rocks, holes, trees, etc.) will be highlighted in the design evaluator's field of view.

Utility Airlock

The utility airlock will require an algorithm similar to the ingress and egress. It will include the same formatting and composition, but will be applicable to the goal states of the utility airlock and instructions from the mission controller at the LMCC.

Equipment Diagnosis and Repair

The equipment diagnosis and repair will require an algorithm similar to the ingress and egress. It will include the same formatting and composition, but will be applicable to the goal states of the utility airlock and instructions from the mission controller at the LMCC.

Geological Sampling

Multiple algorithms will work in tandem towards the geological sampling task. One algorithm will take input in the form of an audio clip from the HMD; a timestamp; a scan of a geological sample; and a recording of where the sample was taken in order to add them to a database that is accessible from the focus display of the LMCC. Additionally, an algorithm will take in RFID data from the spectrometer, and search the database, designating a level of importance to the sample which will tell the DE if the sample should be stored.

Rover

The main algorithm necessary for the rover will take in keystrokes and mouse movements from the LMCC and translate them into instructions for the rover's controller, in turn moving the rover. Special keybinds will allow actions such as geological collection, pin drops, and navigating to habitat to take place.

LMCC

For the LMCC, a GUI based algorithm will take in keystrokes, mouse movements, clicks, and state variables to decide what to display on screen. The focus display will show the current mission based on state variables but can change by the user navigating through a menu.

c. Concept of Operations

1. **Egress**

The first objective of our mission is to have a secure egress of the astronaut out of the habitat. In the habitat, the HMD, suit, and other tools will be equipped, and the astronaut will be ready to embark on the mission. When preparing to exit the habitat, the HMD will be turned on and enter its Egress Mode.

This Egress Mode includes a verification of the astronaut and their current bio-stats, as well as a checklist of objectives to be completed before fully exiting the habitat. This objective list will be displayed on-screen in the margins to not obstruct the astronaut's view as they complete each objective. Each time an objective is completed, the user will receive both audio and visual feedback, appearing as a verbal affirmation and a green check mark on the objective list. The reassurance of both the audio and visual feedback supports the integrity of communication between the machine and the user.

2. **Navigation**

Upon completion of all egress procedures, the HDM will exit Egress Mode, and enter into its default state as navigation begins. This default state will include an array of widgets, sitting in the margins, all of which can be interacted with through a series of physical interaction, audio cues, or gestures. The goal is to have all widgets be just as useful as they are convenient and unobstructive.

One such widget will, once again, be a checklist of objectives, similar to what was seen during egress. The list of objectives will be ordered by priority in the margins. There will be accompanying audio and visual feedback as objectives are completed.

An active compass will be available, as well as a mini-map. This map, while in the widget form, will display the user's location, and well as any marked paths of dropped pins. When this widget is interacted with, it will become enlarged on the screen, displaying more details, including a larger area covered by the map, the location of other astronauts, the location of important sites, etc. In this enlarged mode, the user can drop a pin of their current location or a location of interest to be viewed on both the mini-map and its enlarged version. Any pin or marker left behind by a field member in the HMD or by a member in the LMCC can be interacted with to receive directions to that point. These directions will be visualized with an AR path in front of the field member and a drawn path on the mini-map.

A display of current statistics will be shown in the margins, including heart rate, O2 levels, and battery level. When the heart rate is interacted with, it will enlarge, and bring up a page including all relevant bio-stats available, such as a chart of heart rate activity. When the O2 widget is activated, it will enlarge to show the progression of O2 availability and an estimate of when the tank needs to be changed. The battery widget will work in a similar way, expanding to show battery efficiency, a chart of battery availability, and an estimation of when the battery should be charged. Each of these widgets will be accompanied by audio and visual cues that indicate both cautionary and emergency levels (high heart rate, low battery, low O2), and when they have returned to a safe state.

In the center of view, the user can see the terrain in real time, but with AR arrows on the ground or an outlined path, helping them find their way to their next destination.

3. Utility Airlock

Once the astronaut has effectively navigated to the Utility Airlock, a pop up will appear for the user to interact with, in order to tell the system to initiate Airlock Open Mode. This pop-up will be both audio and visual, and the user can interact both verbally and physically to respond. The HDM will once again leave the baseline state of navigation, and enter a mode, similar to Egress Mode, suited for the airlock.

