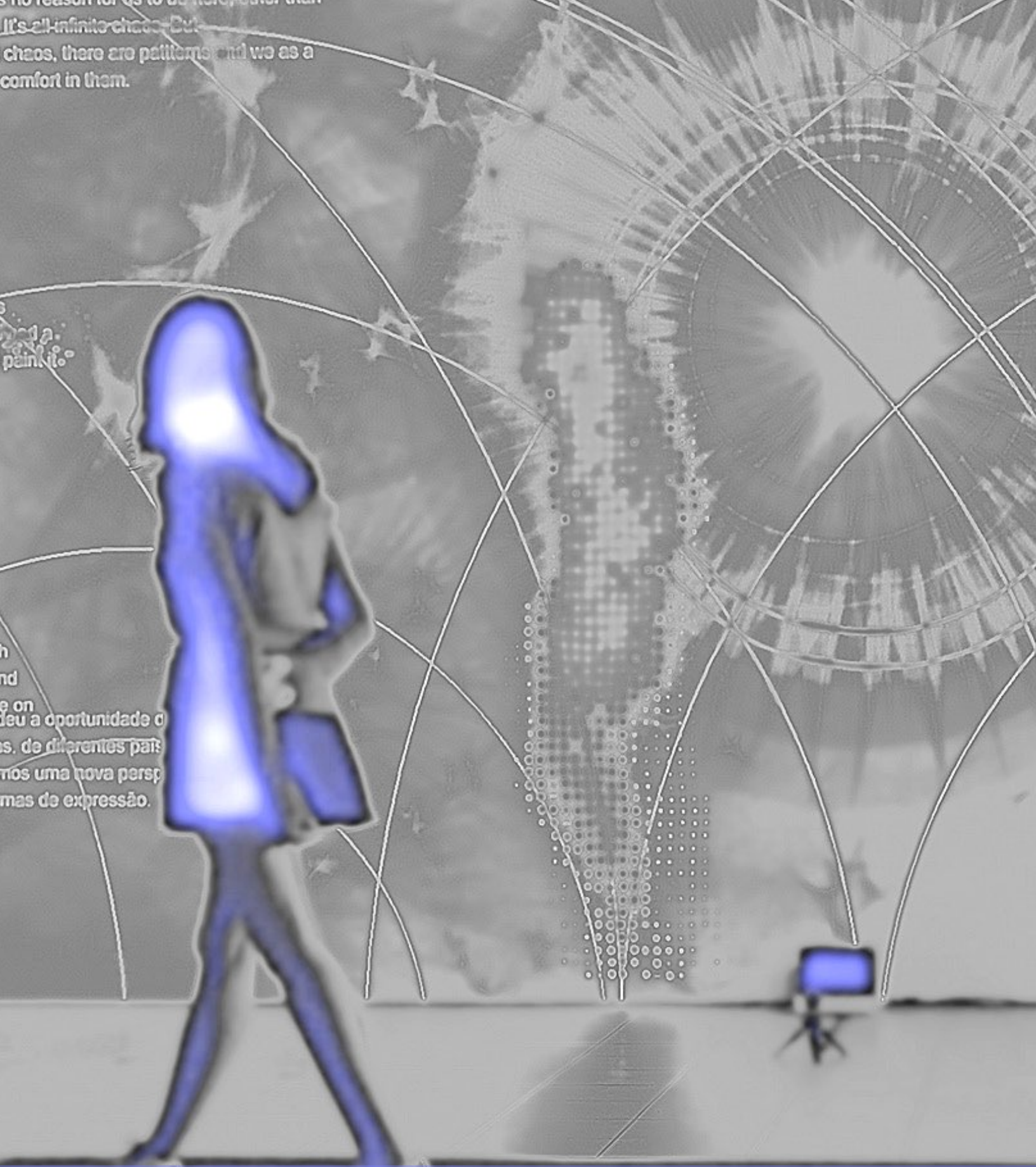


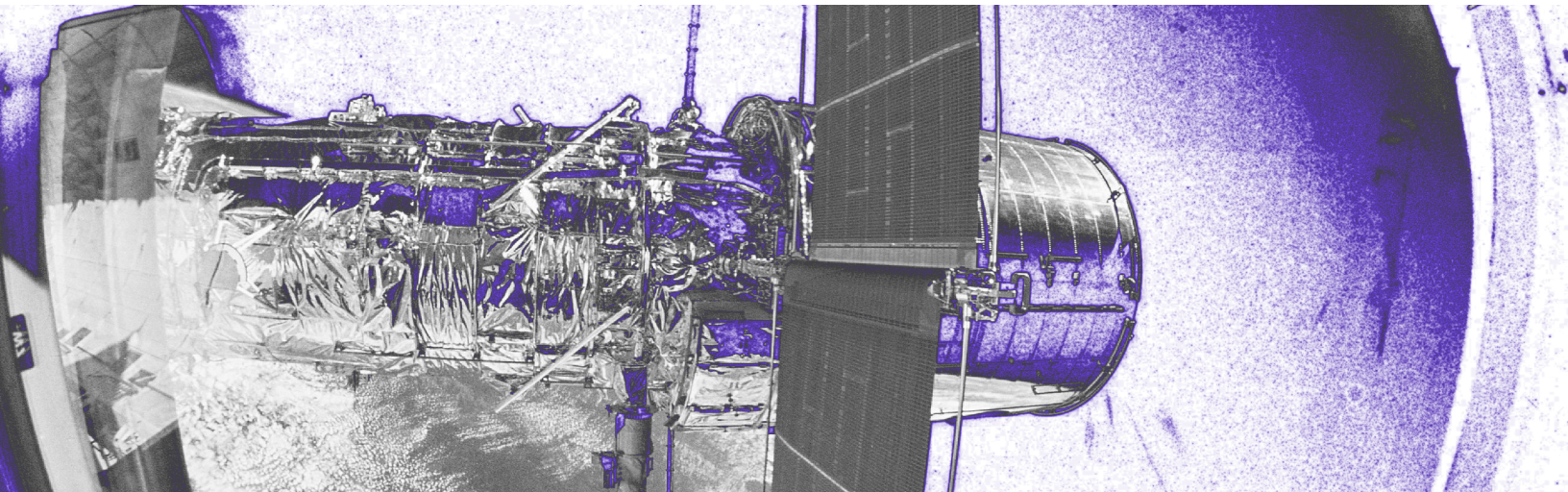
STEMarts Lab International Design Challenge

SPACE FOR EARTH- SPACE FOR ALL

GUIDE FOR TEACHERS

TABLE OF CONTENTS

Teacher Introduction	1
Space for Earth-Space for All Design Challenge	2
Design Criteria	3
STEMArts Design Tool	4
Themes to Explore	5-6
Research the STEMarts Wiki	7
Brainstorming, Sketching and Feedback	8
Submission Deadlines	9
Standards	10
Snapshots and Worksheets	11-22



