Fulure City COMPETITION Program Handbook









Each year 6th, 7th, and 8th grade students embark on a transformative experience as they explore how to make the world a better place. Working in teams, participants spend four months imagining, researching, designing, and building cities of the future.





What Does DiscoverE Do?

DiscoverE works to ensure people everywhere understand how engineers, technicians, and technologists make the world a better place. Thirty years ago, we were the first to call on the engineering community to volunteer in local schools and help young students discover engineering. Now we lead a growing volunteer and educator movement recognized worldwide.

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Join live conversations with engineers. Hear about their careers, how they got there, and how they are making the world a better place. Your host is Tiffany, a Future City Competition alum and current high school sophomore in Texas.



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Leading Your Team

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Overview

What Is Future City?

Future City is a project-based learning program where students in 6th, 7th, and 8th grades imagine, research, design, and build cities of the future. Keeping the engineering design process and project management front and center, students work in teams to ask and answer an authentic, real-world question: How can we make the world a better place? **Going virtual!** For this cycle, Future City has been restructured so teams can complete the deliverables in person (i.e. in a classroom or afterschool program) or remotely (i.e. collaborating online while learning from home). The competitions (regionals and Finals) will also take place online, rather than in person.

Students participate in the Future City Competition as teams, guided by an educator and a volunteer STEM mentor. Teams spend approximately four months creating cities that could exist at least 100 years in the future. Each city must incorporate a solution to a design challenge that changes each year. **This year's challenge, Living on the Moon, asks teams to design a futuristic lunar city and provide examples of how the city uses two Moon resources to keep its residents safe and healthy.** In January and February, teams present their future cities to judges at virtual Regional Competitions throughout the United States, Canada, China, and Africa. Teams that earn the top place at their Regionals will participate in the virtual Finals in April 2021.



- "The Handbook has everything you need. It's a real treasure. It can be overwhelming at first, so be kind to yourself. Sit down with a cup of tea and in a leisurely way flip through. Use sticky notes and mark what you think will be helpful for you."
- Carol Reese, Texas (North), Educator of 2017 Grand Champion team

The Future City Framework

Three strands form the framework of this project, each supporting and informing the others. The creation of the city via five competition deliverables is the main strand. The other two are the engineering design process and project management. This framework gives the project a real-world structure that both enriches the whole experience of Future City and extends the learning into the students' academic and professional futures.

Future City Deliverables

During the program, Future City teams design solutions to the annual challenge and create a city that could exist at least 100 years in the future. They complete five deliverables along the way: a project plan that helps teams organize their project and stay on track, and four other deliverables that showcase their ideas and future city: a 1,500 word essay; a scale model and slideshow; a short, creative video presentation; and a Q&A session with judges.

Engineering Design

Future City introduces students to the engineering design process. This logical series of steps shows how engineers approach a problem. As students work through the process, they realize they can think like engineers and see themselves as problem solvers. Once they get the hang of the engineering design process by using it to build their future city, students can apply it to all kinds of challenges and other school assignments.



Project Management

In engineering, the success of a project often hinges on proper management of the project goals. Project management is a professional organizing system that focuses on keeping projects and teams coordinated and moving forward. Future City uses a student version of the project management process.



Leading Your Team

Visit the Leading Your Team section of Future City's website to learn more about using the engineering design process and project management methods to successfully implement Future City, whether you're leading a team in person or virtually! (futurecity.org/ leading-your-team).

What Educators Are Saying

"Future City is an amazing program! I am always amazed at how far my students come as individuals and students from the start of this project to the end. What it teaches my students and the experiences it gives them cannot be matched."

-Bill Bostain, Indiana Future City Educator & 2020 Finals Champion





Create Your Future City





Stages and Steps of Future City

This graphic illustrates a basic road map to guiding your team through Future City successfully. Your team may move quickly through some steps and take extra time for others. You can share this graphic with your students by:

- Showing an animated version from Leading Your Team at futurecity.org.
- Downloading and displaying a colorful printout at futurecity.org/resources (filter for Handbook & Student Handouts) for students to refer to as they design their city.

educational tool to test their ideas and

practice designing and managing a city.

How Does the Competition Work?

Coordinator or at FutureCity.org/resources (filter for

Competition Forms & Project Plan).

New! Due to COVID-19, Future City has been restructured. Teams can complete the deliverables in-person (i.e. in a classroom or afterschool program) or remotely (i.e. collaborating online while learning from home). The competitions (regionals and Finals) will also take place online, rather than in person.

About Due Dates:

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Each region sets its own due dates. Check with your Regional Coordinator to find out what your region's due dates are. At the virtual Regional Competitions, scores from all of the deliverables are added together to determine the top team. The first-place team in each US region advances to the Finals, held virtually in April 2021.

PI	ROJECT DELIVERABLE		DUE DATE		
1.	PROJECT PLAN	10 POINTS	DUE BEFORE VIRTUAL COMPETITION		
	Teams complete a Project Plan to he	lp them plan and organize th	eir work. They use it throughout the project.		
2.	CITY ESSAY	58 POINTS	DUE BEFORE VIRTUAL COMPETITION		
	Teams describe the unique attributes and provide examples of how your ci (1,500 words maximum).	s of their city and their solutio ty uses two Moon resources	on to this year's challenge: Design a lunar city s to keep your residents safe and healthy.		
3.	CITY MODEL	65 POINTS	DUE BEFORE VIRTUAL COMPETITION		
	Teams build a physical model of their city (in one piece or multiple segments) using recycled materials. Teams then present their work to judges in a slideshow document, using photos of the model to showcase specific aspects of their future city and the team's solution to this year's challenge. It also needs to include at least one moving part, demonstrated via video.				
4.	CITY PRESENTATION	50 POINTS	DUE BEFORE VIRTUAL COMPETITION		
	Teams record a 7-minute presentation about their future city and their solution to the challenge. The short video highlights the futuristic innovations in the city and gives each team a chance to bring their city to life.				
5.	CITY Q&A	25 POINTS	LIVE AT THE VIRTUAL COMPETITION		
	Teams have a 10-minute question-an engineering, city, and technical comm	l virtually, with a panel of judges from the			
		DEC			
ſ.	All teams must submit their City Es	sav. Citv Model	The Vintual City is no low one induction		
VLINE	 slideshow, City Presentation video, 	, and Project Plan	required deliverable. We encourage teams		
	via the Online Portal at FutureCity.c instructions are available from you	org. Submission Ir Regional	to use SimCity or similar software as an		



Overview

New to Future City?

This year's virtual Future City program is new to everyone, whether you are a returning educator or brand new to the program. One of the best things about Future City is how many curriculum connections educators can make and all the different ways you can structure the program, whether you are meeting with your team in person or online.

We hear from many first- and second-year educator participants that having so many options can also be a challenge. To help you get started, we asked veteran Future City educators to share the one piece of information they wished someone had told them when they were new.



Read the whole Handbook.

veteran teacher.

One of the biggest things I would say is to read the Handbook carefully. It took me a few years of falling down to learn that lesson the hard way myself. So be sure that you read the Handbook carefully, and if you have any questions, reach out to your Regional Coordinator.

> Travis Koupal, Justice Page Middle School, MN, 9 years in Future City

Ask your Regional Coordinator to connect you to a

When I first started, my coordinator put me in touch with an awesome teacher with tons of Future City experience. My region even has workshops for new and returning educators – all of the veteran teachers have been amazingly helpful!

> Margo Gore, Kennedy Middle School, SC, 13 years in Future City

Attend the Regional Competition even if your team didn't complete all of the deliverables.

I love taking them to the competition, even when they're unprepared. They can learn so much.

 Kristine Miranda, Transit Middle School, NY, 16 years in Future City

Pick one or two deliverables and concentrate on them.

I always say you don't have to start big. Start small! Let the kids be creative, direct them towards research and you will be surprised. You have to be patient because it is a learning process for everybody.

> Eleonora Straub, St. Jude the Apostle Catholic School, GA, 9 years in Future City

Let the kids do the work.

I delegated the responsibility to the students and they do a lot of work on their own after school, on weekends, and I, you know, I give them the criteria for success and they just run with it, which has really been nice to see.

> Michael Gervis, Harding Township Middle School, NJ, 5 years in Future City

Find a STEM mentor for your team.

My team's mentor has been so helpful! They bring a different perspective to the whole project and the kids really love working with them. I found my mentor by asking around. It turns out the neighbor of a teacher I work with is an engineer and he volunteered! He was happy to take the time to give back to the community and pass along his interest in engineering.

> Karen Compton, The Ellis School, PA, 11 years in Future City

Can I Still Do Future City Without Competing?

Yes! Future City is first and foremost a Science, Technology, Engineering, Art, and Math (STEAM) program. Educators, parents, and mentors are encouraged to adapt Future City to match their specific goals. Over the years, educators and mentors have used the City Essay to strengthen research and writing skills, the City Model to understand scale and city planning, and the City Presentation to improve public speaking skills.

Many regions encourage teams to participate in the competition even without all the deliverables completed. This is especially true during this virtual program cycle. Your team must complete and submit all the deliverables if you want a chance to win your Regional Competition. However, you may also have the option to focus on one or two deliverables and only have those judged. Check with your Regional Coordinator to see if this is an option in your region.



Future City Aligns with Academic Standards

Go to futurecity.org/resources (filter for Standards) and download PDFs showcasing how Future City aligns with:

- Common Core State Standards
- Next Generation Science Standards
- Benchmarks for Science Literacy
- National Education Technology Standards
- Principles and Standards for School Mathematics



Future City Curriculum Connections & 21st-Century Skill Development



Overview

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Community and Impact

A recent evaluation conducted by Concord Evaluation Group found that Future City delivers on its educational promise.

Students Build 21st-Century Skills

Educators, mentors, and parents agree Future City strengthens students' skills.

	Educators	Mentors	Parents
Teamwork	94%	94%	94%
Problem Solving	90%	84%	92%
Public Speaking	89%	92%	85%
Writing & Research	85%	86%	78%
Time Management	80%	77%	81%

Students Learn Value of Math, Science, and More

- 85% now see math and science as important to their future.
- 57% said Future City helped them in their other classes.

Students Discover Engineering

- 83% reported they learned how to use engineering to solve real-world problems.
- 80% reported that Future City helped them learn the value of project planning.
- 68% said Future City helped them see themselves as engineers someday.
- 69% said Future City made them want to keep doing other engineering clubs or activities.



Student Confidence Soars

- 75% said Future City boosted their self-confidence.
- 85% said Future City taught them they could create something on their own—without the direction of an adult.
- 68% report Future City gave them a place where they fit in.

Students Learn How Their Communities Work

- 85% report that Future City helped them learn how cities work.
- 89% reported that Future City helped them appreciate all of the engineering that goes into a city.
- 73% reported they are more aware of civic issues like politics and taxes.

Get Social with Us!

Follow us on your favorite social media channel:



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facebook.com/FutureCityCompetition



- @DiscoverEorg
- @DiscoverEorg
- @FC_Competition
- pinterest.com/DiscoverEorg

Share your experiences and pictures using hashtag #FutureCity2021!

Want to see your team in next year's handbook or on FutureCity.org? Send pictures of your team working on their city to Info@FutureCity.org and they may be included next year.

Overview

Preparing for the Competition

Prepare to Lead: A To-Do List for the Educator

This checklist is a compilation of the preparatory tasks successful educators do in order to ensure a great Future City experience for all involved—their students and themselves. Check off each box until you've completed the list and you can be sure that you're ready to lead your team!

Getting Started

Read this Handbook in its entirety. It gives you a sense of the scope of the project, who you need to be in touch with, how to find key information, and what the steps are for students to complete the project. Make note of the changes this year, including required deliverables.

Depending on your school district's operations for the Fall and Winter, decide how your team will work and interact. This year, the entire program can be completed virtually. Students can complete deliverables remotely at home or work together in person, depending on local public health guidelines.

REGISTRATION

It only costs \$25.00 per organization to register. Participants who register will receive everything they need to successfully implement Future City, including:

- Program handbook
- Curriculum materials (activities, rubrics, worksheets)
- · Competition forms and checklists
- SimCity software (up to two codes per registered educator)
- Support from your region, such as training sessions, email updates, and tip sheets
- Opportunity to compete at a virtual Regional Competition

Contact your Regional Coordinator to find out what your regional deadlines are. See if there are any trainings or other ways to check in and get questions answered.

Register your school/organization at futurecity.org/ register by October 31, 2020.

- Complete the Home School Affidavit. If you are a home school educator, you will need to complete the Home School Affidavit Form to verify that your home school is operating in accordance with the laws in your state. You can download the form at futurecity.org/resources (filter for Competition Forms & Project Plan).
- Choose activities from the Resources section of futurecity.org to introduce students to specific elements of the project, such as infrastructure and scale. This Handbook tells you when students should complete an activity. Practicing with concepts and skills before they work on the project is important so that students can apply what they've learned and exercise judgment and creativity rather than learning on the fly.
- Create a preliminary schedule to guide your team through each step of the project, leaving time for contacting mentors and having them work with students as well as allowing wiggle room to meet the regional deadlines.
- Obtain SimCity Codes if you plan to use SimCity as an educational tool. You may request up to two codes. You will receive your codes automatically in the Future City Online Portal after completing the second step of registration, the Program Details Survey. Note: Additional codes may be requested by emailing info@ futurecity.org. Extra codes are not guaranteed.





Establish a schedule of when the mentor can remotely connect with the team. Be sure that you are always on these calls or video meetings – the mentor should never connect with the students by themselves.

Mentors Make a Difference

variety of recyclable materials-art supplies, bits of

water bottles, and so on.

household appliances, paper towel rolls, leftover paint,

80% of students said the mentor was important in guiding them through the project, and 53% said the mentor helped them see themselves as an engineer someday!

> "It was incredibly rewarding to see the students be creative. Instead of simply taking my suggestions as described, they made it their own."

- Anya Dela Cruz, California Mentor

Preparing for the <u>Co</u>mpetition



The Website

Futurecity.org is your online destination for:

- Activities and Background Information—Use these resources to teach key concepts to your students.
- Competition Forms—Download a writeable PDF version of the Competition Expense Form and instructions how to complete the Media Waiver and Honor Statement online.
- **Gallery**—Get inspired as you view winning models, read City Essays from past winners, and watch student presentations.
- Leading Your Team—Learn how project management can help you successfully complete your future city.
- **Online Submission Center**—Upload your City Essay, Project Plan, and all competition forms via the website.
- Rules & Rubrics—Download the assessment rubrics and competition rules for reference throughout the competition.