In Airlock Mode, the user can efficiently interact with the tools and equipment needed. There will be a procedure, based on received instructions, which will be read aloud to the user, as well as displayed in the margins. Opening the airlock and accessing whatever is inside is an objective on the objective list, to once again be verified with audio and visual confirmation. To reemphasize, the text accompanied with voice command is integral in maintaining the machine-user confidence and supporting overall mission efficacy.

4. **Equipment Diagnosis and Repair**

The LMCC is largely responsible for the duties of equipment and diagnostic repair, and as such, will have all vital information of the crew member made available to them in real time–being prioritized on their focus display. This includes crew-member camera feed, audio and visual cues, and the objective list for the current phase. Whoever is in the LMCC will have access to all technical information in order to most accurately assist in solving the problem at hand by communicating their home base information with the in-field member. These instructions will be heard by the field-user and will appear in their objectives list.

5. **Geologic Sampling**

Once again, communication between the LMCC and HMD becomes a crucial aspect of the mission. All information for geological sampling will be given to the HMD from the LMCC. The searching and obtaining of a specific rock will be objectives appearing in the widget. The field-member will be instructed by the LMCC with audio and visual descriptions, and will then scan their rock. The user will then be prompted to send the scan of the rock back to the LMCC, which can be done with both physical and verbal confirmation.

6. **Rover**

Between the two displays, if the LMCC wants to activate a feature to have an enlarged or more detailed look, they can look at their constant display, tap on what they wish to activate, and it will enlarge for the user. With the rover, the LMCC may gain rover control by tapping on the rover in their constant display. This expands all information pertaining to the rover, including control, but additionally access to the two enlarged camera feeds, battery status, and all necessary physical diagnostics.

When the LMCC is in the rover state, their access to the mini-map is prioritized. What the HMD can do while navigating, the LMCC can do in the rover state. This includes dropping a locational pin of interest (to show up on both the LMCC and HMD mini-maps) and having item collection commands.

7. **Ingress Procedure**

When heading back to the habitat, the field member will enter Ingress Mode, which is comparable to Egress Mode. The user can tap through the menus or use voice control to enter this mode. In Ingress Mode, directions are shown to the user back to the habitat, both in AR directions in front of the user, and as a path on the mini-map.

The LMCC will communicate instructions to the HMD, resulting in a verifiable objective list in the HMD, and once all objectives have been completed, the field user may interact with the airlock, and safely enter the habitat.

Throughout all phases of the mission, there will be caution signals hard coded into the system. This includes low heart rate, low O2, high UV exposure, rover damage, etc. All of which will be sent to whom it pertains (biostats to HMD, rover stats to LMCC, etc.). Each person will be alerted with a warning and details about the issue. Additionally, the LMCC will have the power to send a warning or caution signal out to the field HMD.

As for additional features, the LMCC in constant view will have a timer of how long the HMD has been out of the habitat on their mission, and all users in the HMD, when engaging with the biostatistics feature, will be shown not only their biostatistics, but the biostatistics of their fellow field members at the time in case of emergency.

d. Human in the Loop Testing

We will structure our plan as follows to test various conditions, ranging from basic functionalities to more complex situations:

1. **Projection into the AR Space**

We will first test the ability for Microsoft's Hololens 2, to project information into an AR space. We plan to implement our software using Unity, and will test printing basic output (i.e "hello world").

2. **Projection of Mini Map and Base HMD Display**

Our next phase of testing will ensure that the minimap and base HMD display will be able to be projected into the Hololens' output. Members of the team will be first to test the projections, focusing on ensuring that our envisioned designs will be intuitive and non-obtrusive. Next, we will employ other students at our institution (peers, friends), to see how a new perspective can improve the usability of our designs. We will incrementally test the functionality like this until the base display is fully implemented.

3. **Communication between LMCC and HMD**

We will then test the communication of the LMCC and HMD through the TSS. We will do this by testing the HMD's ability to print our relevant real time data from the LMCC (i.e., sending biometrics, oxygen levels, and reading objectives to and from the LMCC and HMD).