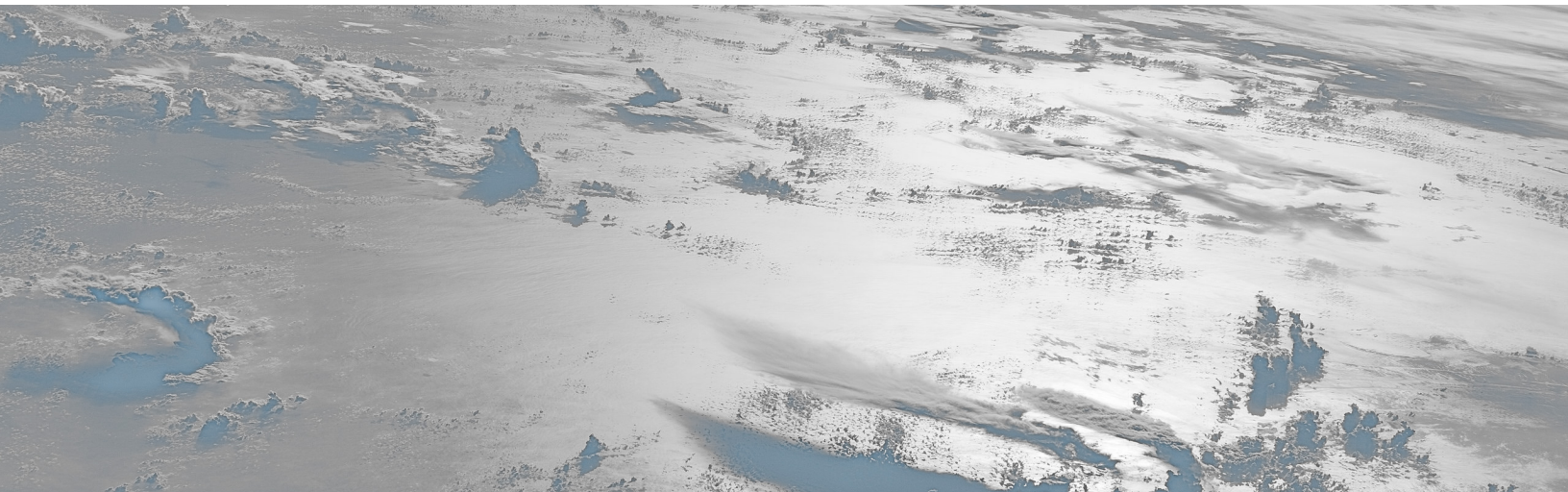
TEACHER INTRODUCTION

"When people are supported to become creative and rigorous futures imaginers, they come to realize that the future is not something that will happen to them tomorrow but is being created by everyone today." Riel Miller (2003)

The Teachers Guide is a curriculum supplement to help navigate the creative design process. It includes the Design Challenge, an overview to get started using STEMarts tools, and worksheets that go into topics related to the project and creative design processes.

The International *Space for Earth-Space for All Design Challenge* asks students to submit a drawing that envisions how space science and technologies can improve life on Earth for all citizens. The design challenge utilizes 'futures thinking': a mindset that reflects a set of skills for anticipating and building the future – from scanning the horizon for signals of change, to imagining alternative futures, exploring the implications of potential futures, and designing technology, art, policy and more to shape the future-starting now!

The *Space for Earth-Space for All* design challenge theme will explore our place in the universe through technology, physics and art. Research the latest scientific and technological innovations to ask: how might technology look in space and used on Earth?

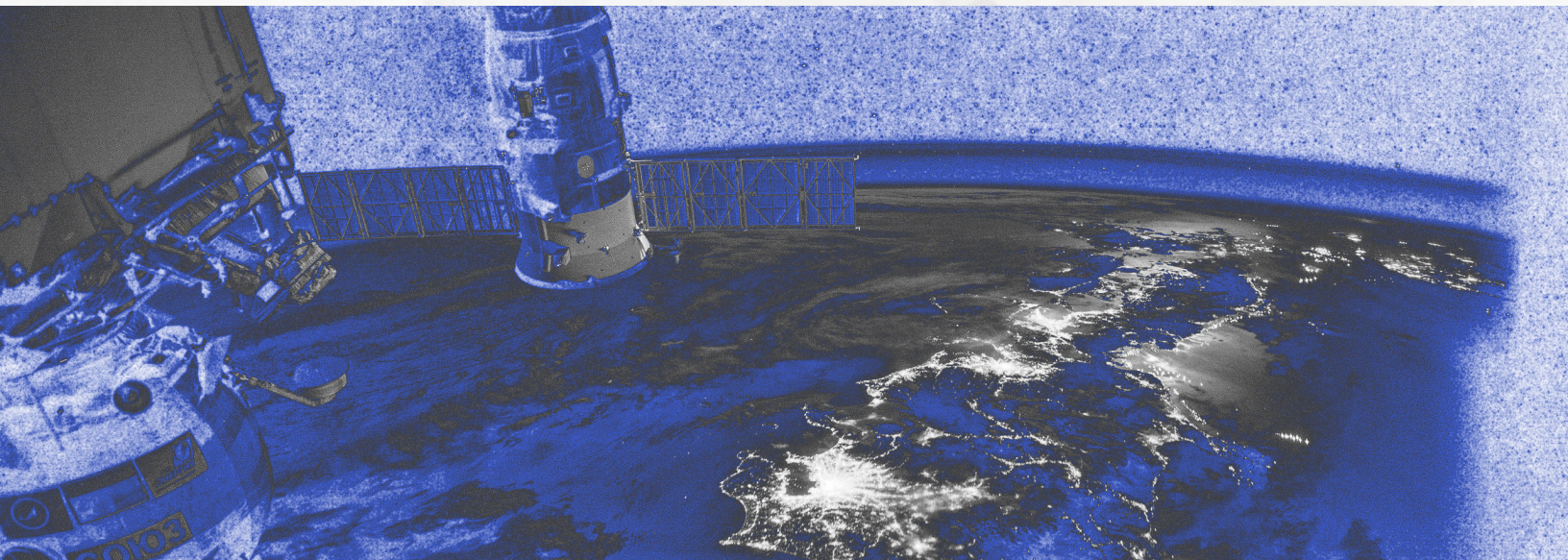


SPACE TO EARTH-SPACE FOR ALL INTERNATIONAL DESIGN CHALLENGE

The STEMarts Lab International Design Challenge asks students to submit a drawing that envisions how space science and technologies can improve life on Earth for all citizens.