There is a filter system in the Resources section that makes it easy to find what you need. You can sort by specific topics, such as Competition Forms, Student Handouts, and Background Activities.

Team Format Options

Future City is open to kids in grades 6, 7, and 8 who are from the same school, a home school environment, or are members of a nationally, regionally, or state-recognized youth-focused organization, such as the Boy or Girl Scouts, Boys and Girls Clubs, or 4-H. This year, due to the heightened potential for distance learning at home, parent-led teams will also be accepted. Not sure if your organization qualifies? Contact info@futurecity.org.

1. OFFICIAL TEAM

The Official Team includes the three student video presenters, one educator, and one mentor. Most Future City regions welcome teams that are larger than the three presenting students; however, only the three official students are allowed to be in the team's recorded City Presentation video.

2. MULTIPLE TEAMS

An organization can form multiple teams under one Future City Educator Account. If you are interested in this option, check with your Regional Coordinator about the number of teams that may participate in the virtual Regional Competition. Note: Only the top-scoring team from an organization is allowed to advance to the final round of the Regional Competition. See Competition Rule number 9 on page 81 for more information.

3. OTHER TEAM FORMATS

Some classrooms or clubs choose to work together as one team, dividing the work into smaller working groups such as a research group or city model group. If you decide to work in this manner, you will need to select three students to serve as the "official presenters" and participate in the City Presentation video.

This year only, teams may choose different student representatives for different deliverables. Three students will participate in the Presentation video and three students will participate in the live City Q&A. These students may be the same or different – it's up to the team to decide.





Preparing Your

Students

Preparing Your Students

Students will get the most out of Future City if they first develop some familiarity with:

- Engineering and what engineers do
- The engineering design process
- Project management
- Cities: what they are and how they are planned

Introduce Engineering

What do your students already know about engineers and the different kinds of engineering? Have a conversation to find out.

QUESTIONS TO DISCUSS:

- What do engineers do? Do you know any engineers?
- Can you name a few things that engineers have designed or built?

KEY POINTS TO SHARE:

- Engineers are changing the world all the time. They dream up creative, practical solutions and work with teams of smart, inspiring people to invent, design, and create things that matter.
- Engineers protect the planet by developing stateof-the-art recycling systems. They design high-tech running shoes and develop life-saving medical technology.
- Engineers get to work in any field they want to. Love music? Engineers design new ways to record and listen to sounds. They also design technology so that deaf people can hear. Love cars? Engineers build better, more efficient engines that run on everything from corn husks to electricity. Engineering offers limitless possibilities for your career and your future.

Learn from Real Engineers

Work with your team mentor to provide students with opportunities to learn more about engineering.

- Have students interview different types of engineers and share what they learn with their teammates.
- See engineers in action. Arrange a virtual field trip to an engineer's office, power plant, water treatment center, local engineering college or university, or other engineering-related workplace.
- Invite your mentor and other professionals to talk to the students about science, engineering, and technology careers.
- Share current news about projects your mentor or other engineers are working on.

DIG DEEPER

(New this year, Dig Deeper suggests additional resources and areas for your team to explore.) Have students do a quick search of the many careers and areas of focus within the engineering field. Good resources include:

- DiscoverE.org/discover-engineering
- pbs.org/designsquad

Some of their results might include aerospace, agricultural, bioengineering, biomedical, chemical, civil, computer, electrical, environmental, industrial, manufacturing, materials science, mechanical, nuclear, petroleum, and more!

Engineering Design Process

When engineers work to answer questions or solve problems, they use a specific approach: the engineering design process. It is a great way to work through any challenge that involves creating something that did not exist before or improving a process or product.

As your team learns about engineers through discussion, research, and interviews, introduce them to the engineering design process:

- Show your students the engineering design process animation at futurecity.org/leading-your-team.
- Review "The Engineering Design Process" graphic and discuss the various stages. Point out that engineers don't follow the engineering design process as if it's a list, with one step followed by another. Instead, it's cyclical: they may begin at one step and move back and forth between steps numerous times. Download the graphic at futurecity.org/resources (filter for Handbook & Student Handouts).



Students can practice applying the engineering design process with:

- Tower Building Activity (filter for Activities & Background at futurecity.org/resources)
- Cargo Bridge Game (http://www.engineering. com/GamesPuzzles/CargoBridge.aspx)



ENGINEERING DESIGN PROCESS

Display a colorful version of this graphic for students to refer to as they design their city. Download at futurecity.org/resources (filter for Handbook & Student Handouts).



Preparing Your Students



- "Once my students understood what the Engineering Design Process was, it became the glue that held their team together."
- Aliyah James, Pennsylvania Future City Educator

Engineering and Teamwork

Teamwork is essential to the engineering design process. Engineers have to be able to communicate accurately and work well with colleagues and clients in order to be effective members of a team. Frequently, the combined ideas of the team lead to the best solutions!

The Tower Building activity (referenced on the previous page) also allows you to introduce the teamwork element of the engineering design process. After you've completed the activity, ask:

- Did you work in person or remotely? Was it easy or challenging to work that way?
- Was there conflict in your group?
- How did you resolve it?

We have more resources on team building. Go to futurecity.org/resources (filter for Activities & Background Info) for information and activities related to team building.

DIG DEEPER

Share the following TED talk with students. In this video, Peter Skillman shares his research after conducting more than 70 Marshmallow Challenges with a variety of participants ranging from lawyers to recent business school graduates. His findings include the importance of prototyping and



that having a team with diverse skill sets really matters. He also shares some of the reasons why engineers, architects, and kindergarten students are able to create the tallest, most stable structures!

Marshmallow Challenge video: www.youtube.com/watch?v=1p5sBzMtB3Q

Project Management

Project Management Cycle



Project Management Cycle (Professional Version)





Preparing Your Students

In engineering, the success of a project often hinges on proper management of the goals, budget, timeline, and resources. As engineers work to solve problems, they incorporate specific project management methods into the engineering design process.

To help students learn this process, the Future City Competition uses a student version of the project management cycle. This version differs slightly from the more detailed project management cycle used by professional project managers.

Introduce Project Management

What do your students already know about project management? Have a conversation to find out.

QUESTIONS TO DISCUSS:

- Has anyone heard of the term project management? What do you think it means?
- Have you worked on a big project, one with a lot of steps and a team of people? How did it go? How did everyone know what to do? Did everyone do the same thing, or did you break the project down into smaller parts? Did you encounter any problems or challenges?

KEY POINTS TO SHARE:

- We all manage projects—students, parents, educators, everybody. Planting a garden, remodeling a kitchen, creating a year's worth of lesson plans—projects are how we get important things done. Engineers manage them too. Project management is a short way of describing all the stuff that we have to do to get from the beginning to the end of a project, like knowing what we want to accomplish, what we'll need in order to accomplish it, who needs to do what, and by when. The more complicated the project, the more management it takes.
- There are four main stages of project management: Define, Plan, Do, and Review. Discuss each stage and ask students if they can give any examples from projects they've worked on.
 - ★ In the **Define stage** of project management, we think about all the things involved in the project. We get a good understanding of the requirements. We learn what the goals are, what the budget is, and the due date. We gather all of the pertinent information about the project.
 - For example, pretend you're on a committee planning a school dance. In the Define stage, you would figure out the date of the dance, how much of the school's money you can spend on it, and the committee's specific objectives for the dance (e.g. will it have a theme?).

- Preparing Your Students
- ★ In the Plan stage we create a schedule, assign roles, and decide what materials we need. The Plan stage is critical to the success of the project. The better a project is planned, the more likely it is to go smoothly! For Future City, your Project Plan is a handy place to write down this information. You will probably have to change things as you go and fill in some things later. Plans need to stay flexible but at the same time help you make your deadlines.
 - In the school dance example, the Plan stage is where the committee would figure out who is responsible for doing what (e.g. who is planning the music? Who is in charge of decorations? What about food and drinks?). You would also define a schedule that allows you to accomplish the whole to-do list before the dance.
- ★ The **Do stage** is where you actually work on the project. It's where you build, create, fix whatever the project needs. You have to stay in good communication with your teammates as you accomplish each step. You also keep track of your progress by checking in with each other regularly.
 - During the Do stage, dance committee members work on their specifically assigned tasks. They make a music playlist. They buy their party decorations and hang them up. They keep each other up to date about accomplishments and any challenges along the way. Finally, the committee puts on a successful dance!
- ★ The Review stage happens once the project is complete. Now is when you share your results, reflect on what you've learned, and celebrate.
 - After the dance, the committee meets to review the overall event. Did you meet or stay under your budget? What parts of the dance were really fun? What could be improved next time?
- If you know what you need to do in each stage, your project will go more smoothly. Engineers rely on project management because without a system, their projects can go over budget, take too long, or not meet goals. They also might get really confusing. Using project management as you build your future city will show you how useful it is.



DIG DEEPER

Two resources you can use to introduce project management to your students are:

- A project management cycle animation at futurecity.org/leading-your-team.
- The Lego Structures activity at futurecity.org/ resources (filter for Activities & Background).

"I love that Future City asks students to use project management, especially because it isn't something we usually teach. Recently a student told me, 'Oh, you know after Future City, my National History Day project was so much easier because I laid out my deadlines, I figured out what I needed to do, I made a schedule, and I set my goals. It wasn't nearly as stressful.""

– Kate Baten, Florida (Tampa Bay) Future City Educator

Leading Your Team

This section of the Handbook has been structured around the Engineering Design Process and Project Management Cycle. Putting these two processes together is a win-win: the engineering design process helps students design their future city and the competition deliverables, and the project management cycle provides the approach they need to successfully complete such a big undertaking.

We suggest you use this section as a step-by-step guide to lead your students through Future City – especially if you are new to the program. The headings in this next section follow the Engineering Design Process, with the Project Management Cycle integrated throughout. If you prefer, you can instead jump directly to the Appendix, which begins on page 41. The Appendix is organized by each competition deliverable and you may choose to work solely from that section of the Handbook.

To illustrate how Project Management and the Engineering Design Process work together, we will continue with the school dance example from page 15:

Project Management Stage	Engineering Design Process Stage	Hypothetical Party Planning Example
Define	Identify the Problem	Determine when and where the dance will take place. Set goals that will help the committee achieve a fun event.
Define	Learn the Specifications	What is the budget for the party? What size room will it take place in?
Plan	Brainstorm Solutions	Consider past dances and what worked well and what could be improved. Brainstorm ideas to make this dance great. The party committee makes a schedule to help accomplish the goals.
Plan	Design It	Finalize roles (who is in charge of decorations, food, and music). Draw a room layout. Where will the food table be? Where should the music speakers be?
Do	Build It	Hang up decorations, put out food, create an exciting music playlist.
Do	Test, Improve & Redesign	Oops, the measurement for the streamers weren't correct and they have fallen down.
Plan	Redesign It	Rethink how to improve your decorations now that you know they are too short. Remeasure and cut new streamers.
Do	Build It	Hang up the redesigned decorations.
Do	Test, Improve & Redesign	Give one last look to be sure everything looks good before you open the doors.
Review	Share It	Everyone has a great time at the dance! Afterwards, the party committee meets to review the event. Did they stay on budget? Did they achieve their goals? What lessons were learned for the next dance?



Identify the Problem

During this first stage of the engineering design process— Identify the Problem—students establish an initial understanding of the scope of the challenge and build background knowledge about designing a city. This stage aligns with the first stage of the project management cycle, known as the Define stage.

Getting Started

Engineers solve problems. Clearly understanding and identifying the problem is the first step that all engineers must take.

Briefly introduce students to the objectives of the Future City Competition:

- 1. You will use the engineering design process and project management methods to design and create a city that exists at least 100 years in the future. Your city must reflect an understanding of what a city is and highlight the general responsibilities that cities have to the people who live there.
- 2. You will address this year's challenge: Living on the Moon. Artists, science fiction writers, scientists, and engineers have imagined a thriving city on the Moon, one with healthy people and a resourceful, sustainable ecosystem. Your challenge is to design a future lunar city and provide examples of how your city uses two Moon resources to keep your residents safe and healthy.

Reminder: designing a Virtual City is no longer a required deliverable! Teams are encouraged to use SimCity or similar software as an educational tool.





3. You will work together with your mentor and educator to create five deliverables:

City Essay – you will describe the unique features of your lunar city and how your city uses two Moon resources.

City Model – you will build a scale model (or model segments) of your city using recycled materials and incorporating at least one moving part.

City Presentation – you will film a video presentation about your city.

City Q&A – you will answer questions from judges about your city and solution to the Living on the Moon challenge.

Project Plan – you will create a project plan to help you organize the creation of your future city.

Learn About Cities

In order to create cities of the future, students need to understand what a city is. What makes a city a city? What are its underpinnings? Who plans, designs, builds, and maintains cities?

Exploring cities of today is a great way to build students' background knowledge before they start creating their future city.

Defining a City

First things first: What, exactly, is a city? We know that New Delhi, Paris, New York, and Beijing are all cities. But what makes each of them a city? Is it population size, location, presence of government buildings, or social and civic institutions? How do you define a city?

Work with your students to come up with an informal working definition of a city. Write down their first thoughts on the board. Note: These questions are drawn from the What is a City? Activity. Download it at futurecity.org/ resources (filter for Activities & Background Info).



QUESTIONS TO DISCUSS:

- What do cities look like? Why do people live in cities? Are they designed or do they just happen?
- What are the differences between a city, town, and village?
- If you had to describe your city or town to a stranger, what would you say about it? How is it different from other cities or towns? What do you like about it? What don't you like?

KEY POINTS TO SHARE:

- Cities come in all shapes and sizes and there is no single population number to define a city. Similarly, Future City does not require a specific population for the cities that teams create.
- You could say that a city is everything inside the border of a particular city's government. Everyone inside that border votes on what happens in their city. But a lot of times the city has outgrown those borders, or there is just as much urban area surrounding those borders. If you had to say how many people lived in Mumbai, how would you decide where that massive city begins and ends?

DIG DEEPER

To highlight the concept of how cities change over time, compare the differences between cities 100 years in the past and cities of today. You can show students the 4-minute video *Urbanization and the Future of Cities* (youtube.com/ watch?v=fKnAJCSGSdk), which illustrates how cities developed and ways cities of the future will need to adapt to growing populations.