4. **Mock Mission Run on an open flat surface**

We will test the full basic functionality of our systems combined together. This test will ensure that full basic functionality was reached in the prior stage. We will hold this mock run in an open, flat environment, (i.e., the lawns on campus) to see that our programs are able to communicate with each other efficiently. Both team members and other students will execute these tests.

5. **Mock Mission Runs - Complex Conditions**

Our final stage of testing will seek to recreate the mock mission we set forth in the prior stage, but with more complex conditions. Examples of these conditions include: going to a field with rocks and hills to obstruct possible paths and recreate conditions and JSC rock yard, and testing in night and day conditions to see what solutions will lead to the best visibility in both results.

e. Project Management

Over the course of 5 months, the team will meet for an hour every Wednesday and Friday, with each member being expected to work 1-3 hours outside meetings. Every meeting, the team will discuss work in progress, provide feedback for each other and assign new tasks to be completed if necessary.

<u>Legend</u>
All - all team members
DT1 - development team 1
DT2 - development team 2

Month	Who	Planned Action	Planned Outcome
1: JAN	All	Learning how to code in C#, familiarize w NASA's IDE	Able to code in C# proficiently
2: FEB	DT1	Connect HMD with LMCC through TSS ● Ensure the TSS' update frequency is sufficient to deliver data in a timely manner ● Ensure the data transferred to and from TSS are formatted correctly	HMD is able to communicate with LMCC
	DT2	Code a skeleton program outlining the major algorithms to be written later, algorithms include: 1. Communicate egress directions 2. Navigate DE between stations 3. Communicate task directions to DE 4. Communicate repair directions to DE 5. Access and display geological data 6. Control navigation, trigger behavioral functions, mark location of collected sample, view collected data 7. Navigate DE back to airlock ● Ensure different algorithms can pass data to each other successfully	A rough code framework addressing mission aims is established and ready to be filled out
3: MAR	All	Writing code to achieving mission aims (as outlined by Requirements section of Mission Description)	Each algorithm is completed and accomplishes mission aims

		• Work on code and UI simultaneously • Complete preliminary testing and final testing	
4: APR	All	Final full testing with external evaluation • Consult NASA point of contact / somebody outside our team to test product Final adjustments and polishing • Tweak product design based on evaluation feedback • Fix hiccups discovered during testing • Refine product appearance	Revise product based on third-party feedback Ensure everything runs smoothly and is presentable
5: MAY	All	Have everything polished a week before the challenge • Review code • Deploy and submit product	Ensure everything is ready to go

f. Technical References

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“The Shortest-Path Algorithm.” *Shortest-Path Algorithm*, www.cs.cornell.edu/courses/JavaAndDS/shortestPath/shortestPath.html#:~:text=The%20shortest%2Dpath%20algorithm%20calculates,from%20one%20place%20to%20another. Accessed 1 Nov. 2023.

II. Outreach Plan

Columbia's SUITS team operates as a part of the Columbia Space Initiative (CSI), a larger student-run organization on campus dedicated to space science and engineering. Each year, CSI facilitates robust educational outreach efforts in the greater New York community by volunteering directly in local middle and high schools. This year, as in the past, the SUITS team will contribute heavily to CSI's outreach efforts by volunteering for and improving many of the longstanding programs facilitated by the Outreach team. However, the team will also be designing their own outreach curriculum this year in an attempt to incorporate computer science into CSI's existing curricula, as well as to directly disseminate the results of the SUITS challenge.

The outreach work conducted by CSI is completed in under-resourced schools throughout New York City, and the team works primarily with students underrepresented in STEM, most of whom live at or below the NYC poverty line. Moreover, many of the students that CSI serves are a part of the "Artemis Generation," making the team's efforts of particular relevance to NASA and the future of spaceflight. In total, CSI works with over 1,000 students each year to bring excitement and hands-on experience to space-themed STEM educational programs.

CSI's Outreach team has many partnerships with schools, non-profits, and other educational organizations across New York and the US. Some of the team's partners this year include:

- Sophie Gerson Healthy Youth (SGHY), a NYC non-profit dedicated to supporting underserved middle schoolers at 5 schools in the city
    - Within the SGHY umbrella is the immersion cohort, a small group of students at each SGHY school who take part in more intensive space science programming
- The Columbia Engineering Outreach Office, an internal organization that facilitates educational outreach events with local high schoolers
- Eagle Academy for Young Men of Harlem, an all-boys middle and high school in East Harlem
- SEEQS, a middle school in Honolulu focused on sustainability in education
- The Columbia Astronomy Department, which the Outreach team regularly collaborates with for public viewing and lecture nights

The team's efforts span several programs, including the new SUITS curricula and lessons. Each of these programs is described briefly below.