The theme of the STEMarts Lab International Design Challenge is *Space for Earth-Space for All*. The theme aligns with the United Nations Sustainable Development Goals. This global framework is a call to action to tackle real world challenges and mitigate environmental degradation, climate change and inequalities by 2030. Sustainable Development Goals (SDGs) extend to space and draw from the big idea that access to space technology is of benefit to all peoples of the Earth now and into the future. Space-related exploration, innovation, science, and technology contribute to bettering humankind and securing the resiliency of our planet. Partners working to meet the Sustainable Design Goals are already working on technologies within many areas such as agriculture, climate change, mass migration, species extinction, disaster response, transportation, health, communication, spinoffs and applications.

As humanity reaches into space the big questions we have been exploring on Earth get deeper. ***Who are we? Where do we come from? Where are we going? What are we taking with us? What are we bringing back?*** Tap into your imaginations to envision future technologies that address one or more of the SDGs to improve life on Earth, impacting everything from fashion and transportation to agriculture and architecture. Dive into art, science and creative thinking to envision new technologies in a sustainable interplanetary future.



DESIGN CRITERIA

When crafting your design, it's essential to consider the specific criteria that judges will evaluate. The following chart delineates the crucial criteria and their corresponding point allocations, providing a framework for understanding how designs will be assessed. By aligning your design with these criteria, you can optimize its potential for success in the judging process.

Creativity	The design is creative in its concept, style and artistic application	2
Science & Technology	Research-based science and technology is reflected in the design	2
Style & Craftmanship	The design reflects effort and attention to detail and a stylish and professional presentation	2
Sustainable Development Goal	The design addresses one or more of the United Nations Space4SDG goals	2
Sustainable Practices	The design applies a creative and innovative use of sustainable materials or practices	2
Futuristic Innovation	The design shows exceptional and imaginative solutions for technologies of the future	2
Digital Submission	Correct digital submission with file labels including City, school, grade level and project name *City_School_grade_ProjectName*	2

STEMarts DESIGN TOOL

Jump into the Design Tool which takes you through the stages of the *Space for Earth -Space for All* design process. Get started with these basic steps:

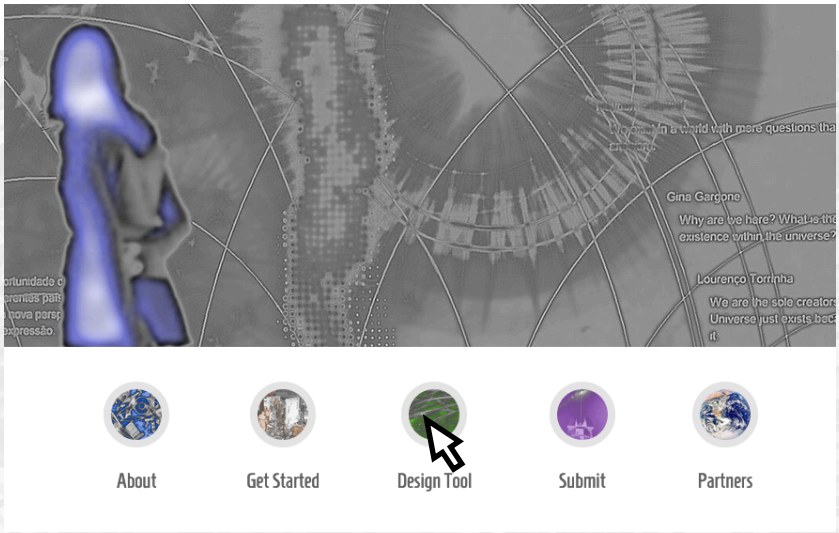
EXPLORE This is the first stage of the design process. Explore the STEMarts Wiki using the *explore* keyword to access the curated links, articles and videos. Use keywords to refine ideas, and find inspiring solutions and innovative ideas from artists and designers working on the cutting edge of technology.

RESEARCH Research the science/technology behind space exploration, to imagine future innovations inspired by space. Explore the United Nations Sustainable Development Goals (SDGs) and the Space4SDGs to identify topics of interest. Search through the research links to uncover the fusion of art, science, and technology, providing essential insights to shape your designs. Keep track of your findings and resources as they will be crucial references for developing your Design Statements.

BRAINSTORM Experiment with different materials, markers, colored pencils, or graphics programs such as GIMP or Adobe Illustrator. Go through several iterations and sketches and hone in on the features that make your design stand out in quality and purpose. Get feedback on your designs and work through any challenges.

DESIGN Create your final design. Remember that designs will be judged for quality of presentation. Write your design statement to explain the space-related science and technology behind your design. Give a detailed explanation on how your invention meets the design criteria.

SUBMIT The final stage is to submit your design and statement. The final design and design statements should be sent electronically following the submission guidelines.



THEMES TO EXPLORE

Thematic units were created to provide science-based resources and act as a launchpad to inform your design. You are welcome to explore any topic as long as it is science-based and promotes the mission to envision how space science and technologies can improve life on Earth for all citizens. Check out the STEMarts favorite links and resources for each theme to start your exploration.

PHYSICS of SPACE

Explore the fundamental building blocks of the universe and the ways in which scientists interpret signals from space. Consider incorporating elements of particle physics and astrophysics into your design concepts to reflect humanity's connection to the cosmos.

The Most Astounding Fact

Voyage into the world of Atoms

Origin of the Universe 101

Astronomers Toolbox

A Tour of Data Sonification: Sounds from Around the Milky Way

Wrinkles in Spacetime

Understanding the Universe Through Particle Physics

View Space Interactive

SCIENCE COMMUNICATION

Foster a futures thinking mindset in your design process by considering the long-term impacts and ethical considerations of your designs. Space exploration has expanded our understanding of the universe. Communicating about ideas, data and breakthroughs drives science forward. How can your design help bring this knowledge to all citizens and inspire curiosity and activism for the sustainable development of space?

Space Supporting the Sustainable Development Goals

Understanding the Dimensions of Sustainable Development

The Sustainable Development Goals: 17 Goals to Transform Our World

Could Future Homes on the Moon and Mars Be Made of Fungi?

What is Sustainability?

The Importance of Human Space Exploration

Why trash in space is a major problem with no clear fix

LIFE in THE UNIVERSE

Reflect on the adaptability of life forms and the potential for extraterrestrial exploration. Consider how your design can incorporate innovations that address the challenges and opportunities presented by life beyond Earth, integrating elements of sustainability, adaptability, and coexistence with diverse ecosystems.