City Features and Infrastructure

As students are working through their definition of a city, share with them that they've been talking about both city features and infrastructure. City planners, engineers, elected officials, government employees, developers, and residents spend a lot of time, thought, and money on the location of a city's infrastructure. Yet many people don't think about or even notice these aspects of their cities. Introduce your students to these terms and then start a discussion.

KEY POINTS TO SHARE:

- The term "features" refers to general characteristics of a city. Is it located near a lake or by mountains? Is it a big or small city? Is it densely populated? What is the city's most important industry?
- The term "infrastructure" includes the structures, systems, and facilities that make a city inhabitable that is, the things people need in order to live and thrive.
 - Structures include bridges, roads, and government buildings.
 - Systems include sewage and water systems, electric and telecommunications systems, and transportation systems.
 - Facilities include hospitals and schools.
 - Soft infrastructure is used to describe the social and cultural resources that nurture communities, like education systems, fire protection, and government.

You can see why infrastructure is a very important term when we're talking about cities, even though it's a hard word to pin down!

DIG DEEPER

A great way to help students wrap their heads around infrastructure is the Infrastructure Scavenger Hunt Activity at futurecity.org/ resources (filter for Activities & Background). • Engineers and architects design most of a city's infrastructure. For instance, teams of civil and mechanical engineers design water and waste systems, while teams of electrical and systems engineers design power and telecommunication systems. What other types of engineers do you think support a city's infrastructure?

QUESTIONS TO DISCUSS:

- How might a city's location and terrain affect its infrastructure?
- What public services are vital? Why?
- Thinking about where you live, what infrastructure improvements would you recommend?

Zoning

Another important element of city planning is zoning. Zoning refers to the way in which land in a city gets divided up and categorized. Zoning regulations and laws help ensure that a city can grow and change in a manageable, safe, and attractive way.

KEY POINTS TO SHARE:

- City planners work with city officials, engineers, architects, lawyers, and developers to create specific zones for how land will be used within a city. Zones usually fall into one of the following categories:
 - A residential zone is where people live. It can be high density, meaning that a lot of people can live in an area, usually in apartment buildings. Or it can be low density, which is usually single-family houses.
 - A commercial zone is for stores and restaurants.
 - Industrial zones are where factories and power plants are located.
 - Agricultural zones contain farmland where food is grown or raised.
 - Mixed use means a blend of zones. City developers sometimes use the same area for residential and commercial zoning. An example of mixed use: a city block featuring both apartment buildings and a café, movie theater, clothing store, and grocery store—sometimes in the same structure!

DEFINE

QUESTIONS TO DISCUSS:

- What might you expect to find in each of these different zones?
- Why is zoning an important factor to consider when planning a city?
- How is zoning related to a city's infrastructure and services?
- What happens when thoughtful zoning has not been executed?

DIG DEEPER

- Show students a zoning map of their city and identify different zones. (Research the city name plus "zoning map" online to find a map of your city or one nearby.)
- Have students research the zoning designation for their home address, school, or other local businesses. Many cities have websites that allow individuals to input a specific address and receive information on the property, which includes its zoning designation. What are some of the different zones? What areas in their own city are considered industrial, commercial, mixed, and/or residential zones?
- Invite guest speakers from your local city planning department to show zoning maps and explain how cities are typically zoned. This can be done virtually through a platform like Zoom or Google Classroom.
- Do the City Zoning Activity at futurecity.org/ resources (filter for Activities & Background).



City Planning & Simulation Tools

City planning requires an understanding of how all the city features, systems, infrastructure, and zoning come together to make up a city. City planners are always thinking about how to improve the quality of life in a city by fixing problems and planning how the city can grow and change.

While no longer a required competition deliverable, SimCity is a great learning tool for students to understand the complexities of city planning and design. Taking the time to experiment in SimCity is highly beneficial to students, as they will gain knowledge that they can then apply to their future city. For example, they can explore:

- Zoning: Exploring zones in SimCity will help teams determine what zones need to be near each other in order to optimize city function and resident happiness.
- Infrastructure: From transportation to energy and communication systems, SimCity provides endless opportunities to experiment with placing infrastructure and its impact on the city's overall function.
- Budgets & Taxes: SimCity citizens are quick to provide their opinions on your city's tax rates and where your budget excels or falls short.
- Systems thinking: The simulation aspect of SimCity allows students to see the consequences of their design decisions. For example, where they place their roads may positively or negatively affect their city's public transportation system in the future.

DIG DEEPER

Visit futurecity.org/resources (filter for Activities & Background Info) and continue exploring city features and the process of city planning:

- City Planning Background Information
- City Planning Key Terms & Concepts
- People Who Create and Sustain Cities: Learn about the many professionals involved in designing cities.
- City Planning Word Investigation: Research definitions for common city planning words.
- Zones and Interconnectivity: Make basic urban plans for an imaginary city.
- City Planning Game: Learn how to design the placement of city elements within zoning areas.

DEFINE Learn the Specs

Learn the Specs

In the Learn the Specs stage of the engineering design process, students carefully review the competition requirements and learn about the specific characteristics that each deliverable must meet. They'll also identify resources, team roles, assumptions, and goals as part of their Project Plan.

Future City Deliverables

These five deliverables are required for teams who choose to fully compete in Future City. Detailed information about each deliverable can be found in Appendix: Deliverables starting on page 41.

Deliverable 1: Project Plan

Consisting of four parts, the Project Plan helps students stay organized, focused, and on schedule as they complete their other Future City project deliverables. The four parts are:

- Part 1: Set Goals
 - Completed during the Define: Learn the Specs stage, students describe what they hope to achieve by the end of the project.
- Part 2: Create a Schedule
 - Completed during the Plan: Design It stage, students plan how and when they will complete each deliverable.
- Part 3: Conduct Check-Ins
 - Completed during the Do: Build It and Test, Improve & Redesign stage, students monitor their project's progress to keep on schedule, meet their goals, and see where the plan needs tweaking.
- Part 4: Reflect on the Project
 - Completed in the Review: Share It stage, students reflect on what they accomplished and how they did it.

Unlike the other Future City deliverables, there is no rubric for the Project Plan. Teams that complete and submit all four parts receive ten points. Teams that submit an incomplete plan may receive five points. Teams that do not submit a plan will receive zero points.

Further instructions and the easy-to-complete project plan templates can be found in the Appendix: Deliverables starting on page 41.

Remember – the program this year is virtual! All deliverables can be completed remotely and the Regional and Finals competitions will take place online rather than in person.



DEFINE Learn the Specs

Deliverable 2: City Essay

Begun in the Plan: Design It stage, students write a 1,500word essay that describes the unique attributes of their city and provides a solution to this year's challenge, Living on the Moon: Design a lunar city and provide examples of how your city uses two Moon resources to keep your residents safe and healthy.

This deliverable is worth 58 points and is due before the competition. Further instructions, student handouts, and the rubric can be found in the Appendix: Deliverables starting on page 53.

Deliverable 3: City Model

Begun in the Do: Build It stage, students build a physical model, or multiple model segments, of their city. Then, teams submit photos and brief descriptions of their work as a PDF, using a provided slideshow template.

Note:

- models should be made primarily out of recycled materials;
- each team may create one single model or multiple segments (segments do not have to physically fit together);
- each team must design at least one moving part and demonstrate it in a short video. The team will provide a link to the video within the slideshow;
- teams will use the provided template to create their slideshow;
- remember the \$100 total expense budget.

This deliverable is worth 65 points and is due prior to the competition. Further instructions, student handouts, and the rubric can be found in the Appendix: Deliverables starting on page 65.

IT'S NOT A STRAIGHT LINE

Although each deliverable is designed to stand on its own, teams may find that they are working on them concurrently and will quickly realize that each deliverable informs the others in critical ways. The **Living on the Moon: Questions to Consider student handout** may prove relevant to keep in mind as students work on the various deliverables.

Deliverable 4: City Presentation

Also begun in the Do: Build It stage, students present their future city and solution to this year's challenge in an up to 7-minute video presentation. This year, presentations will be pre-recorded instead of live.

Video presentations are made by the three presenting students and can be formatted in a variety of ways. Teams include the model (or model segments) in the video and may also include:

- Visual aids
- Costumes

Costs of the presentation materials must be included in the \$100 total expense budget. These materials include anything used on screen for the presentation; it does not include background tools like the phone or computer used to record the video. This deliverable is worth 70 points and is submitted prior to the virtual Regional Competitions. Further instructions and the rubric can be found in the Appendix: Deliverables starting on page 72.

Deliverable 5: City Q&A

Completed in the Review: Share It stage, three student team members will have a live, virtual 10-minute question and answer session with judges from engineering, technical, city planning, and related fields. This year, the Q&A will be conducted remotely via a virtual platform and is separate from the City Presentation. Judges will ask questions about engineering, the Living on the Moon challenge, teamwork, and the team's future city. Judging sessions will be scheduled by your Regional Coordinator.

This deliverable is worth 25 points. Further instructions and the rubric can be found in the Appendix: Deliverables starting on page 77.

Many regions provide the opportunity for teams to give brief presentations to additional judges to earn special awards. Check with your Regional Coordinator for details.

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Project Plan: Set Goals

Setting project goals occurs in the Define phase of the project management cycle. Deciding what students hope to achieve through the Future City project is also the first step of the Project Plan. As part of goal setting, students think about what resources are available to them, what roles each team member will take on, and any assumptions they may have. Whether your team is physically together or working remotely, taking the time to complete this goal setting process is invaluable. Throughout the Future City process, team members will look back at their goals to access progress and track their responsibilities.

Share Part 1 of the Project Plan located on page 44 and at futurecity.org/resources (filter for Competition Forms & Project Plan). Tell students that the first team goal is the same for everybody and is already listed:

• Our team will create a lunar city that uses two Moon resources to keep residents safe and healthy.

Before creating more goals, have students start to identify available resources, team member strengths and interests, and assumptions. The Project Plan template has useful explanations of these terms and questions to get the kids thinking. Let students know that thinking about what they want to do before they do it is critical to their success!

Now it is time to guide your team to think up additional goals. Explain that these goals are what they plan to achieve by the end of the Future City Competition. Goals can be about their city, like the one described above, or they can be about their team, how they will work together, and how they will handle the project itself. For example, "stick to the deadlines we set" or "work well together as a team" can be goals.



Learn more about goal setting and project management in the Leading Your Team section of futurecity.org.



PLAN

Brainstorm Solutions

During the Brainstorm Solutions stage of the engineering design process, students use their Project Plan to schedule how they will complete each deliverable. Then they steep themselves in research and brainstorm various solutions to the Living on the Moon challenge. Project managers refer to this second stage of the project cycle as the Plan stage.

Project Plan: Start Making a Schedule & Assign Tasks

Explain to students that since they now have a better understanding of the project, it's time to start making a schedule and identify what needs to be done, by whom, and in what order. A schedule will help them keep track of time and the tasks they must do to successfully complete their deliverables.

Of course there are many unknowns! Emphasize that this schedule is an important starting point, but students should expect to change it as they continue their work.

Creating Schedules

There are many ways to make a schedule, such as:

- Google sheets or docs
- text message threads
- emails
- visual representations, and
- brain maps.

The most important thing is for students to use a process that works best for them.

Create a schedule using the process outlined below or let your students come up with their own.

Sample Process: On index cards, sticky notes, or in a shared online spreadsheet, write down the big milestones and the smaller tasks required to complete each deliverable. Color code them so that every task related to a particular deliverable is easy to see. This way, tasks can be easily moved around as the project and timeline evolves.

After the team identifies their goals, milestones, and tasks, they can come up with a schedule to accomplish it all. With a schedule in place, specific roles and responsibilities can be divided up among the team members. Make sure the team remembers that the schedule is not set in stone. Once work begins, it may need to be adjusted throughout the project.



For more tips on creating schedules, visit the Plan section of Leading Your Team at futurecity.org.



PLAN Brainstorm Solutions



Research Solutions

Before students start brainstorming what their city will look like and their solution to this year's challenge, they need to begin the research process. To create an innovative lunar city, students will need to ground themselves in not only current city design best practices, but also the cutting-edge and futuristic solutions engineers are researching and experimenting with, both on Earth and beyond.

Guide Students' Research

This year's challenge asks students to create a future city on the Moon. Teams will determine where on the Earth's Moon to place their city, who lives there, and what daily life is like. They need to share the innovative and futuristic aspects of their city, describe two different Moon resources, and explain how their lunar city uses these resources to keep its residents safe and healthy.

There are many resources to help guide your students' research. The following handouts for students can be found starting on page 55 or downloaded at futurecity. org/resources (filter for Program Handbook and Student Handouts).

STUDENT HANDOUTS

• Living on the Moon: Overview and Research Questions

This handout will help your students learn about the Moon: its features, terrain, available resources, and unique hazards. It provides an overview of this year's challenge, background information, and questions to jumpstart students' research and exploration.

• Living on the Moon: Questions to Consider

Once students have learned about the Moon, it's time to start researching how their lunar city will function: from providing a livable atmosphere to transportation options and everything in between. This handout provides background information and questions designed to help your students think of practical and innovative ideas for their future cities.

• Living on the Moon: Real World Case Studies

It can be helpful to read about current advancements related to Moon technology while researching. This handout offers short explanations of four examples of advancements related to the Moon, including travel, building materials, and growing food.

• Living on the Moon: Research Resources

This handout provides a helpful starting place for your team's research. The list is not exhaustive, though – there are many more sources to discover and research!



Suggested websites and books related to this year's theme are available at www.futurecity.org/resources (filter for Research Resources & Websites)



PLAN Brainstorm Solutions

Research Tips

- Use the Research Cards as a way for students to document and organize the information and relevant sources that they find. Download and print copies of the Research Cards for teams, as needed, at futurecity.org/ resources (filter for Research Resources & Websites).
- Create an electronic project archive. The project archive could contain file folders that can hold information produced and collected throughout the project. Basic folders could be titled Project Plan, Expense Information, Research, City Essay, City Model, City Video Presentation, and City Q&A. The project archive should be accessible to all team members.
- Refer to the Research Strategies document at futurecity.org/resources (filter for Activities & Background Information) for more research strategies and information on citing sources.



Brainstorm Solutions

It's time for students to begin brainstorming what their future city will look like. Now is the time to encourage creativity, problem solving, and futuristic thinking. Remind students that their city will exist at least 100 years from now.