Auditorium Programs

Through the team's partnership with SGHY and Eagle Academy, CSI has visited six middle and high schools in the area several times over the past few years, with a number of visits already planned for this year. Each visit consists of a space-focused STEM lesson, complete with an interactive activity to allow students to directly engage with the topic. Throughout each educational lesson and activity, CSI emphasizes the hands-on nature of STEM, and works to convey every club member's passion for space exploration. These programs take multiple forms, the most popular of which is a hands-on lesson on the principles of aerodynamics. Following a short lecture on fundamental concepts, students apply their aerodynamics knowledge by designing, building, and launching paper airplanes in an attempt to hit small drones and compete for the farthest launch.

Photos of various auditorium program activities from the previous academic year

Model Rocketry

Outside of these recurring visits, CSI also recently spearheaded a new model rocketry program with plans for expansion in the coming year. The program includes a digital curriculum which consists of volunteer-created video lessons and interactive activities. These lessons provide instruction on aerodynamics, propulsion, and the impetus behind space exploration (including information about the Artemis program). The program culminates with a model rocket launch where students showcase what they've learned with custom designed and decorated rockets. Thanks to an additional partnership and further funding from the New York Space Grant and Discovery Education, these same programs will also be implemented at Eagle Academy. This year, the team plans to continue to improve the curriculum with more varied and innovative designs, as well as to expand the program to involve students from all five SGHY schools and Eagle Academy.

Photos from last year's first rocketry launch at 75 Morton

Coding Curriculum

Although SUITS team members will be a part of every facet of CSI's larger outreach endeavors this year, CSI also plans to develop SUITS-specific programming to help boost the computer science aspects of the team's efforts. Some preliminary topics include:

- An introduction to AR & how AR works
- How AR can help astronauts & engineers
- Program development and introductory coding

These lessons, along with in person programming, will be offered to the immersion students at our SGHY partner schools. Some proposed CSI Outreach will also publish structured online and video lessons on the CSI Outreach website, which our partner schools already use to access the rocketry curriculum.

Current homepage of CSI's new digital curriculum website

CubeSat Curriculum

Additionally, as a part of NASA's CubeSat Launch Initiative grant (which was recently won by CSI's Cube Satellite team), SUITS team members will contribute to the creation of a brand new CubeSat outreach effort aimed at educating middle and high school students about satellites. The program will provide access to hands-on examples and activities to build STEM knowledge and excitement in students underrepresented in STEM. This multi-year course will also include open-access digital lessons, in-person visits to schools, and optional independent projects, which could be presented as research posters to CSI members as part of our end-of-year Spaceposium event.

Other Events

Below, you will find further information on a number of formally planned outreach events with SGHY and Eagle Academy in the next year, as well as smaller, one-time supplemental events that CSI will also be hosting. This additional programming also includes periodic public telescope viewings to enable New York City residents to see the stars. Further down are correspondences with Alan Gerson, the director of the Sophie Gerson for Healthy Youth, and AP Davis, the assistant principal at Eagle Academy, as well as photos from previous outreach events.

A collection of photos from previous years' Spaceposium events. Bottom right: Middle school students presenting to professor and former NASA astronaut Mike Massimino.

Events Timeline

Event	Number of events	Notes/Description	Dates
Rocketry Launches	6	Visit to facilitate launches at each school	Early to Mid Spring
Auditorium Programs	6	Space-themed STEM lessons and activities	Fall and Early Spring
CubeSat	4–6	First auditorium programs with schools	Late Spring
SGHY Summer Camp	1	CSI volunteers work at SGHY-funded summer camp as astronomy counselors	1 Week in August
Columbia Science Honors Program Talk	1	Presentation for 300 high schools students on some of CSI's technical projects	Sep 30th
Presentation to SEEQS students	1	Presentation for 300 middle schools students on some of CSI's technical projects at SEEQS charter school in Hawaii	?
Astronomy Telescope viewings	?	Open access telescope viewings for New York residents	?