- Can We Survive Prolonged Space Travel?
- Living in Space
- What If We Built an O'Neill Cylinder?
- Astrobiology-Life in the Universe
- Meet the Tarigrade The Toughest Animal on Earth
- Life on Other Planets
- Why Caves- Astrobiology
- What is a spacesuit? (grades 5-8)

HUMAN as SENSOR

Consider the role of space technology in enhancing human capabilities. Explore how your design can leverage technological advancements real and imagined to benefit life on Earth. Think critically about the ethical implications of technology and its potential to change the future of the human body.

- What Happens to the Human Body in Space?
- Why the Human Brain Is So Good at Detecting Patterns
- The Human Body in Space
- The Clothing of the Future Could Shift Shape With Just a Glance
- The World is Poorly Designed. But Copying Nature Helps.
- Make It Wearable | Becoming Superhuman
- How Animals and People See the World Differently
- This Blind Astrophysicist 'Sees' the Universe in the Most Amazing Way

SUSTAINABLE DEVELOPMENT GOALS CONNECTION

Research the Space4SDG initiative to explore how your futuristic design can contribute to a sustainable and inclusive future for humanity, both on Earth and in space. Follow the hyperlinked icons below to find out how Sustainable Development Goals and space technologies are benefiting earthlings now.

RESEARCH the STEMarts WIKI

The STEMarts Wiki contains all the curriculum content to inspire and inform your designs through curated links. Here you will find links to articles, images, video, and tutorials that we have collected from the web around the topic of art, science, culture around phenomena in space and technology. Open-ended inquiry and discovery allows you to make connections between art, science and technology in an open framework that encourages critical thinking, analysis and experimentation.

You can navigate the STEMarts Wiki by entering keywords into the search field or clicking through the word cloud. Word clouds visualize the amount of information available on a topic - the bigger the word in the cloud, the more links to discover.

The STEMarts Wiki is just a starting point, the keywords below are for organization and can be explored at any point in the design process. We encourage you to do your own research to see what you find.

STEMarts WIKI KEYWORDS

Check out these keywords and more on the STEMarts Wiki

EXPLORE	RESEARCH	BRAINSTORM	DESIGN	SUBMIT
Art	Astrophysics	Technology	Sketch	**keywords are not used for the submission phase. The above link will take you to submission guidelines under the Get Started page from STEMartsLab*
Mixed-Reality	Astrobiology	Physics	Design	
Wearable Tech	Particles	Science	Spin Off	
Futures Thinking	Physics	Life in Space	Tech Tools	
Data-Sonification	Gravity	Futures Thinking	STEAM	
Space Matters	Waves	Wearable Tech	Space Design	
	Spin Off			
	Messengers			
	Science			
	Space			
	Sustainability			
	Life in space			
	Light			

BRAINSTORMING, SKETCHING & FEEDBACK

Artists and scientists are often solving a creative problem such as: How can I talk about this intangible thing? Or, how can I use these materials to communicate my big idea? Or, how can I develop or re-imagine a technology that can express my big idea? Communicating and presenting the big idea or intention of your work as an artist or scientist is an important part of the creative process. Brainstorming, Sketching, and Feedback are powerful tools to organize abstract ideas and to identify patterns or new ideas. These steps help you conceptualize, expand and refine your big ideas that will become your final design. These tools can help at any stage in the creative design process to garner fresh ideas, work through problems or clarify an idea.

Brainstorming is a creative problem solving technique used by individuals or groups to put a bunch of ideas out on the table. The brainstorming phase is where you can discuss, build-on or experiment with your ideas or solutions and test them in a low risk environment before your design may be built or developed further.

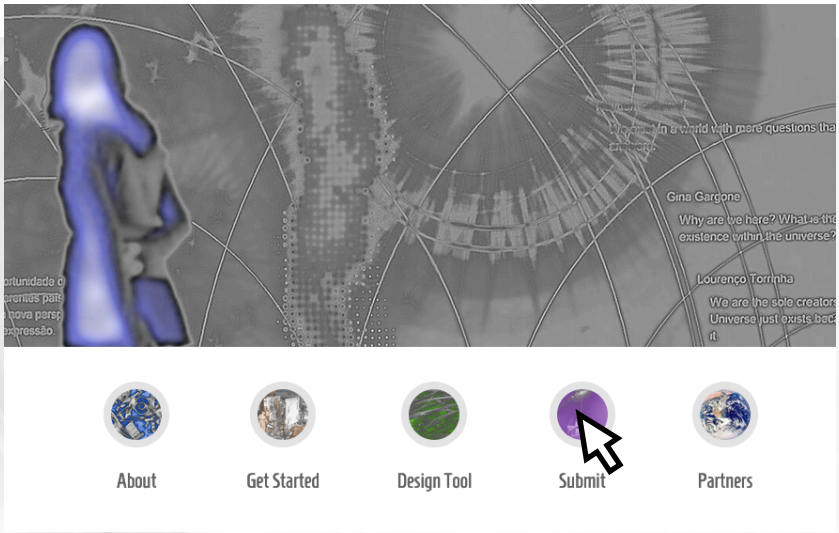
A **sketch** is a quick drawing to visualize ideas. It is a rough draft of your final design.The initial sketches of your design help you experiment with what will work and what does not. You can refine the look of your design and add the details that make it special. It is a tool to help you include new ideas and share them to get feedback. A sketch becomes a drawing with more detail, style, and is presentation ready.

Feedback is a stream of communication or helpful response to a person's design. It is a preliminary part of the sharing phase in which you put your ideas out there to be critiqued. Other trusted designers, teachers or peers can help you refine and improve your ideas before the final stages of submission.

Your final drawing for *The Space for Earth-Space for All Design Challenge* can be anything you can imagine; fashion, transportation, wearable sensors, industrial products, technological systems, etc. It should show the specific details you outline in your design statement including material choices, sustainable systems, power, and other technical or special elements in your design.

SUBMISSION GUIDELINES

1. One page drawing of how “space science and technologies can improve life on Earth for all citizens”. The final image can be created with any medium (marker, pen, graphics program).
2. Drawings must be scanned using high quality digital scanning software to assure the highest quality (i.e. Scanner Pro). You can also remove the background if you want a clean image of an object using free background removal apps (i.e. Magic Brush). All images must be exported to JPEG format with a minimum 2000 pixel resolution.
3. Label and save your design as follows: City*_School_grade_ProjectName, example: Taos_MyMiddleSchool_8_GravityCruiser*
4. A one-page 'Design Statement' in PDF format must accompany the image file. It is important to consider the Design Criteria to provide comprehensive explanations regarding design goals, SDG alignment, materials, usage, and the underlying science.
5. Where to submit: Submit on STEM arts Website Design Challenge SUBMIT
6. Please refer to the SUBMIT page for the latest updates on submission guidelines and deadlines.
7. The Design Criteria is used by challenge judges to select winners and prizes. Winning submissions will be showcased on this website for global recognition. Cash prizes will be awarded for the categories: Best of Show ($300), Best of Categories ($100) i.e. Best Futuristic Design and Best Sustainable Solution. Prizes are made possible thanks to our sponsors.