Have the students review their research and the Living on the Moon: Overview and Research Questions and Living on the Moon: Questions to Consider student handouts starting on page 55. Discussing these questions and their research with teammates will yield lots of ideas and can serve as a roadmap for what to include in their future city.

QUESTIONS TO DISCUSS:

- How do you think a city on the Moon would be similar to cities here on Earth? How would it be different?
- What are some challenges of living on the Moon?
- What resources are available on the Moon? Which ones will you use in your city?
- What industries are active in your lunar city (e.g. tourism, mining, manufacturing, finance)?

KEY POINTS TO SHARE:

As students dive into their brainstorming, review the following with them:

- Engineers identify more than one solution and explore all kinds of ideas. Recording pros and cons for each one will help students identify the best solution.
- Engineers use simulation tools to test various ideas and gather information about possible solutions. We recommend teams use SimCity, CitySkylines, PocketCity, or a similar simulation. What ideas do they want to test out? What might they learn from using a simulation? What might surprise them about their ideas?
- Engineers are not afraid to take risks. Tell students that they shouldn't be afraid to share their ideas and try new designs. Even if the design seems too complex or unrealistic, share it! Sometimes the best ideas are born from someone's wacky suggestion.
- Engineers know that brainstorming is a team effort. It requires perseverance, creativity, determination, communication, and an open mind. Download Brainstorming Tips at futurecity.org/resources (filter for Activities & Background) for more brainstorming techniques and guidance.





PLAN Brainstorm Solutions



Choose Solutions Before Designing the City

Before students move into the Design It stage, they need to choose two Moon resources and determine how they will be used in their lunar city. A good way to narrow their choices is to measure their ideas against the essay, model, presentation, and Q&A rubrics. How well they match up could help students select the best solutions.

Check the Schedule

Teams will probably need to make some changes to their project schedule, now that they have decided on their Moon resources and how they'll be used in their city. Give students time to add tasks, move them around, and make sure that everybody is sharing the workload.

PLAN

Design It

This stage of the engineering design process is where ideas take shape and visions grow. Students draw from their research and brainstorming to plan how they will create their lunar city. Encourage students to ask the team mentor for feedback. The mentor may have expertise in this area or be able to call upon colleagues to help evaluate the students' designs.

Draft the City Essay

The City Essay is the first place that students will share their vision of their future city. Here they will answer the question: What makes your city special, futuristic, and innovative? They will also describe their solutions to the Living on the Moon challenge. Drafting the essay helps students synthesize their research, finalize key elements of their future city, and reflect upon life on the Moon.

The City Essay and the team's research lay the groundwork for the other deliverables. Students will frequently refer to their research, the answers they came up with to the **Questions to Consider** handout, and their essay in order to build the model (or model segments) of their future city and complete their slideshow, decide what to say in their presentation video, and determine how to answer the judges during the Q&A. This is an example of how the engineering design process works: what they accomplish in one stage informs what happens next.

CHECK THE SCHEDULE

Remember, the essay is due before the Regional Competition. Make sure you have checked with your Regional Coordinator for the exact due date and have noted it on your team schedule.



PLAN Design It

KEY POINTS TO SHARE:

- Before students begin to write, review the City Essay: Suggested Outline (page 61) and the City Essay rubric (page 62) with them.
- Share City Essays from past Finals winners. Analyzing essays from prior years will give students a strong sense of what they are aiming for in their own essays. Go to futurecity.org/gallery and filter for City Essay.
- A draft is kind of like a prototype: it's the version where you work out the kinks. The draft of the City Essay is the prototype that helps students evaluate ideas, plan resources, and anticipate possible roadblocks before they create their final version of the City Essay, their model or segments, and their video presentation.

QUESTIONS TO DISCUSS:

- Is there anything in the City Essay outline or rubric that the team hasn't discussed or developed a solution for? If yes, it's time to go back to the research and brainstorming phase.
- 1,500 words is not a lot. What aspects of the city need to be in the essay? Are there aspects of their city that are better represented in their model slideshow, presentation video, or Q&A?
- How many drafts are they prepared to write? Have a conversation about their expectations and those of their teammates.



Future City has several resources to help students write their City Essay. Download the Living on the Moon Research Resources from futurecity.org/resources (filter for Research Resources & Websites) for a list of good places to start your team's research.



PLAN Design It

Build It

During the Build It stage of the engineering design process, students create many project deliverables. They finalize their City Essay, build their City Model and begin their slideshow, and write the script for their City Presentation video. As they work, students use the Project Plan to conduct check-ins to make sure their project stays on track. Project managers refer to this third part of the project cycle as the Do stage.

Project Plan: Conduct Check-Ins

As students move into the Build It stage, they should review the requirements for the Future City deliverables and make sure they're working towards meeting them. They may find it necessary to change responsibilities among team members as some tasks are completed and new ones begin.

Conducting regular check-ins will help students monitor their work. Ask each team for a quick verbal check-in every time you meet so that students keep an eye on their schedule and tweak it frequently. Check-ins will also encourage students to become adept at summing up their progress across deliverables for you and the other team members.



For more tips on conducting check-ins, visit the Do section of Leading Your Team at futurecity.org.





DO Build It



Finalize the City Essay

It's time for students to look at the rough draft of their essay and to turn it into the final, polished version. Guide students through this important phase of writing using your preferred method. If you don't have a favorite way of helping students work in groups to complete essays, you can use the following approach.

If each team member wrote the rough draft of one section of the essay, tell the team to put the sections in order and read through them together.

Next comes a group editing process. Students are likely to find repetition and will need to decide where to cut and where to keep content. They will also need to add connecting sentences so that each section flows logically to the next. If they see any errors in spelling or grammar, they can catch them now. Remind students to check their essay against the City Essay Rubric on page 62 or download it at futurecity.org/resources (filter for Rules & Rubrics).

Once they have a near-final draft, you or the team mentor should read it and give the students feedback. Together, students can decide how to make changes to their essay based on this feedback. Then one student should be in charge of writing the final version. Everyone on the team should read it one last time and make sure their essay is in great shape.

Explore Scale

Before students begin their City Model, introduce the concept of scale.

Scale is a very important requirement for the City Model and teams should think carefully about the most appropriate scale to use. Factors to consider include the geographical location and terrain of their city, its layout, the level of detail they wish to include, and cost. If students choose too small of a scale, they may have trouble finding objects to build with; too large of a scale may prevent them from including all the details and specifics they would like to feature.

Tell students that engineers use scale models to test their design ideas at an early stage of development without the risk of creating a full-sized model. If you have access to your school's blueprints, compare these drawings with familiar school buildings and rooms to illustrate the concept of scale.

Share the following terms:

- Scale is the ratio between two sets of measurements.
- Scale drawing is a drawing that uses scale to make an object smaller or larger than the real object.
- Scale model is a proportional model of a threedimensional object.

DIG DEEPER

Visit futurecity.org/resources (filter for Activities & Background Info) and continue exploring scale:

- Scale: Background Information
- Scale: Key Terms & Concepts
- Introduction to Scale: Learn how to use ratios to create a scale drawing.
- Plan and Elevation View: Architects and engineers use sketches as a way to communicate and convey their design ideas to others. This activity introduces students to creating scaled drawings.
- Proportions, Ratios, and Scale Drawings Activity: Apply learning about proportions, ratio, and scale to create a scale drawing of a room.
- Scale Map Activity: Plan the City Model by creating a two-dimensional city map.

DO Build It

Build the City Model

New this year for the virtual program, teams will submit a slideshow containing photos and descriptions of their City Model, rather than presenting their model in person at regional competitions. Teams may choose to create a single model or multiple segments. Be sure to read through the requirements, slideshow template and example, and rubric before beginning.

Start your students off by sharing and reviewing the Build Your City Model handout on page 67 and at futurecity.org/ resources (filter for Activities & Background Info). It's full of valuable information about ways to create different parts of the model, questions to keep in mind, and tips for the moving part component. Discuss how your team wants to complete this deliverable: will they make one single model? Will every teammate create a model segment? Or will a handful of teammates work on a few model segments?

KEY POINTS TO SHARE:

- Model segments do not need to fit together to form a single, physical model.
- Each model segment must be consistent in its scale. However, each individual model segment (even among the same team) may use different scales.
- Each team must have at least one moving part on their model. Each model segment does not need its own moving part, but at least one is required per team.
- Models themselves will not be judged. Rather, teams will showcase specific aspects of their model/model segments in a slideshow that will be submitted prior to the competition. Share the required template and example slideshow, available online at futurecity.org/ resources (filter for Competition Forms & Project Plan).
- Remember to refer to the City Model rubric before and as they build, not just at the end.

QUESTIONS TO DISCUSS:

- Will your team build a single model or multiple model segments?
- What parts of the city need to be represented in the slideshow? Refer to the template and rubric!
- What are some creative ways you can use recycled materials in your model?
- What scale works best for your model? How will you ensure that the scale is consistent within each model segment?
- What recycled or reused materials are available to your team?



City Model Resources

Future City has several resources to help students create their model. Below are a few highlights. Find them and more in the Appendix: Deliverables starting on page 65.

- **City Model Requirements:** Make sure the team is familiar with the requirements (go to page 65).
- Build Your City Model student handout: This handout offers questions to consider and model building tips.
- **Past Models:** Get inspired! See models that teams have created over the years at futurecity.org/gallery. Remember the presentation format of the models to judges is new this year, but your team can still find inspiration from past models.
- Moving Parts Video: Get ideas about different kinds of moving parts at futurecity.org/resources (filter for Webinars & Videos).
- City Model slideshow template: Learn exactly what photos and descriptions need to be included in the slideshow your team will submit. Available online at futurecity.org/resources (filter for Competition Forms & Project Plan).
- City Model slideshow example: See an example of a completed slideshow at futurecity.org/resources (filter for Competition Forms & Project Plan).
- **City Model Rubric:** Review the rubric on page 69 and at futurecity.org/resources (filter for Rules & Rubrics).

Remind students that as they work toward completing the deliverables, they will be moving back and forth between the different phases of the design process. This is natural. Engineers go back and reevaluate or refine their solution as the need arises; sometimes the best ideas are those that are not selected first!

Create the City Presentation

The City Presentation gives students an opportunity to showcase all that they have accomplished and learned in the Future City Competition. Set a celebratory tone for students! That way their presentations will convey their enthusiasm for, and pride in, their future city.

KEY POINTS TO SHARE:

- Presentations this year will be different than in the past. Teams will submit a recorded presentation video prior to the competition. Brainstorm with students the different ways they might make their video. Use the ideas on the How To Make a City Presentation Video student handout as a starting point to discuss the variety of formats and filming options and determine what works best for your team. Find this resource on page 73 and at futurecity.org/resources (filter for Handbook & Student Handouts).
- Teams will not answer questions from judges at the end of their presentation this year. City Q&A is a separate deliverable and will be conducted via live virtual sessions scheduled by your Regional Coordinator.

DIG DEEPER

Visit futurecity.org/resources (filter for Activities & Background Info) and continue exploring strategies for constructing models.

- Model Construction: Key Terms & Concepts
- Model Construction: Background Information
- What is a Model? Activity: Examine different types of models and discuss why they are useful.
- Plan-Relief and Architectural Models Activity: Create and compare two-dimensional floor plans and three-dimensional models of a classroom.
- Building Strong Activity: Build a paper structure that will support a book.

DO Build It
DO Build It

- Help students get inspired by watching presentations from last year's winning teams at futurecity.org/gallery. While the format of the City Presentation deliverable is different this year, past videos can provide ideas and encourage creativity that can be adapted to a recorded format. Discuss the videos by asking the following questions:
 - What made the presentation engaging?
 - What features and infrastructure made the city appealing, unique, and futuristic?
 - How did the team incorporate last year's challenge into the city design?
 - What will you need to do to prepare for your own presentation?
- Another resource is the Living on the Moon: Questions to Consider student handout that the team used when writing their City Essay. Encourage students to revisit their answers to these questions and pick out what is most important and interesting to say in their presentation. They can't say everything; they have to pick and choose.
- Remind teams to keep the rubric in mind as they design and develop their presentation. Refer to it often!

QUESTIONS TO DISCUSS:

- How will you highlight your model or model segments during the presentation video?
- What visual aids and props will you use to enhance your video presentation? How can you ensure that these aids are easily readable by your online audience?
- How did the engineering design process and project management cycle help you plan your city?
- How can you show the ways you work well as a team? (For example, do you share presentation tasks, do you support each other during the presentation, do you display equal amounts of knowledge?)

City Presentation Resources

Future City has multiple resources to help students create fantastic presentations. Below are a few highlights. Find them and more starting on page 72.

- **City Presentation Requirements:** Make sure students understand the requirements.
- **City Presentation Rubric:** on page 75 and at futurecity. org/resources (filter for Rules & Rubrics).
- **Past Presentations:** Watch prior years' winning teams presenting at Finals at futurecity.org/gallery.
- How to Make a City Presentation Video student handout: on page 73 and online at futurecity.org/resources (filter for Handbook & Student Handouts).
- City Presentation Tips student handout: on page 74 and at futurecity.org/resources (filter for Handbook & Student Handouts).

DIG DEEPER

Share the following presentation:

NineTalks by Impressive Kids at: blog.ted.com/9talks-by-impressive-kids/

Discuss what made these presentations engaging. What did students notice about the speaker's body movements and voice? How does the speaker use research, stories, and questions to hook the audience and convey a message? Encourage students to emulate effective public speaking techniques in their own video presentations.





DO Test, Improve & Redesign

Test, Improve, & Redesign

In the Test, Improve, and Redesign stage of the engineering design process, students evaluate their solutions, get feedback from others, and make improvements based on this feedback. They'll continue to monitor their project's progress through frequent check-ins with you and their teammates. The goal is to make sure their project is the best that it can be.

During this stage, students carefully review the rubric for each deliverable to ensure they have met all of the requirements. They should also get as much feedback from you and their mentor as possible on each competition deliverable. At this point, feedback should be specific and actionable—students should understand exactly what they need to do to implement your feedback.





DO Test, Improve & Redesign

Finalize the City Model

Now is the time for the team to put the finishing touches on their model/model segments and finish their slideshow. Make sure they took good, clear photographs to include in the slideshow and inserted the hyperlink to their moving part video.

Before submitting the deliverable, encourage the team to compare their slideshow to the rubric on page 69 to make sure they're earning as many points as possible.