Spaceposium	1	End of year CSI event presenting our projects to middle school students, running engineering activities, hosting a Q&A with an astronaut (club advisor), and touring the engineering labs	April
Education First Tours	~4 expected	CSI volunteers give engineering tours for middle and high school students to help fund other programming	January–August 2024 (none scheduled)

Below are correspondences from Alan Gerson, President of Sophie Gerson Healthy Youth, and AP Davis, Assistant Principal at Eagle Academy, confirming their intent to work with us this year. All emails are with Kate Lampo and Will Specht, CSI's broader Outreach leads.

11/2/23, 10:36 AM LionMail Mail - Columbia Space Initiative - Space Science @ Eagle Academy

LIONMAIL @COLUMBIA

Kathryn Lampo <kel2169@columbia.edu>

Columbia Space Initiative - Space Science @ Eagle Academy

William Lawrence Specht <wls2128@columbia.edu> Tue, Oct 10, 2023 at 10:59 PM
To: Kathryn Lampo <kel2169@columbia.edu>
Cc: Assistant Principal Davis <cdavis@eagleharlem.org>, Andrew Peterson <apeterson@eagleharlem.org>

Hey AP Davis,

I hope that you are doing well. Now that the school year is up and running, we wanted to reach out to see what you might be interested in in regards to programming this fall and spring. We had a great conversation with Mr. Peterson about the auditorium programming we did last year, a model rocketry program that we ran last year at other middle schools, and a new Cube Satellite program. We also had a conversation about a potential high school engineering club, which we could support in terms of activities and potentially some cool events in conjunction with CSI in the future. We would love to chat the week of the 16th if you are available. We could do before 1pm on Mondays, 11:30am-3pm Tuesdays, 11:00am-2:30pm Wednesdays, 8:00am-1pm Thursday, anytime during the school day Friday, and most times during the weekend.

Sincerely,
Will Specht
[Quoted text hidden]

Assistant Principal Davis <cdavis@eagleharlem.org> Thu, Nov 2, 2023 at 9:12 AM
To: William Lawrence Specht <wls2128@columbia.edu>
Cc: Kathryn Lampo <kel2169@columbia.edu>, Andrew Peterson <apeterson@eagleharlem.org>

Good Morning William
Firstly, please accept my apologies for a delayed response.

We are excited to discuss all opportunities mentioned here. The weekend does work best for me or early Friday evenings.

Looking forward to it

Above is correspondence with Eagle academy, following a successful auditorium program the previous year as well as a meeting between the outreach leads and a science teacher at the school regarding expanded programs for the upcoming school year.

LIONMAIL @COLUMBIA

Kathryn Lampo <kel2169@columbia.edu>

Verification of Interest from Schools

5 messages

William Lawrence Specht <wls2128@columbia.edu> Fri, Oct 27, 2023 at 3:35 PM
To: alan jay gerson <alanjgerson@gmail.com>
Cc: Kathryn Lampo <kel2169@columbia.edu>

Dear Alan,

I hope that you are doing well. Kate and I are reaching out with a somewhat time sensitive email. We are submitting a NASA proposal next week, which requires the schools we work with to verify that they do in fact plan to take part in our programs. Would you be able to send us an email with the school's names and the programming we do with them (Auditorium programming, rocketry, CubeSat, on-campus visits, museum visits).

Best,
Kate and Will

Kathryn Lampo <kel2169@columbia.edu> Tue, Oct 31, 2023 at 11:18 PM
To: William Lawrence Specht <wls2128@columbia.edu>
Cc: alan jay gerson <alanjgerson@gmail.com>

Hi Alan,

Just following up on this! We're hoping to submit our proposal in the next day or two, and having confirmation from you would be great! We don't need anything particularly fancy—just acknowledgement that CSI and SGHY are actively working together.