NEXT GENERATION SCIENCE STANDARDS

All STEMarts projects include the application of science and technology through art and design. Projects are designed to the Next Generation Science Standards (NGSS). The National Research Council (NRC) of the National Academy of Sciences released the Next Generation Science Standards (NGSS) which lay out the disciplinary core ideas, science and engineering practices, and crosscutting concepts that students should master in preparation for college and careers. We also design to the P21 standards. The P21 Framework for 21st Century Learning was developed with input from educators, education experts, and business leaders to define and illustrate the skills, knowledge, expertise, and support systems that students need to succeed in work, life, and citizenship. The Framework continues to be used by thousands of educators and hundreds of schools in the U.S. and abroad to put 21st century skills at the center of learning. All elements of the Framework are critical to ensure 21st century readiness for every student. To learn more about how STEMarts uses the NGSS or more information on specific standards please visit: https://www.stemarts.com/about/standards/

MS. ETS1-1 Engineering Design
Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

MS-ESS3-3 Earth and Human Activity
Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.

HS.ETS1-2 Engineering Design
Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

HS.ESSS3-4 Earth and Human Activity
Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.

HS. SpaceSystems
Communicate scientific ideas about the way stars, over their life cycle, produce elements.

NATIONAL CORE ARTS STANDARDS

STEMarts programming harmoniously integrates with the National Core Arts Standards, weaving together the core principles of creating, performing/presenting/producing, responding, and connecting. Our curriculum encourages students to actively create original works, whether through digital media, augmented reality, or other artistic mediums, fostering self-expression and innovation. Through performances, presentations, and productions, students showcase their creations, honing their skills in communication and presentation. Furthermore, our program encourages students to critically respond to art, technology, and scientific concepts, cultivating analytical thinking and reflection. By fostering connections between STEM disciplines and the arts, STEMarts empowers students to see the interconnectedness of knowledge domains, facilitating a holistic understanding of the world and their place within it.

SNAPSHOTS + WORKSHEETS

Using creative design to solve problems engages students in 21st century skills like creativity, collaboration, critical thinking and communication. The Snapshots and worksheets are included in this guide to create in-class engagement opportunities in the creative design process. Use any notebook or binder to document participation in the student process like questions, research, interesting ideas, sketches, doodles and feedback.

SNAPSHOTS

Snapshots can be used to help anchor the contextual ideas behind the Space for Earth-Space for All Design Challenge. They include a thematic reading, open-ended questions and STEMarts Wiki keyword suggestions related to the topic.

- PHYSICS IN SPACE
- LIFE IN SPACE
- TECHNOLOGY AS HUMAN EXTENSION
- SCIENCE COMMUNICATION

WORKSHEETS

- **The Creative Design Process:** This diagram is a visual representation of the creative design process. Design processes have cyclical phases of questioning, research, brainstorming, designing, re-designing and sharing.
- **Observation/Question:** The Observation/Question worksheet is a notice wonder template to jumpstart the design process and background research. Paste into student notebooks to document any questions or musings when exploring the STEMarts Wiki, or other interesting content to inform space challenge designs. It can also be used in the brainstorming phase to document ideas or in the feedback phase to communicate ideas.
- **The Sketch:** The Sketch is a worksheet to practice the ideation process in your science notebook. Drawing the design creates a visual model to work out challenges, define style and improve designs. Students should be encouraged to create multiple iterations of their design before the final submission phase.
- **Feedback Worksheet:** The Feedback worksheet is a supplement to help guide analysis and gather response in order to improve the design before the final version. A full page feedback worksheet is for student self-reflection and half sheet feedback worksheets are for outside critique and comments.

SNAPSHOT

PHYSICS IN SPACE

Humans are extraordinary pattern observers. Our eyes are sophisticated sensors that take in signals from the environment around us. Our brain interprets these signals and sends information to our body. These adaptations help us make sense of our world. Humans have always tried to answer big questions like **Where do we come from? What are we made of?** We developed great cosmologies around the world to explain our origins. We developed arts and sciences that broke down our universe to its fundamental units, and invented other sciences to build a big picture of our place in the universe as a whole. One of the most profound discoveries that came from trying to answer these big questions is the fact that the elements that make up our bodies are the same that were created at the beginning of our universe billions of years ago. When Carl Sagan said " We are stardust" he meant it literally. The atoms in our bodies, on earth and in space can be traced directly to the early exploding stars in our universe. We are connected to the Universe, the universe is in us.

Physics is the study of matter and energy. Scientists like particle physicists study the smallest unit of our creation, while astrophysicists look at the particles that make up the large cosmic bodies that make up our galaxies. The universe sends us messages in the form of waves including light and ripples in spacetime. Multi-messenger Astronomy tracks these high energy particles as they pass through space and Earth to be interpreted and answer some of the biggest questions in our universe.

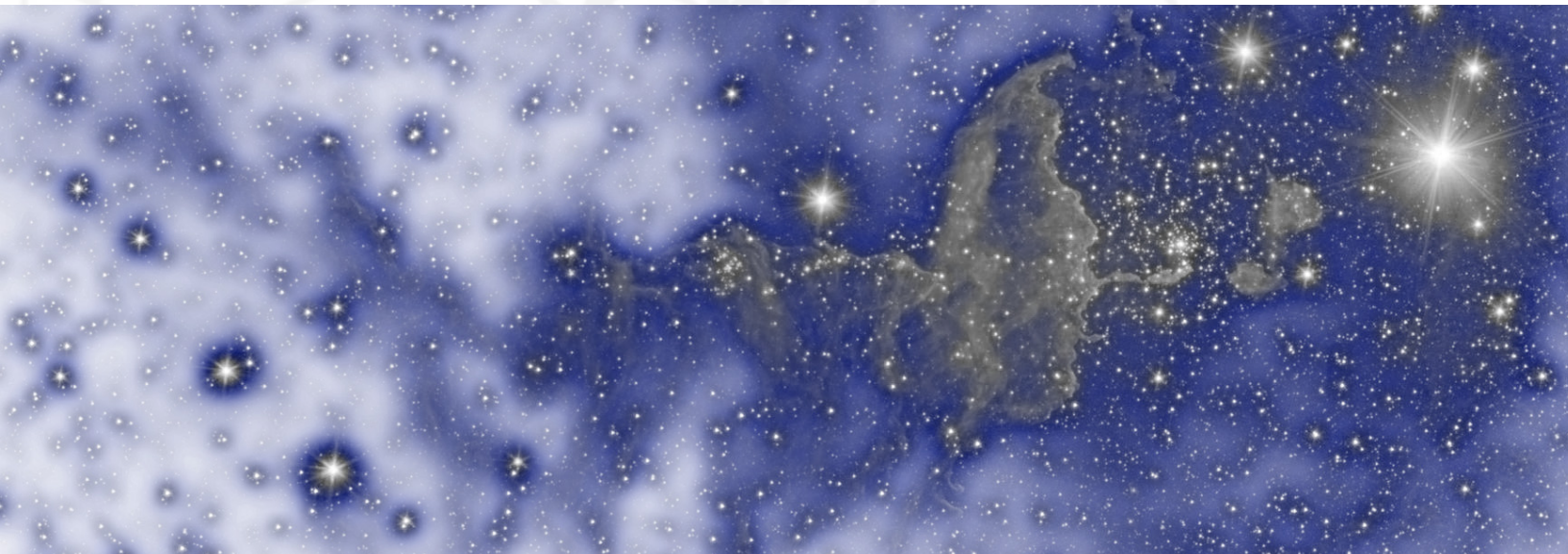
How are we connected to the universe?