Rehearse the Presentation Video

Practicing your presentation is very important, especially this year. Presenting to a camera feels different than giving your presentation in front of a live audience in many ways. The three student video presenters should practice and record their parts, then review with team members to identify areas to change or improve. Once the presentation is polished, record and submit your video! Check with your Regional Coordinator for additional submission instructions.

KEY POINTS TO SHARE:

- Continue practicing your presentation in front of friends, family members, and your team mentor. Each of these audiences can provide feedback on what was most interesting, areas to improve, and how well the presentation aligns with the rubric.
- Presenters can record their part and then watch the video to identify ways to improve. Practice until you are comfortable speaking to the camera.
- Refer to the **City Presentation Tips student handout** on page 74 and at futurecity.org/resources (filter for Handbook & Student Handouts) for tips and best practices to help your team design and record the best possible video presentation.

QUESTIONS TO DISCUSS:

- What parts of the presentation video could your team improve? Are there parts that are unclear or confusing?
- How are you showcasing your team's creativity during the video?

Practice City Q&A

The City Q&A gives students an opportunity to demonstrate their knowledge and understanding of all aspects of their future city project. Three student representatives will field questions from a panel of engineering, technical, and city design judges via an online, virtual platform. This is the team's chance to show off their understanding of engineering, project management, city design and operations, and the Living on the Moon challenge.

KEY POINTS TO SHARE:

- The Q&A session this year is different than in the past, as it will take place separately from the Presentation.
 Q&A will be conducted virtually via an online video conferencing platform and scheduled by your Regional Coordinator.
- Remember that the three student representatives for the Q&A do not need to be the same students who participated in the City Presentation video.
- Questions from the judges will run the gamut of the entire Future City project. They could include questions about city design and operations, the engineering design process and project management cycle, your team's specific solutions to the Living on the Moon challenge, struggles your team encountered, and examples of teamwork.
- Two good places to start preparing are the City Q&A Practice Questions student handout on page 78 and online at futurecity.org/resources (filter for Handbook & Student Handouts) and the Designing a Lunar City: Questions to Consider student handout that the team used when writing their City Essay.
- Role play to practice answering questions. Team members, the mentor, or other adults can play the role of judges and ask questions to the student presenters.
- Practice answering questions in a virtual environment, like Zoom or Google Hangouts, so students can figure out how they will work as a team to share their knowledge without speaking over each other.
- Review the City Q&A rubric as teams prepare for the live session.



DO Test, Improve & Redesign

QUESTIONS TO DISCUSS:

- How can you show the judges that you understand the information, rather than just having talking points about your city memorized?
- How did your team use the engineering design process and project management cycle to complete your project?
- What lessons did your team learn about city design and operations? What did they learn about living on the Moon?
- Team members will likely be in separate locations for the virtual Q&A session. How will you know when to speak and when to let other presenters answer? What systems or signals can you devise to smoothly take turns answering questions in a virtual environment?

City Q&A Resources

Future City has multiple resources to help students prepare for the Q&A. Below are a few highlights. Find them and more starting on page 77.

- **City Q&A Requirements:** Make sure students understand the requirements.
- **City Q&A Rubric:** on page 79 and at futurecity.org/resources (filter for Rules & Rubrics).
- **City Q&A Practice Questions student handout:** on page 78 and available at futurecity.org/resources (filter for Handbook & Student Handouts).

Final Preparations

When students are satisfied that they have met the requirements for each deliverable, they should prepare their deliverables for online submission by the regional deadline. These deliverables need to be submitted though the Future City Online Portal at futurecity.org:

- City Essay
- City Model slideshow PDF
- City Presentation video link
- Project Plan

Share the Final Checklists with your team. See page 80 or download at futurecity.org/resources (filter for Handbook & Student Handouts). Give the team time to look through every line on these lists. Then check in with the team to see what they still need to finish. Make sure students have a concrete plan for tying up loose ends.

Now is also a good time to ensure that each student has a completed Media Waiver and Honor Statement (electronically signed online) and that the team's Competition Expense Form and scanned receipts have been submitted.



ONLINE SUBMISSION PROCEDURES

All deliverable submissions must be made via the Online Portal at futurecity.org. Submission instructions are available from your Regional Coordinator or at futurecity. org/resources (filter for Competition Forms & Project Plan).

REVIEW

Share It

The Review stage is where students look back and reflect on all that they have accomplished—an important step that both engineers and project managers take in any project. Here students will complete the final step of the engineering design process—Share It—by presenting their work to others, answering questions from judges, and celebrating their accomplishments. Now is the time to reflect on everything they've done and complete their Project Plans.

Project Plan: Reflect on Your Project

During this final stage, students reflect on their Future City experience by reviewing and assessing the process and end products. Consider both how well the project succeeded and what lessons were learned.

Let students know that reflecting on their project allows them to consider what worked and how they might do things differently—information that can help make their next projects easier. Reflection is also a great way to prepare to answer the judges' questions during the virtual competitions. You can find the Project Plan Part 4 template on page 51 or download it at futurecity.org/ resources (filter for Competition Forms & Project Plan).



For more tips on reflection, visit the Review section of Leading Your Team at futurecity.org.





REVIEW Share It

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City Q&A: Live Session with Judges

The virtual City Q&A session with judges is a very exciting moment for students and the culmination of months of work. Three student representatives will show off their knowledge of engineering and city design, the team's entire project and process, and their solutions to the Living on the Moon challenge.

KEY POINTS TO SHARE:

Here are a few final performance tips to share with your students:

- Sleep well the night before the virtual competition.
- Eat a healthy breakfast.
- Remain calm; no one knows your city better than you!
- Be poised and confident; there are no wrong answers.
- Look into the camera as you answer questions.
- Devise signals or systems so that you will know which teammate will answer a judge's question.
- Speak clearly. Put energy in your voice and don't rush, be confident, move with purpose, face the camera, and smile!

All team members will receive a certificate of participation.

Congratulations on completing your city of the future!



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Note: All forms (including the Media Waiver, Honor Statement, Competition Expense Form, and Home School Affidavit) are available online at futurecity.org/resources (filter for Competition Forms).





Appendix: Deliverables Project Plan

DELIVERABLE #1: Project Plan

10 POINTS DUE: BEFORE REGIONAL COMPETITION

Students work with their team to complete a four-part project plan to help them stay organized, focused, and on schedule as they complete their other Future City project deliverables.

What Is a Project Plan?

A project plan is a tool engineers use to manage their work. It's where Future City participants record their project goals, plan how they'll complete the competition deliverables, and monitor their project's progress. A well-crafted project plan will help students stay on track as they use the engineering design process to research and create their cities. It's like a roadmap that students refer to as they move through the competition, but it is also changeable. Decisions made at the beginning of the project may turn out to need revising!

NO RUBRIC FOR THE PROJECT PLAN

Note: There is no rubric for the Project Plan, but you still need to turn it in. Fully completed plans (with all four parts) earn 10 points. Partially completed plans may earn 5 points.

Project Plans Take Many Forms

What a Project Plan looks like depends on the project and the team; a plan needs to work with the needs of the project and the style and preferences of the team. For this competition, students start with the Project Plan template starting on page 44. It has four parts that align with the project management cycle stages: Define, Plan, Do, and Review. Within each section, students have the leeway to make the plan work for them. In fact, we encourage students to make the Project Plan their own, in whatever ways it will best meet their needs for the competition.



An editable Word version of the Project Plan template can be downloaded at futurecity. org/resources (filter for Competition Forms & Project Plan). You can also see examples of Project Plans from previous years in the Gallery section of futurecity.org/gallery.



Appendix: Deliverables Project Plan

As the team puts together its Project Plan, team members need to keep the four parts in mind. You can share this chart so the kids can see which stage of the competition each part addresses.

PROJECT PLAN PARTS

PROJECT MANAGEMENT STAGE

PART 1: SET GOALS

Students describe what they hope to achieve by the end of the project. They also ensure that goals are realistic by considering resources, team roles, and assumptions.



PART 2. CREATE A SCHEDULE

Students plan how they'll complete each deliverable.



PART 3. CONDUCT CHECK-IN SESSIONS

Students monitor their project's progress to keep on schedule, meet their goals, and see where the plan needs tweaking.



D0:

PART 4. REFLECT ON THE PROJECT

Students reflect on what they did and how they did it, a great way to prepare for the competition and make their next projects easier.

REVIEW: SHARE IT

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Project Plan Requirements

- All four parts of the Project Plan must be included in one document and saved as a PDF.
- Teams submit their Project Plan (containing Parts 1–4) via the online portal at futurecity.org. Submission instructions are available from your Regional Coordinator or at futurecity.org/resources (filter for Competition Forms & Project Plan).

Project Plan Resources

- **Project Plan template**: The template includes instructions for what the Project Plan has to include as well as space for students to complete each of the four sections. It starts on the next page or can be downloaded at futurecity.org/resources (filter for Competition Forms & Project Plan).
- Training for Educators: If you would like guidance on how to lead your team, explore the Leading Your Team online training at futurecity.org.
- Final competitions checklists on page 80.

Competition Scoring

Teams who submit their completed Project Plans on time will receive 10 points. Teams who submit incomplete Project Plans may earn 5 points. Remember, there is no rubric for this deliverable. Teams that do not submit a Project Plan will receive zero points.

Scoring Deductions

5–10 points

Late submissions may be accepted with a penalty. Check with your Regional Coordinator before the deadline to find out if this is an option in your region.



Visit Leading Your Team at futurecity.org to learn more about how the Project Plan will help your team successfully complete their future city.



SET GOALS

INSTRUCTIONS

In Part 1 of the Project Plan, you will outline your overall goals, resources, and assumptions to help you envision your final project. You will also start thinking about how to divide up work and determine who will take on which roles and responsibilities.

Goals explain what will be achieved by the end of Future City. Setting goals will help you determine what you want the outcome of your project to look like. Goals help you answer the question, "How do I know when I'm done?"

Once you have a general vision of your project, make sure your project goals are realistic and attainable. Then figure out how you will divide up this work among the team.

Think About It

- How do you want to work as a team?
- What would you like to achieve with each deliverable?
- What are the strengths of each member of the team?
- Which overall goals are most important to your team?

Use the blank space below to brainstorm ideas, then write your final thoughts in the chart on the next page.

Appendix: Deliverables Project Plan



FUTURE CITY TEAM NAME:

ORGANIZATION/SCHOOL:

Appendix: Deliverables Project Plan

EDUCATOR:

TEAM GOALS

The first goal is listed for you. Write in at least two more goals.

1. Our team will create a future lunar city that uses two Moon resources to keep residents safe and healthy.

2.	
3.	
4.	

Brainstorm possible resources, team roles, and assumptions for your project.

Resources	
List the things that you might use as you research, design, and create your city. These could include teammates' skills, people to ask for advice, and equipment or supplies you have at home or school.	 THINK ABOUT IT What resources are available through your school, home, and community? Who can you call on for support?
Team Roles	
List the tasks and responsibilities needed to reach your goals. Think about the strengths and interests of each member of your team and start dividing up the roles so everyone has an idea of what job(s) they will be doing.	 THINK ABOUT IT What does each team member like to of What skills do team members have? Will everyone work on all deliverables, or will you divide them up? Either way, be clear about who will do what tasks.
Assumptions	
List the things you believe to be true about your Future City project.	 THINK ABOUT IT How much time might you need for planning? Will materials be easy or difficult to find the project seem most challenging?





INSTRUCTIONS

In Part 2 of your Project Plan, you will make a schedule to keep your team on track as you complete each deliverable. Once your schedule is set, you can finalize each team member's roles to be sure everyone has a job and knows what they need to do.

To create your schedule, you will identify what needs to be done and in what order. Follow the process outlined below or use your own.

Step 1: Establish Milestones & Tasks

Begin by brainstorming the milestones and tasks for each deliverable. Write the milestones and tasks for each deliverable on index cards or in a shared spreadsheet. This will allow you to move them around later. (Use the template below as a guide or create your own.) If you're working remotely, your team may choose to do this using a shared Google spreadsheet or similar virtual option.

- **Milestones** are important points in the project's timeline that help you determine whether your project is on schedule. Milestones are written as statements of what has been, or what needs to be accomplished.
- **Tasks** are the "to do" items you need to complete to accomplish each milestone.

Think About It

What tasks support each milestone?

For example, one milestone for the City Model is to complete the moving part. Tasks for this milestone could include researching ideas, collecting materials, designing and building the part, and recording the moving part in action.

TIP: COLOR CODE DELIVERABLES

Choose a different color sticky note, index card, or highlight color to represent each deliverable. That way you can see the tasks for each deliverable and how the deliverables work together.

Appendix: Deliverables Project Plan

Step 2: Put Tasks in Order

Now it's time to think about the order in which things should be done. Arrange the tasks for each deliverable in a logical order.

Think About It

Does one task need to be completed before another one can begin? For example, before you start building your model or model segments, your team should read the model rubric closely.

Step 3: Estimate the Time Each Task Will Take

Think about how much time tasks will take and record the time on your team schedule. Remember that as you work, you'll probably need to update these time estimates.

Step 4: Confirm Role Assignments

Next, confirm who will get the work done. Look at the roles your team brainstormed in Part 1 of the Project Plan, then assign team members to each role. Record their names as the schedule begins to form.

Think About It

- What are the interests and skills of each team member?
- How will you divide the work?
- Is work being distributed fairly among team members?

Step 5: Maintain the Schedule

On a bulletin board, whiteboard, shared online spreadsheet (or any other format you like), create a full schedule on which you can track the tasks. Things will likely change along the way—be sure to review and revise your schedule as needed.

Show Us Your Style!

An image of your schedule is a required part of your Project Plan deliverable. What does your schedule look like? Is it a large wall calendar, shared online calendar, or something else?





Appendix: Deliverables Project Plan

PROJECT PLAN DELIVERABLE 2 SCHEDULE



Appendix: Deliverables Project Plan FUTURE CITY TEAM NAME:

ORGANIZATION/SCHOOL:

EDUCATOR:

Instructions: In the space below, insert a photo, drawing, screenshot, or other representation that captures how your team scheduled your project.

TEAM SCHEDULE



PROJECT PLAN 3 CHECK-IN

INSTRUCTIONS

In Part 3 of your Project Plan, the teammates and educator hold check-ins to monitor progress and ensure deadlines are being met. Most of these check-ins can be quick conversations. But at least one of them needs to be written down as part of your Project Plan deliverable. Part 3 of your Project Plan is where you put this written check-in.