Thanks again!
Kate & Will
[Quoted text hidden]

alan jay gerson <alanjgerson@gmail.com> Tue, Oct 31, 2023 at 11:29 PM
To: William Lawrence Specht <wls2128@columbia.edu>
Cc: Kathryn Lampo <kel2169@columbia.edu>

Hi,

It looks like I missed something. All schools have expressed more than interest, enthusiasm, in working with CSI on all of your proposal! The enthusiasm stems from the meaningfulness of the impact and inspiration your past years' programs have imparted, as observed by principals and teachers. The schools remain the same as last year - MS 126, 80 Catherine Street, Lower East Side/Chinatown; MS 140, 123 Ridge Street, Lower East Side; MS 302, 681 Kelly Street the South Bronx; MS 167, 220 E 7th Street, uptown Manhattan/Upper East Side; MS 297, 75 Morton Street, Greenwich Village/Chelsea. The first three are Title One schools, meaning virtually all of the student body, if not all, qualify for free lunch under the Federal Program because their household incomes's fall at or below the poverty line. The other two schools,includes students in that demographic, but are more economically mixed. The schools include children living in homeless shelters and from migrant asylum seeking families.

If you need anything more, let me know. But I'm out of commission for the day tomorrow and won't be able to do much until late evening. Is this or that OK?

'Hope you enjoyed Halloween.

Alan.

III. Administrative

a. Institutional Letter of Endorsement

November 2, 2023

Proposal Review Committee SUITS 2024 Design Challenges
Johnson Space Flight Center
Houston. TX 77058

Re: NASA SUITS 2024 Design Challenges

Dear Members of the Review Committee,

The Columbia Space Initiative is a student-led organization within Columbia University in the City of New York. Its faculty sponsor is Michael Massimino, a Professor in the Department of Mechanical Engineering.

The Fu Foundation School of Engineering and Applied Science endorses the team's participation and commits to support the participation of the Columbia Space Initiative in their challenge.

Please do not hesitate to contact me or Professor Massimino should you have any questions or concerns.

Sincerely,

James Hone
Wang Fong-Jen Professor of Mechanical Engineering
Chair, Department of Mechanical Engineering

The Fu Foundation School of Engineering and Applied Science

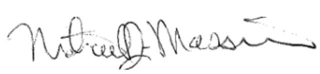
b. Statement of Supervising Faculty

November 2, 2023

Dear SUITS Proposal Committee,

As the faculty advisor for an experiment entitled "C.U.I.T.S" proposed by a team of undergraduate students from Columbia University, I concur with the concepts and methods by which this project will be conducted. I will ensure that all reports and deadlines are completed by the student team members in a timely manner. I understand that any default by this team concerning any Program requirements (including submission of final report materials) could adversely affect selection opportunities of future teams from Columbia University.

Sincerely,



Michael J. Massimino
Professor of Professional Practice

c. Statement of Rights of Use

As a team member for a proposal entitled "C.U.I.T.S" proposed by a team of higher education students from Columbia University, I will and hereby do grant the U.S.

Government a royalty-free, nonexclusive and irrevocable license to use, reproduce, distribute (including distribution by transmission) to the public, perform publicly, prepare derivative works, and display publicly, any technical data contained in this proposal in whole or in part and in any manner for federal purposes and to have or permit others to do so for federal purposes only. Further, with respect to all computer software designated by NASA to be released as open
source which is first produced or delivered under this proposal and subsequent collaboration, if selected, shall be delivered with unlimited and unrestricted rights so as to permit further distribution as open source. For purposes of defining the rights in such computer software, "computer software" shall include source codes, object codes, executables, ancillary files, and any and all documentation related to any computer program or similar set of instructions delivered in association with this collaboration. As a team member for a proposal entitled "C.U.I.T.S" proposed by a team of higher education students from Columbia University, I will and hereby do grant the U.S. Government a nonexclusive, nontransferable, irrevocable, paid-up license to practice or have practiced for or on behalf of the United States Government any invention described or made part of this proposal throughout the world.

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Michael J. Massimino

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Moises Mata

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Chloe Jones

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Sarah Hong

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Jonah Aden

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Shirley Deng

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Adam Dawood

d. Funding and Budget Statement

Item	Projected Cost
Materials and Supplies	
Development Software and GitHub Premium	$200
Other	$500
Materials and Supplies Total	$700
Travel	
Airfare for 5 (NYC - Houston)	$3,000
Hotel (3 Rooms 4 Nights)	$3,500
Car Rental	$300
Food ($50 per person per day)	$1,500
Uber to and from JFK	$300
Travel Total	$8,600
GRAND TOTAL	$9,300

e. Hololens2 Loan Program

If selected to continue, the team would not require a Loan Hololens to aid in development.