What kind of messages is the universe sending us?

What tools do humans have to answer the big questions in the universe?

How do humans measure phenomena that we can't see?

STEMarts WIKI KEYWORDS
Physics
Astrophysics
Gravity waves
Particles
Messages



SNAPSHOT

LIFE IN SPACE

The human body adapted to survive on earth. Our skeletons are strong against the crush of Earth's gravity. Our respiratory systems depend on oxygen created by complex connected systems on earth. We've been successful in adapting to our environment practicing agriculture, building shelter and community, developing technology, and communicating solutions. We have also waged wars, contaminated environments, and generally made mistakes that had dire consequence. Human impact has been positive and negative.

Scientists called Astrobiologists study the life in the universe. They ask questions about the origins of life, look at different lifeforms, how they interact with their environment, and conceptualize life beyond earth. Astrogeologists looks at the geology of planets, moons, astroids and other celestial bodies. These scientists are looking for evidence of how we might impact the life and environments on other planets.
It makes us wonder **where are we going and what are we taking with us?**

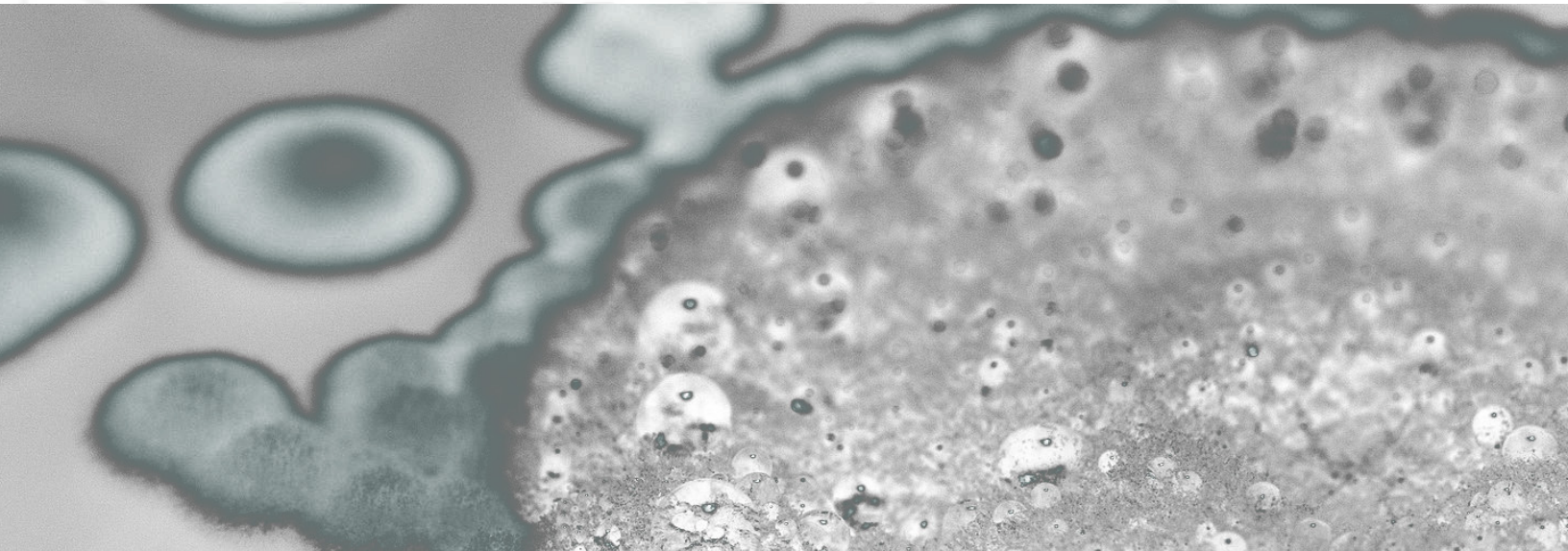
Space exploration has already generated space trash on the moon, and satellite debris called space junk that circles Earth. These have been consequences of humanity reaching out into the stars. Today agencies like NASA and the ESA are following policies of sustainability like the SDG4Space to ensure space exploration and development meets the needs of today while protecting the needs of future generations.

What is a positive way you impact your environment? What is a negative way you impact your environment?

What ideas and practices should we be taking into space?

What does an interplanetary life look like? How will we know if we are successful?

STEMarts WIKI KEYWORDS
Astrobiology
Astrogeology
Life in Space
Earth
Light
SDG



SNAPSHOT

SCIENCE COMMUNICATION

"The future is a process not a destination. The future is a verb not a noun." Bruce Sterling, 2004

Futures thinking is a mindset that approaches the future not as a distant abstract place, but instead is a process in which we as active participants can shape change. Thinking, communicating and planning for the future is something we can participate in *now*. Futures thinking is a skill that involves creative problem solving and innovation that goes beyond conventional forecasting. It can empower us to envision and share a plan for the future instead of reacting to the changes of time.