You can also save copies of the Check-In Report template (on the next page) and use it to update all project stakeholders (team members, educator, mentor) on the status of your Future City project regularly. Especially if your team is working remotely, regular check-ins and use of the template are great for helping everyone stay on track.

Tips

BEFORE EACH CHECK-IN:

• Review your schedule and the requirements for each deliverable.

AFTER EACH CHECK-IN:

• Make changes to your schedule as needed.

Show Us Your Style!

One Check-in Report is part of your Project Plan deliverable.

Submit one report that illustrates an important point in your project, such as when you solved a problem, made a critical revision, or reached a major milestone. You only need to turn in one Check-In Report, but you may want to use the template regularly with team members throughout the project.



Appendix: Deliverables Project Plan







Appendix: Deliverables Project Plan

FUTURE CITY TEAM NAME:

ORGANIZATION/SCHOOL:

EDUCATOR:

TEAM CHECK-IN REPORT

Date: _____

Team Member(s): _____

What have you completed recently?	
What are you working on now?	
When do you think the current task will be done?	
What do you need to keep your work on track?	
Beyond the task(s) you're working on now, are you on track to meet your milestone goals?	



PROJECT PLAN 4

INSTRUCTIONS

Part 4 of your Project Plan is a place to reflect on what you learned from the experience of participating in Future City. Each project teaches us a lot, and your thoughts now can make your next project go more smoothly.

Working as a team, record your responses to the questions on the next page.



TIP: PREPARE FOR THE COMPETITION

Judges might ask questions just like these. Reviewing your project and answering these questions is a great way to prepare for your City Q&A!



Appendix: Deliverables Project Plan





Appendix: Deliverables Project Plan

FUTURE CITY TEAM NAME:

ORGANIZATION/SCHOOL:

EDUCATOR:

TEAM REFLECTION

1. Look back at your original project goals from the Define stage. Did your team fully meet your stated goals for the project? Were there some goals that were met more completely than others?

2. Look back at your original ideas for your city. Did any of the ideas change as you went through the process of creating your final city? Describe one way your city changed and why.

3. Consider your team. How well did your Future City team work together? What do you know now about being part of a team that you didn't know before?

4. What was the most valuable experience you gained from the Future City Competition?

DELIVERABLE #2:

City Essay

58 POINTS DUE: Check date with Regional Coordinator

Students research and write a 1,500-word essay that describes the unique attributes of their city and provides a solution to this year's challenge.

The essay asks students to imagine what it would be like to live in the city they have imagined, at least 100 years in the future. What would they hear, see, smell, and feel? How would the people who live in this future city describe it? How is it different from a city in 2020?

As students draft their City Essay, they explore questions such as these and more to develop their future city. Students will think deeply about their city: its population, infrastructure, culture, unique characteristics, and community needs. In addition, the essay asks students to thoughtfully address this year's challenge: **Living on the Moon**.





Appendix: Deliverables City Essay

Living on the Moon Overview

At night, surrounded by stars or clouds, the Moon looks distant and lifeless. However, it holds a place of unique beauty and dominance in the sky and has inspired humanity for eons. Dreamers of all kindsincluding artists, science fiction writers, scientists, and engineers-have imagined a thriving city on the Moon, one with healthy people and a resourceful, sustainable ecosystem. The challenges of living on the Moon do not daunt them—though those challenges are sizeable! There's no breathable atmosphere. In most places the temperature is either freezing cold or boiling hot. Human bodies weaken with gravity only 1/6 of that on Earth. On much of the Moon, night lasts for 14 days at a time. There are no plants or animals, no flowing water. Tiny meteorites crash into the Moon regularly. Solar radiation is constant and deadly. Dust that's sharp as glass gets into every crevice.

Engineers and scientists are exploring solutions to the obstacles that make living on the Moon sound

far-fetched. Frozen reservoirs of water are believed to exist at the Moon's poles, deep inside craters. This water can be extracted, filtered with algae, and made drinkable. Lunar pioneers can eat the algae as well. They can breathe the oxygen produced during the process of extracting water. There are no trees or building materials as we know them, but regolith lunar dirt and dust—can be heated into a strong, hard material for making buildings and roads. The Moon's lava tubes could offer some protection from meteorites, making these places more inviting for building living quarters, and there is sunlight that can be harnessed for energy. New ideas are constantly being dreamed up and tested. A future lunar city is really going to happen!

The students' challenge: Design a future lunar city and provide examples of how your city uses two Moon resources to keep your residents safe and healthy.

Future City's Living on the Moon challenge is generously supported by a grant from NASA for the New Worlds Await You STEM program.



Appendix: Deliverables City Essay

City Essay Requirements

- The team's future lunar city is set at least 100 years in the future. It has already gone through many years of development. It started as a collection of lunar landers that expanded into an outpost. Gradually it grew into a village and is now a city. The students' job is to build on this history, describing the complete city that is there.
- In their essay, students will present their future lunar city, describe its location, share its innovative features, and provide a detailed description of how the city uses two of the Moon's resources in futuristic ways to keep their residents safe and healthy.
- The essay cannot exceed 1,500 words and should be free of grammatical and spelling errors.
- The essay can include a maximum of four graphics.
- The essay must cite at least three sources of information used during the idea development process. MLA style is preferred; download guidelines from futurecity. org/resources (filter for Handbook & Student Handouts.)
- Students should use a variety of sources of information, such as interviews with experts, reference books, periodicals, and websites. (Note: Wikipedia is not accepted as a source for citations.)
- The essay must be submitted as a Word document via the Online Portal at futurecity.org. Check with your Regional Coordinator for the deadline.

City Essay Resources

Use these resources to help your students develop their essay. The first four items in this list are in the Appendix: Deliverables City Essay starting on page 55. They can also be downloaded at futurecity.org/resources (filter for Handbook & Student Handouts).

- Living on the Moon Overview and Research Questions student handout: This resource provides background information on the Moon and guiding questions for student research.
- Living on the Moon: Questions to Consider student handout: These guiding questions will help students remember to research all the different aspects of their future city.
- Living on the Moon Real World Case Studies student handout: Students will find these real-life examples of lunar technological advances both inspiring and instructive.

- City Essay Suggested Outline: This outline explains what students should include in each section of their essay and how to organize their essay.
- Living on the Moon Resources: Start your team's research with this preselected set of websites, books, and videos. Download the list at futurecity.org/resources (filter for Research Resources & Websites).
- **City Essay Rubric:** Review this rubric with students so they understand how their essays will be evaluated. See page 62 or futurecity.org/resources (filter for Rules & Rubrics).
- City Essays from past Finals Winners: Analyzing essays from prior years will give students a strong sense of what they are aiming for in their own essays. Go to futurecity.org/gallery.
- **Research cards** help students track and organize the information they want to use in their essays. Go to futurecity.org/resources (filter for Research Resources & Websites).
- Final competition checklists: see page 80.

Competition Scoring

Teams can earn up to 58 points for their City Essay. Make sure they have thoroughly covered these categories in the rubric to maximize points:

Total	58 points
Writing Skills	6 points
Judge Assessment	12 points
Using Moon Resources	16 points
Introduce City & Define Problem	24 points

Scoring Deductions

5–10 points	Late submissions may be accepted with
	a penalty. Check with your Regional
	Coordinator before the deadline to find out
	if this is an option in your region.
10 points	Be sure to check your word count and do
	not exceed the 1,500-word limit.



Living on the Moon: Overview and Research Questions

Living on the Moon Overview

At night, surrounded by stars or clouds, the Moon looks distant and lifeless. However, it holds a place of unique beauty and dominance in the sky and has been inspiring humanity for eons. Dreamers of all kinds-including artists, science fiction writers, scientists, and engineershave imagined a thriving city on the Moon, one with healthy people and a resourceful, sustainable ecosystem. The challenges of living on the Moon do not daunt them—though those challenges are sizeable! There's no breathable atmosphere. In most places the temperature is either freezing cold or boiling hot. Human bodies weaken with gravity only 1/6 of that on Earth. On much of the Moon, night lasts for 14 days at a time. There are no plants or animals, no flowing water. Tiny meteorites crash into the Moon regularly. Solar radiation is constant and deadly. Dust that's sharp as glass gets into every crevice.

Engineers and scientists are exploring solutions to the obstacles that make living on the Moon sound far-fetched. Frozen reservoirs of water are believed to exist at the Moon's poles, deep inside craters. This water can be extracted, filtered with algae, and made drinkable. Lunar pioneers can eat the algae as well. They can breathe the oxygen produced during the process of extracting water. There are no trees or building materials as we know them, but regolith—lunar dirt and dust—can be heated into a strong, hard material for making buildings and roads. The Moon's lava tubes could offer some protection from meteorites, making these places more inviting for building living quarters, and there is sunlight that can be harnessed for energy. New ideas are constantly being dreamed up and tested. A future lunar city is really going to happen!

The students' challenge: Design a future lunar city and provide examples of how your city uses two Moon resources to keep your residents safe and healthy.

Research Questions

Life on the Moon will be quite different from life on Earth. It's literally another world! Before you begin to design your city, you'll start your research by learning about the Moon: its features, terrain, available resources, and unique hazards.

Lunar Features and Terrain

The Moon is 238,900 miles away from Earth. While we can only see one side of the Moon here on Earth, there is a lot more to explore.

- Does the Moon have an atmosphere? Is there oxygen or a way to make it?
- What is the Moon's surface gravity? How does that compare to Earth's? How will the Moon's surface gravity affect humans living on the Moon?
- What are days and nights like on the Moon? How long is an average "day" in most places?
- Are there areas of the Moon that get more sunlight than others?
- What is the temperature on the Moon? What affects the Moon's temperature? Are there places where the temperature is more stable than other areas?
- Terrain is a term for the natural features of the land. What types of terrain are found on the Moon?
- Like Earth, the Moon has an equator and a north and south pole, it also has different types of regions. What are the Moon's regions? Where are they? How do they differ from each other in terms of temperature, amount of sunlight, and terrain?
- Does the Moon have a magnetic field? How would a magnetic field, or the lack of one, affect people's lives?





Appendix: Deliverables City Essay

Lunar Resources

Conditions may be challenging on the Moon, but certain abundant resources could make living there sustainable. And some might be valuable resources back on Earth! Below are a few resources to explore, but it is not a full list. What other resources does the Moon contain? As you research these resources ask how your future city's residents might use these lunar resources.

- **Sunlight** is strong and predictable on the Moon as there are no clouds to get in the way.
- Water can be found as ice in deep craters near the Moon's poles.
- **Key Elements** including oxygen, silicon, aluminum, iron, calcium, magnesium, hydrogen, and titanium are found in the surface layer of lunar dust, soil, and broken rock.
- **Geographic Features** such as lava tubes or craters might make good building locations.
- Helium 3 is an isotope that some people think might be a good energy source.
- Rare Earth Elements (REE) may be used to manufacture many types of electronics.



Lunar Hazards

Moon dwellers will face serious hazards that we don't have on Earth and that our cities aren't built to withstand. Everything must be engineered to protect people from these hazards and that means thinking in a whole new way about how a city is planned and built.

- Lunar dust is mostly made of silicon dioxide glass with some particles of iron, calcium, and magnesium, that has been ground into a very fine powder over billions of years of being smashed by meteorites. How is lunar dust dangerous to humans?
- **Radiation** is energy that travels through space; solar radiation is energy emitted by the sun that travels to the Moon as well as Earth. Without a magnetosphere and with little atmosphere, the Moon offers no protection against solar radiation. Moon dwellers will have to be protected from solar flares and cosmic rays, two especially dangerous forms of radiation. Why is this radiation a hazard to your lunar residents?
- A meteorite is an object in space that hurtles into the surface of the Moon, Earth, or other planets. It can be as tiny as a grain of dust or it can be a massive rock weighing many tons. The Moon is bombarded by meteorites because it does not have the atmosphere to break them up before they hit the surface. Meteor strikes can create explosions of energy, as well as damaging micro impacts. What might protect people in a lunar city from meteor strikes?
- **Moonquakes** are known to rock the Moon. Tides, vibrations from meteorites smashing into the surface, and thermal quakes from the Moon's crust expanding in the morning sun are all pretty mild and harmless. A fourth kind, shallow moonquakes, can register 5.5 on the Richter scale and last for more than 10 minutes. What are the implications of these various moonquakes for a lunar city?



Living on the Moon: Questions to Consider

Your future lunar city is set at least 100 years in the future. It has already gone through many years of development. It started as a collection of lunar landers that expanded into an outpost. Gradually it grew into a village and is now a fully functioning city.

Your challenge: Build on this history to develop a future lunar city. You will describe where your city is located on the Moon, share its innovative features, and provide a detailed description of how your city uses two of the Moon's resources in futuristic ways to keep its residents safe and healthy.

Use the topics and questions below to guide your research, brainstorming, and design sessions. Remember that no city can provide everything—especially one on the Moon! What are the most important elements in your future lunar city? What makes your city futuristic, innovative, and scientifically plausible? What tradeoffs do you need to make?

City Location

The conditions and geography of the Moon are very different than on Earth. From your research, you learned that the Moon is covered in regolith, the terrain is full of huge craters, there are lunar highlands that look like old, eroded mountains, and the poles have ice hidden deep inside huge craters. The near side of the Moon always faces the Earth, while the far side always faces away from the Earth. As you think about the Moon, discuss where you'd like to locate your city.

- What areas of the Moon are possible locations?
- What are the benefits of these different locations? What are the drawbacks?
- How do the natural features of each potential area impact your city and its residents (for example, mountains, craters, access to water, sunlight)?

Livable Atmosphere

The Moon has no breathable atmosphere and no plants. All it has is an exosphere, which is not that much more than the vacuum of space. It has some molecules of different gases floating around in it, along with Moon dust that is gritty and clings to everything. To survive and thrive, people will need breathable air at the right pressure. Remember the Moon's low gravity means there is less pressure than on Earth.

- How do you supply breathable air at the right pressure?
- How do you maintain comfortable humidity and temperature?
- How do you replenish oxygen and process excess carbon dioxide so that the air stays breathable?
- How do you filter contaminants out of the air?

Water

At first, scientists thought there was no water on the Moon, but recently they discovered that it exists frozen deep within craters at the poles. This water has to be mined, the way we mine for precious metals and oil on Earth. Small amounts of water are also embedded in lunar soil. Your residents will need water for drinking, bathing, and growing crops. It can also be used to make fuel, especially rocket propellant.

- How does your city harvest water and make it drinkable?
- How does your city supply water? Is there a water recycling system?
- What are the ways water is used in your lunar city? Are there uses that won't be allowed because it's a limited resource?

Energy

Energy will be essential to sustaining life on the Moon. Your residents will need it to harvest water and breathable air, grow crops, stay warm and cool during the Moon's temperature swings, move people and goods around, and travel back to Earth or onward to Mars.

- What energy source(s) does your lunar city use? Is wind a source of energy on the Moon? What about nuclear fusion or fission? Solar energy from light and/or heat?
- What are some ways that energy could be stored and released during the lunar night, when residents need to be kept warm?
- What hazards threaten your city's energy supplies?



Appendix:

Deliverables City Essay



Appendix: Deliverables City Essay

Industry & Manufacturing

Thanks to certain abundant resources, there are great mining and manufacturing opportunities on the Moon. For example, water extracted from lunar craters and regolith can be processed into hydrogen and oxygen—two key elements for rocket propellant. Other elements could be used to make electronics and batteries.

- What resources does your city mine or produce?
- How are these different resources being used in your future city? Is there a Moon resource you use to produce breathable air? To build structures? To grow crops?
- What methods are being used to extract and mine these resources?
- Does your lunar city trade any resources with Earth?

Structures and Housing

On the Moon, buildings will need to protect people from the Moon's many hazards—such as lunar dust, radiation, meteorites, and moonquakes—while also providing breathable air and pressure.

- What Moon resources do you use as building materials? How might these materials affect a building's design?
- How might buildings take advantage of the Moon's terrain?
- Where do your residents live? Individual houses, apartments, or a new configuration? How do your home designs create comfortable places for people to sleep, eat, relax, and exercise?
- How do your city's buildings protect against the Moon's harsh conditions and hazards?

Food

On the Moon, special systems will be needed to grow crops. There are no pastures for farm animals or oceans for seafood. What do your residents eat?

- What crops can you grow and/or farm successfully in small spaces with low gravity? Are some growing methods more efficient on the Moon than others?
- What high-value, nutritious food do you produce?
- How do you provide crops light, water, and humidity?

Transportation

Transportation options need to be designed with the Moon's limits and resources in mind. Traditional Earthbased options like biking, walking, and driving cars will be challenging.

- How do your residents travel around your future city? Is there more than one way to get around?
- What lunar resources are used in your transportation system?
- How do your residents travel back and forth to Earth, Mars, and beyond?

Government, Zoning, & Services

On the Moon, there will need to be ways to govern the people. This includes making and enforcing laws, settling disputes, and planning city growth.

- How is your city zoned? Are the zones separate or are there mixed-use zones (e.g., commercial and residential or commercial and industrial) in your city?
- How is your city governed? Who makes the laws and regulations?
- How does your city provide basic and emergency services (e.g., education, medical, fire)?
- How does your city provide various utilities (water, sewer, waste management and recycling, electricity, Internet)?
- What Moon hazards are possible disruptions to residents' access to those utilities? What alternatives does your city provide?

People, Health & Education

Think about your city's residents. Are they Moon natives, born on the Moon without ever traveling to Earth? How do the Moon's conditions (e.g., low gravity) and restrictions (e.g. staying indoors or traveling outside with protective gear) affect the community and its people?

- How would you describe the people who live in your city and what they do?
- What does your city offer for entertainment and cultural enrichment?
- What specific activities do people need to engage in to stay healthy on the Moon?
- How are public spaces for recreation incorporated into your city?
- How are people educated in your lunar city?



Living on the Moon: Real-World Case Studies

Lunar Elevator

There are abundant resources on the Moon, but their types are limited and none are organic (carbon-based). So, a lunar city could benefit with supplies from the Earth and there are also some lunar resources or products that could be valuable and useful on Earth. How could we make transport trips between the Earth and Moon without using the massive resources and fuel needed to build, maintain, and fly a fleet of cargo rockets?

Two astronomy students at Columbia University have come up with an idea that is being seriously considered: building a lunar spaceline that is anchored on the Moon and stretches about 200,000 miles until it ends at Earth's orbit. It stays taut from its own weight and because it is pointed towards Earth's gravitational field. By anchoring the spaceline on the Moon, where gravitational force is only 1/6th of Earth's, and by dangling the other end at the edge of Earth's atmosphere, the Earth's gravity is no longer a problem. Not only that, but the Moon always shows the same side to Earth, so the spaceline wouldn't be subjected to the twisting it would have to endure if it were anchored to Earth.

The spaceline would be a cable thinner than a pencil! Supply pods would be flown in a rocket and then transferred to a robotic vehicle that would climb the cable until it reached the Moon. The robotic vehicle would not need any fuel; it would rely on solar power and friction to ascend or descend. A rocket still has to get the supplies to the spaceline, but it would use a fraction of the fuel and resources needed to fly all the way to the Moon. The spaceline could be built and maintained using resources from the Moon. For example, the cable could be made from titanium, which exists in abundance on the Moon. Other materials being considered could also be fabricated from precious metals found on the Moon. Lunar silicon could be refined into semi-conductors that create the solar panels used on the robotic vehicles traveling up and down the spaceline.

The cable elevator design still has some challenges to address, such as how to prevent the cable from breaking or collapsing, which could happen from the many stresses that it would experience. There is also the problem of debris flying around in space that could crash into the cable or the robotic vehicles. Nevertheless, this bold idea has engineers working hard to design a prototype and test its feasibility.



Martian Bricks

Lugging heavy, cumbersome construction materials to the Moon or Mars has proven to be so expensive and difficult that it is not considered an option. It's hard enough just getting astronauts to these places! The alternative is to use the materials that are already there, and that's what scientists and engineers have been figuring out how to do.

Fourteen-year-old Sidor Clare from Utah has made a major contribution to this effort. She and her partner Kassie Holt learned about what the soil on Mars is made out of and replicated it here on Earth. They used a mix called Mars Global Simulant MGS-1 because its chemical and mechanical properties are similar to the soil on Mars. They mixed this simulant with different binders to see which ones held the soil together best and then tested their bricks with equipment at a community college. Of the ones they tried, the soil mixed with polyester resin held together really well. This resin plus Martian soil makes extremely durable bricks—they are even stronger than concrete! "Our resin brick was so strong that we had to move to a concrete crusher to test it," Clare said.





Appendix: Deliverables City Essay

Lunar Greenhouse

We can't plant crops on the Moon like we do on Earth. Soil and pollinators like bees don't exist, the atmosphere and temperatures are unlivable, and the available water is frozen inside craters. If we built regular greenhouses, plants couldn't survive the radiation coming through the glass and the plants would die during the two weeks of darkness every month. But without solving the problem of food—nutritious food that can be grown there, using local resources—there can't be any lunar residents.

Engineers and scientists are devising ways around these obstacles. They gleaned some ideas from The South Pole Growth Chamber. It grows food for researchers in Antarctica, who can be cut off from the rest of the world for up to eight months a year. Lunar scientists repurposed successes in this environment to the much harsher conditions on the Moon. They have constructed prototypes for a lunar greenhouse that would exist underground, protected from solar flares, cosmic rays, and micrometeorites. It is tube-shaped,18 feet long and 8 feet in diameter. These greenhouses can be folded into crates while traveling to the Moon. They'd arrive equipped with seeds that can sprout hydroponically, meaning that they only need water (no soil) in order to grow. Water can be brought from Earth to start the greenhouses, but then provided from frozen lunar deposits as well as water extracted from residents' urine.

Light pipes using fiber-optic cables would channel sunlight from the Moon's surface to the plants. Once the greenhouses are set up, the settlers' own breath would provide the CO2 that the plants need, and settlers could breathe the oxygen that the plants create during the process of photosynthesis. Engineers call these greenhouses bioregenerative life support systems: everything they need will exist within them, and they will create habitats where humans can flourish.

Plastic Refabricator

Waste is a serious problem on Earth. Plastics in particular are a monumental issue because they take up to a thousand years to decompose. Plastic waste would also be a problem on the Moon, unless engineers figure out a way to turn it into a renewable resource for lunar residents.

The Refabricator does this brilliantly. It is part plastics recycler, part 3D printer. It melts plastic waste into a 3D printing filament, which transforms it into new tools for astronauts to use. NASA engineers tested the Refabricator's ability to work on the Moon by simulating microgravity. They found that the objects had similar thickness, strength, and flexibility as objects created on Earth.

In November 2018, the Refabricator was installed on the International Space Station. As Niki Werkheiser, the project manager for NASA's in-space manufacturing arm explains, "The Refabricator is key in demonstrating a sustainable model to fabricate, recycle, and reuse parts and waste materials on extended space exploration missions."



Engineers see other applications for the Refabricator that would help make life on the Moon self-sustaining. For example, it could enable the 3D printing of skin, bone, and body parts to treat injured residents! This technology is already being used here on Earth, in the field of regenerative medicine, to bioprint ligaments and tendons from stem cells.



City Essay: Suggested Outline

Tell your students to ask questions and take notes as you review the competition's suggested essay outline and discuss how they can use it to draft their essay.

Part 1: Locating Your Lunar City

Briefly describe where your city is located on the Moon. Include the geographic features and terrain, the benefits of that location, and the risks and tradeoffs of that location.

Part 2: Living on the Moon

Paint a picture of life in your Future Lunar City. Describe:

- Who lives in your city?
- What is daily life like for your Moon residents?
 - What do they do for fun?
 - Where do they live? What jobs do they have?
- What services does your lunar city provide (for example, healthcare, education, and government)?
- · How do goods and people move around your city?
- What are two innovative and futuristic features of your lunar city?
- What makes life in your lunar city challenging?
- How does your city protect your residents against a specific Moon hazard?

Part 3: Using the Moon's Resources

Pick two different Moon resources. Describe how your lunar city uses these resources to keep its residents safe and healthy. Be sure to:

- Describe each resource, including what form(s) it is found on the Moon.
- Share how your city obtains or collects each resource.
- Describe how the resource is used. Include:
 - The problem or challenge the resource is being used to address. (For example, is it being used to create a breathable atmosphere, protect your residents against a Moon hazard, or create rocket fuel for travel to Earth and back?)
 - How is your city's use of the resource futuristic and innovative? What technology is involved?
 - What are the benefits and tradeoffs of using this resource?
- Explain what types of engineering were involved and what types of engineers or technicians were most helpful.

Conclusion: Thriving on the Moon

Share why people want to live in your city. Summarize what makes it a safe and satisfying place to live.



City Essay Rubric

0	1
Poor	F
Majority of	F
requirements are	l
missing.	r

Fair Fair quality. Fulfills less than 50% of requirements.

2 Satisfactory Average quality. Fulfills at least 75% of requirements.

Good

Above average

quality. Fulfills

at least 85% of

requirements.

3

Excellent Excellent quality. Fulfills all requirements with additional distinctive features.

4

I. Introduce City and Define the Problem (24 Points)	0	1	2	3	4
 City location Geographic features and terrain of chosen location Benefits, risks, and tradeoffs of location 	No description of city.	Underdeveloped description of city.	Clear and developed description of city. Description is clear but general and lacks required details.	Clearly developed description of city.	Description is clear and thorough and supported with detailed information.
 2. Lunar life Population and description of residents Daily life: recreation, jobs 	No description of population or daily life.	Underdeveloped description of population or daily life.	General description of city population and daily life, but needs additional details.	Clearly developed description of city population and daily life.	Description of both population and daily life are clear and thorough and supported with detailed information.
 3. Infrastructure and features Could include housing, transportation, energy, food, etc. Incorporates advanced technology 	No description of city infrastructure.	Description of one type of city infrastructure. Technology is not advanced.	Clear description of housing and transportation infrastructure. Technology is somewhat advanced.	Clear and thorough description of housing and transportation infrastructure. Technology is advanced.	Clear and thorough description of housing, transportation, and one more type of city infrastructure. Technology is very advanced.
 4. City services Types of city services could include: education, healthcare, fire, etc. 	No description of city services.	Underdeveloped description of one city service.	Clear description of one city service.	Clear and thorough description of more than one city service.	Clear and thorough description of more than two city services.
5. City innovation and futuristic elements	No description of innovations and futuristic elements.	Underdeveloped description. Seems like a random collection of information.	Describes innovations and futuristic elements, but lacks details.	Clearly developed 'description of innovations and futuristic elements.	Description is clear and thorough and supported with detailed information.
 6. Moon challenges and hazards Challenges of lunar living City protection(s) against hazards 	No description.	Underdeveloped description with limited details.	General description with sufficient details.	Clear description with a good level of detail.	Clear and thorough description with extensive details.



DOWNLOAD THIS RUBRIC at futurecity.org/resources (filter for Rules and Rubrics).

Appendix: Deliverables City Essay

City Essay Rubric

0 Poor Majority of requirements are . missing.

1 Fair Fair quality. Fulfills less than 50% of requirements.

2 Satisfactory Average quality. Fulfills at least 75% of requirements.

Above average quality. Fulfills

at least 85% of

requirements.

3

Good

4 Excellent Excellent quality. Fulfills all requirements with additional distinctive features.

II. Using Moon Resources (16 Points)	0	1	2	3	4
 7. Describes two Moon resources and how they are used in the city Form(s) it is found in How city obtains/collects it Problem or challenge each resource addresses 	No description of Moon resources.	Underdeveloped description of at least one Moon resource with limited details.	General description of two Moon resources with sufficient details.	Clear description of two Moon resources with a good level of detail.	Clear and thorough description of two Moon resources with extensive details.
 8. Describes how the city's use of the two resources is futuristic and innovative Incorporates advanced technology 	No description.	Underdeveloped description of at least one innovative or futuristic use. Technology is not advanced.	General description of innovative and futuristic uses of two resources. Technology is somewhat advanced.	Clear description of innovative and futuristic uses of two resources. Technology is advanced.	Clear and thorough description of innovative and futuristic uses of two resources. Technology is very advanced.
 9. Risks, tradeoffs & compromises related to chosen Moon resources Benefits, risks Tradeoffs & compromises 	No discussion.	Underdeveloped description of at least one benefit, risk, or tradeoff.	General description of two benefits, risks, or tradeoffs.	Clear description of two or more benefits, risks, or tradeoffs.	Clear and thorough description of two or more benefits, risks, or tradeoffs.
10. Engineering disciplines involved and roles of engineers	No description.	Underdeveloped description of one engineering discipline or role of one engineer.	General description of more than one engineering discipline and/or role of engineers.	Clear description of at least two engineering disciplines and roles of the engineers.	Clear and thorough description of more than two engineering disciplines and roles of the engineers.
III. Judge Assessment (12 Points)	0	1	2	3	4
 Effectiveness of protections for living on the Moon Proposed solutions provide adequate protection for residents' health and safety 	Not effective.	Protections need improvement. Questionable ability to ensure resident safety and health.	Protections are somewhat effective but many questions remain about ability to ensure resident safety and health.	Protections are adequate but some questions remain about ability to ensure resident safety and health.	Protections are effective and ability to ensure resident safety and health is addressed.
 12. Innovative and futuristic solutions Reasonable extrapolation and application of technology Degree to which solution involves engineering 	Not innovative or original.	Somewhat original or innovative. Not futuristic. Little engineering involved.	Solution is moderately innovative, original or futuristic. Some engineering involved.	Solution is innovative and futuristic. Considerable engineering involved.	Solution is highly innovative, original and futuristic. Extensive engineering involved.