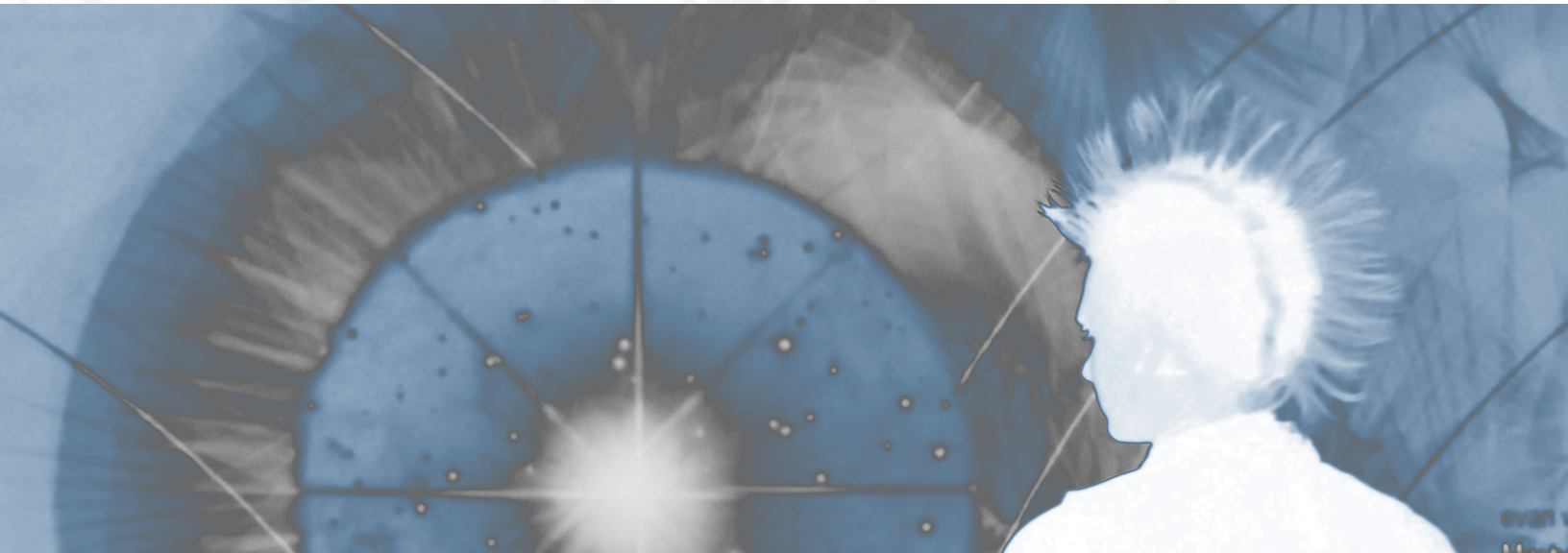
Sustainable development goals like those developed by the UN are a call to action for the peoples today to plan for future generations through policies, management and investments in projects that balance the environmental, societal and social needs of our planet. Planning with sustainability in mind ensures the future solutions we create benefit all peoples through time on Earth and in Space.

As we are accelerating our journey into space and other planets, the ideas, practices and technologies we bring with us will determine our impact; and build a foundation of how we treat new frontiers and each other. **How can we use future thinking to communicate and educate others on why space and the United Nations SDGs matters to humanity and life on Earth? How do we participate in the future today?**

Ask a family member or elder to answer the question: What are your thoughts and wishes for an interplanetary future? How might different generations answer this question?

How can you communicate your thoughts about and wishes for a sustainable interplanetary future? Create a sketch of a sustainable interplanetary future. How do people live? What do they do? What does the environment look like? How does your design operate here?

STEMarts WIKI KEYWORDS
Futures Thinking
Futures
Life in Space
Sustainability
Communication



SNAPSHOT

TECHNOLOGY AS HUMAN EXTENSION

Technology is one of the things that set us apart as human from other species on Earth. Humans have an incredible adaptation to observe patterns, conceptualize solutions and create tools that help us survive on Earth and reach out to the cosmos. Technology like microscopes, particle detectors and telescopes let us peer into the universe on the smallest fundamental level to the unfathomably large. Technology pushes beyond limitations of the human body and serves as an extension of our creative minds. This ability will be especially important as we go farther into space. Astronauts and the engineering teams behind them are faced with very real challenges of physics, the vastness of space, isolation and extreme conditions. The innovations that have come from these endeavors into space are integrated into our daily lives. NASA calls these innovations Spin offs- technologies that were developed for or in space and that benefit life on Earth. Some examples include cordless power tools, satellites, solar energy, lasers, shock-absorbing helmets, bullet proof vests, memory foam and cochlear implants. Physicists at CERN developed the internet to connect scientists so they could share their research and ideas and it connects the whole world today. Technologies are being developed all over the world that will change humanity forever.

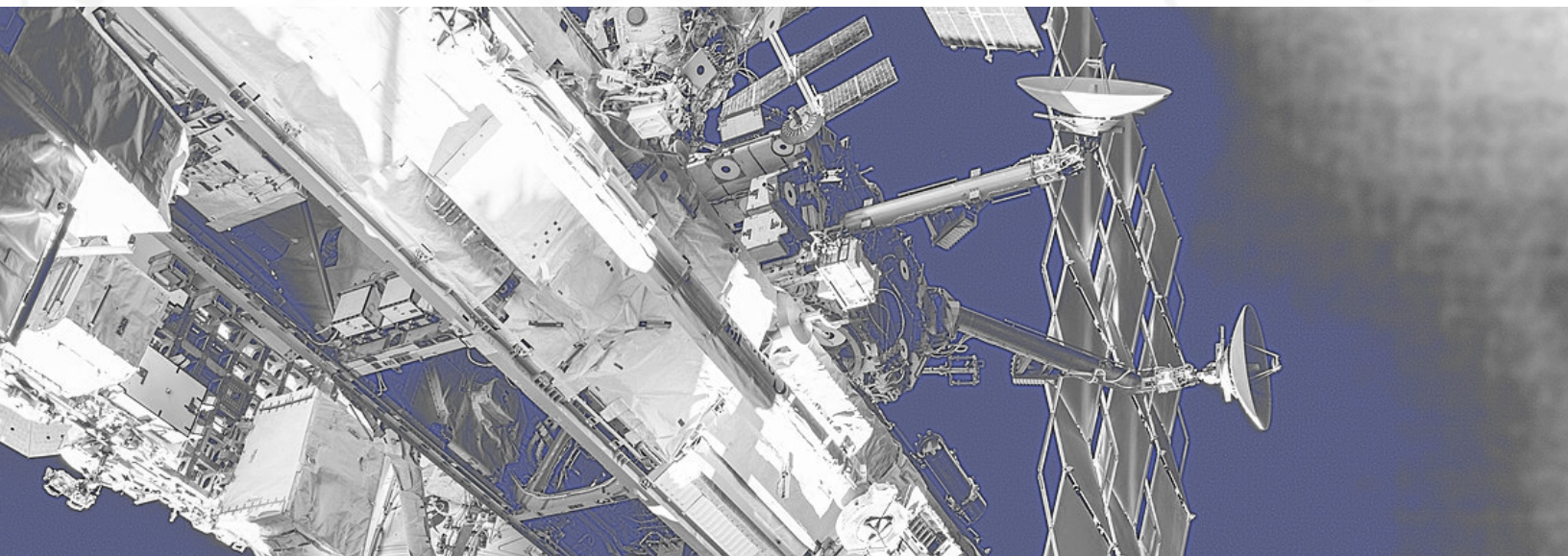
One of the technologies artists and scientists are revolutionizing is mixed reality. Mixed reality is a term that includes Augmented reality and Virtual Reality. The cutting edge of human innovation today is experimenting with a more interactive environments and virtual environments that immerse the user and remove the limits of space and time.

How does technology impact your life? Do you think technology is an extension of the human body? Why or why not?

What do you think will be the technologies of the future?

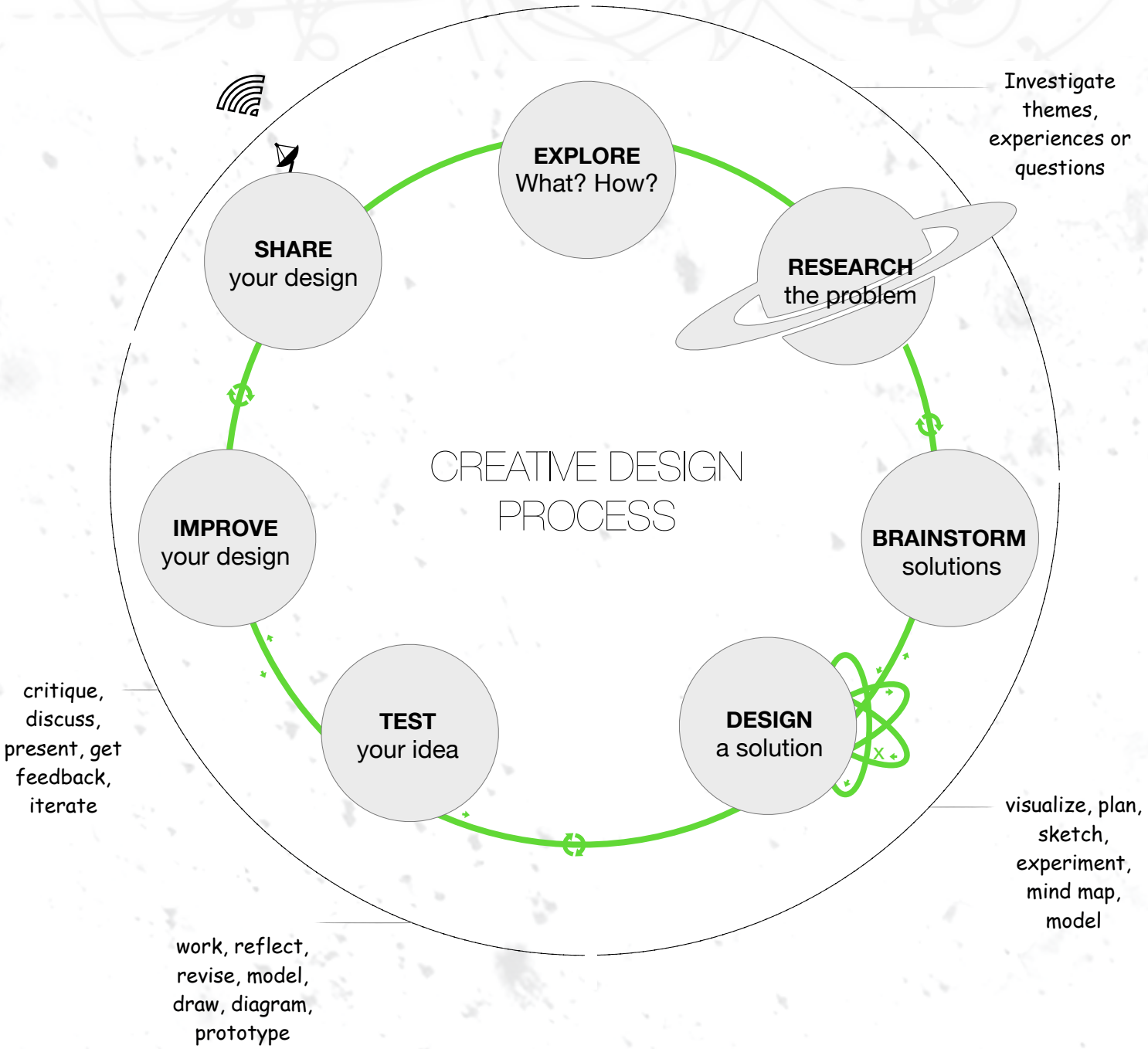
How do you think these technologies will impact life on Earth? How do you think they will impact life in Space?

STEMarts WIKI KEYWORDS
Technology
Spin Offs
Wearable Tech
Mixed Reality
Life in Space



THE CREATIVE DESIGN PROCESS

Design processes have several steps. Both creative and engineering design processes have phases of identifying challenges, doing research, designing and testing solutions, gathering feedback, improving on the design and sharing the final result. The process finishes the cycle where it started where more specific changes may be needed. Engineers and artists engage this process to create new technologies, installations, and products.



OBSERVATIONS notice

QUESTIONS wonder

OBSERVATIONS notice

QUESTIONS wonder

THE SKETCH

The sketching process is an important communication tool in the design process. It is a useful skill in all phases of the design process. Sketching allows you to quickly communicate ideas, analyze them, test and improve your designs. It allows you to visualize the details and how all your components fit together. *Try sketching your idea with different time limits: 1 minute sketch, 3 min sketch, 30 minute sketch.*

FEEDBACK GUIDE

The Feedback stage of the design process is very important. It is an opportunity for reflection, advice and tips on how to change, improve or clarify your design. This occurs when you have completed your first versions of the design sketch and are evaluating what works and does not work. Feedback should be a constructive analysis that supports your vision and goals for the design. Ask trusted people, teachers or peers to give you feedback.

What did you originally hope to achieve with your project? Did you achieve what YOU wanted ?

Summarize the feedback that stood out to you:

How could you communicate the *big ideas* of the design better? How could you communicate the *details* of the design better?

Does the design address the design criteria? What changes need to be made to create a final design that achieves your goals?

FEEDBACK WORKSHEET

Project Name:

On a separate piece of paper evaluate the designs presented:

What stood out to you about their design?

Do you understand the design?

Does it meet the design goals of the challenge?

How could they communicate the *big ideas* of their design better? How could they communicate the *details* of their design better?

Include any other feedback

FEEDBACK WORKSHEET

Project Name:

On a separate piece of paper evaluate the designs presented:

What stood out to you about their design?

Do you understand the design?

Does it meet the design goals of the challenge?

How could they communicate the *big ideas* of their design better? How could they communicate the *details* of their design better?

Include any other feedback