Appendix: Deliverables City Essay

CONTINUED ON NEXT PAGE



Appendix: Deliverables City Essay

City Essay Rubric

0	
Poo	or
Ma	jority of
req	uirements are
mis	sing.

1 Fair Fair quality. Fulfills less than 50% of requirements.

2 Satisfactory Average quality. Fulfills at least 75% of requirements.

Good

3

Above average quality. Fulfills at least 85% of requirements.

4 Excellent Excellent quality. Fulfills all requirements with additional distinctive features.

III. Judge Assessment (12 Points) (Continued)	0	1	2	3	4
 13. Risks, tradeoffs, & compromises Accounting for risks, benefits Assessing consequences and making logical decisions 	Does not explore.	Some consideration, but major issues are ignored.	Adequate assessment of risks, tradeoffs, and compromises. Analysis could be improved.	Good analysis of risk, tradeoffs, and compromises in decision-making process.	Excellent assessment of risk, tradeoffs, and compromises in decision-making process.
IV. Writing Skills (6 Points)	0	1	2	3	4
14. Organization & Writing	No clear structure. Simplistic skills and style.	Organization mostly makes sense but could be better. Good skills and style.	Essay has a logical order and details are presented effectively. Excellent skills and style.		
15. Grammar & Spelling	Many spelling and grammatical errors.	Some spelling and grammatical errors.	Minimal grammatical and spelling errors.		
 16. Graphics, References, & Word Count If used, maximum of 4 graphics/ illustrations (does not include tables) At least three acceptable references. (Wikipedia is not an acceptable reference.) All words except the title and reference list are included in the word count. Word count includes captions and words in graphics, illustrations, and tables. 	No references and/or no word count and/or exceeds allowed graphics/ illustrations.	Fewer than three acceptable references and/ or inaccurate word count.	At least three acceptable references. Accurate word count at end of document. Does not exceed maximum of 4 graphics or illustrations.		

DELIVERABLE #3: City Model

65 POINTS DUE: BEFORE REGIONAL COMPETITION

Students build a physical representation of their city using recycled materials. In addition to showcasing their city of the future, the City Model must also show the team's solution to this year's challenge. The model must have at least one moving part, be built to scale, and may not exceed the \$100 expense budget.

Explain to your team that engineers, architects, scientists, and city planners all use models and visuals like slideshows to communicate their ideas, share their research, and predict the success of their design. Emphasize that the ideas represented in the City Model should be in alignment with their City Essay.

New format for 2020-2021: To accommodate both in-person and virtual learning environments, there are two model building options for the 2020-2021 competition. Both options will be submitted via a slideshow format prior to the Regional Competition.

- **Option 1:** Your team can choose to build one single model.
- Option 2: Your team can choose to build multiple model segments. These model segments are separate pieces that represent various sections of the city. Model segments do not need to fit together physically.

After constructing the model or model segments, each team will complete a slideshow (using the provided template) that showcases their city via photos, a link to a short video of the moving part, and brief descriptions of their work. Slideshows will be scored by judges using the rubric on page 69.

City Model Requirements

• Model Segments:

- Teams may create as many model segments as they want, though there is a limit of 19 photos in the slideshow. Be sure to review the slideshow template and rubric before beginning to plan your model or model segments.
- Segments do not need to fit together to form a single, physical model.
- Scale: Each model segment must be consistent with its scale. However, different segments (even among the same team) may use different scales. For example, if your team creates three model segments, each can have a separate scale (total of three), but each segment should be consistent in its scale.

• Moving Part:

- Each model must include at least one moving part. Each model segment does not need its own moving part, but at least one is required per team.
- Moving Part:
- Each team will record a short video (no longer than 1 minute) demonstrating their moving part in action, describing the role it plays in the city, and explaining how the team designed and built it.
- Teams will include a link to their video within their slideshow (instructions are included in the template). Teams may use any video platform that is publicly accessible (e.g. YouTube).
- Be sure to mention the name of your team/city in your video.
- Slideshow:
 - Each team will submit one slideshow. They can use photos from any model segments made by their team.
 - Teams will use the provided slideshow template, available at futurecity.org/resources (filter for Competition Forms & Project Plan).
 - No slides may be added or deleted. Text in purple should be deleted before submission. Text in black should be left on the slides.
 - Teams may not change the text box sizes in the slideshow template. All descriptions must fit within the box.
 - The font size cannot be smaller than 14 and must be Calibri (or an equivalent) font.
 - The model slideshow must be saved as a PDF and submitted in the Online Portal at FutureCity.org.
- Budget:
 - The combined value of materials used in the City Model, City Presentation, City Q&A, and special award presentations may not exceed \$100.
 - Expenses must be reported using the Competition Expense Form.
- General:
 - Use of live animals, perishable items, or hazardous items (e.g., dry ice, fire, flying objects) is not allowed.
 - While a small number of individual pieces from previous competition models may be reused, models must be a new representation of a future city and built from the bare baseboards up.



Appendix:

Deliverables City Model Appendix: Deliverables City Model There are no size restrictions on the model or model segments this year. But this does not mean that a larger model is better. Be sure to review the rubric and the slideshow template before starting.

City Model Resources

Use these resources to help students create their model/ model segments and then complete the model slideshow template.

- Living on the Moon: Questions to Consider student handout: This handout helps students focus as they design their cities. See page 57.
- **Build Your City Model student handout:** Practical tips for building city models. See page 67.
- Example Model Slideshow: See what a slideshow could look like after the template is completed. Available at futurecity.org/resources (filter for Competition Forms & Project Plan).
- **Model-building activities:** Give students plenty of practice by having them do these activities: What is a Model, Plan-Relief and Architectural Models, and Building Strong, all at futurecity.org/resources (filter for Activities & Background Info).
- Build Scale Models: Students also need practice working with scale. These activities will build students' understanding: Introduction to Scale; Plan and Elevation View; Proportions, Ratios, and Scale Drawings; and Scale Map are all at futurecity.org/resources (filter for Webinars & Videos).
- **City Model Rubric:** Remind students to check their model against the criteria that the judges will use to evaluate their work. See page 69 or futurecity.org/resources (filter for Rules & Rubrics).
- Examples of other City Models: Seeing previous examples can give students a lot of ideas. Check them out at futurecity.org/gallery. Keep in mind that this year the deliverable is different than it has been in the past, but teams can get inspiration from previous models.

Collect or Find Recycled Materials

Remind students that they only have a \$100 budget and need to think creatively about their building and presentation materials.

- Yard sales or your own family's garage/basement are excellent sources for things like bottles, tins, or buttons.
- Old toys, such as Lego pieces, gears, Tinker Toys, and blocks are great materials.
- Keep an eye out for discarded pieces of pipe, wire, and wood.
- Old parts from stoves, cabinets, and plumbing fixtures may be sources for moving parts or may provide unusual shapes for buildings.
- Obsolete or outdated electronic equipment may be reused and can provide visual interest in your city.

Note: All of these items have value and need to be listed on the Competition Expense Form.

HELPFUL HINTS:

• Though not required, the team may want to include labels within their city as they build the model. Such labels can help judges clearly identify buildings, transportation systems, and other features in your model.

Competition Scoring

Teams can earn up to 65 points for their City Model. Make sure students have thoroughly covered these categories in the rubric to maximize points:

Total	65 points
Judge Assessment of Model	15 points
Build It: Quality, Scale, & Materials	20 points
City Design	30 points

Scoring Deductions

5 points	Missing identification information on slide 1
15 points	Exceeding 25 slides
15 points	Changing text box size or including written
	content outside of approved text boxes
15 points	Exceeding the \$100 budget
15 points	Missing, incomplete, or inaccurate
	Competition Expense Form (including receipts)





Build Your City Model

Questions to Consider

- Will your team create a single model or multiple segments?
- Will your team work together in person or remotely? How will you divide up responsibilities?
- What recycled materials could you use? How could you use them in creative ways?
- What scale works best for your model? (Remember: scale has to be consistent throughout each single segment, but different segments can use different scales.)
- · How are your different city zones visually distinctive?
- Think about your city's infrastructure. Where are the energy production facilities? What does your city's transportation system look like? How do the realities of living on the Moon influence your infrastructure choices?
- What are some of the services in your city? How will you represent them in the model?
- How will you incorporate the Living on the Moon challenge?
- How does your city obtain/collect and process/manufacture your chosen Moon resources? How are they used? How will you represent this in your model?
- How can you make your model look as realistic as possible?
- What will the moving part do? How is it related to an aspect of your city's design or function?
- How will the moving part be powered?
- What makes your city innovative and futuristic? How can you show your futuristic ideas are based on real science and engineering?
- How can the engineering design process help you build your model?

Tips for Creating the City Model and Slideshow

- Look at the Example Slideshow at futurecity.org/resources (filter for Competition Forms & Project Plan). This will give your team a clear sense of what the finished deliverable will look like when you are done.
- Check out the Gallery at futurecity.org/gallery to see models from past competitions for inspiration. Although the presentation format of the model is different this year, teams can still get construction and material insights from the Gallery.
- Remember to choose a scale (or multiple scales) that works best for your city design and the materials your team has available. If one model segment builder has large materials to work with, he might choose a scale that shows off a larger physical area of the city. If another builder has smaller materials, she might choose a different scale for her segment to show more detail.
- Remember that each team needs to include a moving part (which can be on any model segment). Designing your own moving part, or creatively modifying an existing item, will earn more points than using a prefabricated or purchased item. The moving part is an excellent opportunity to explore the physics of simple sources of power, such as rubber bands, weights, heat, springs, pulleys, simple circuitry, light, and/or solar power.
- Your team will film a short video demonstration (no longer than 1 minute) of the moving part. Describe the role it plays in the city and explain how the team designed and built it. The team will post their video on a publicly accessible platform (like YouTube) and include a link to it in their slideshow.

Rather than presenting an entire model, you will highlight specific elements of your city design. Review the model requirements, slideshow template, and rubric before beginning.





Appendix: Deliverables City Model

SCALE MEASUREMENTS

Consider a scale that works for both large items, such as buildings, as well as smaller items, such as windows and traffic signs. These measurements below can be used as a general guide for scaling basic city features. Research dimensions for other features that you plan to include in the model.

- 12 feet Width of traffic lane
- 8 feet Height of stop sign
- 10 feet Height of a building story
- 4 feet Minimum width of residential sidewalk

Model Enhancement Ideas

- **Trees:** These can be made from twigs and sticks with cotton balls (can be painted green), lichen from a hobby store, dried flowers or weeds, or sponges with food coloring.
- **People:** These can be made from sticks, toothpicks, mat board, pins, dowels, pipe cleaners, and so on.
- Cars: These can be made from layers of mat board or cardboard glued together, toy cars that are the right scale, Styrofoam, and so on.
- Glass: You can use clear plastic dividers, sleeves, or sheets. Remember to put this on last so that it doesn't get scratched.
- Bricks/Pavers: You can use colored paper or other colored material that matches what you want it to look like and then draw on the pattern or you can take white paper or material and color it with markers, crayons, or similar, remembering to show the pattern.
- Asphalt: You can take black paper or color white paper black and then draw on the lane markers with a white and/or yellow colored pencil or crayon and then cut to size.
- **Cement:** You can use gray paper or color white paper and then cut to size.
- Grade changes (like hills or craters): You can use Styrofoam that is cut/shaped to what you want and use layers of cardboard or mat board to form contours or slope the model.

- Water: You can use blue colored paper or color white paper blue. For added affect, you can put clear plastic or plastic wrap (the kind you use for foods) over it.
- Building material look: To make something look realistic, you can draw on joint lines.
- Sand/beach/lunar soil: You can use sandpaper (very fine grit).

MOVING PART MECHANISMS

Your moving part must be able to have the motion repeated and must be related to a function of the city or this year's challenge. Ideas for moving part mechanisms include:

- Rubber bands
 Springs
- Heat
- PulleysBatteries
- Light/SolarWeights
- Simple circuitry

Creatively engineered or innovatively modified moving parts garner more points. For example: a store-bought, electric, handheld fan that is glued to a model is technically a moving part, but it will not receive as many points as a moving part whose team put time, effort, and engineering thought into its construction or development.

0 l F

City Model Rubric	0 No Points Requirements missing.	1 Poor-fair quality. Fulfills at least 20% of require- ments.	2 Fair Fair-average quality. Fulfills at least 50% of requirements.	3 Good Average quality. Fulfills at least 85% of requirements.	4 Very Good Above average quality. Fulfills 95% of requirements.	5 Excellent Excellent quality. Fulfills 100% of requirements with additional distinctive features.
I. City Design (30 Points)	0	1	2	3	4	5
 City zoning Includes the three primary zones: residential, commercial, and industrial 	No evidence of zoning. No variety of structures.	Zoning unclear. Little variety of structures. Only one type of zone presented.	Somewhat clear zones. Small variety of structures. Only two types of zones presented.	Fairly clear zones, some variety of structures. At least three zones.	Clear zones and some variety of structures. Could be more comprehensive. At least three zones.	Clear and thorough zones. Excellent variety of recognizable structures. At least three zones.
 2. City infrastructure Could include water, power, utilities, etc. Relevant to the challenges of living on the Moon 	No infra- structure examples.	Poor examples. Unrelated to living on the Moon.	Some examples. Does not address needs of living on the Moon.	Fairly clear examples. Not strongly related to living on the Moon.	Clear examples. Related to living on the Moon.	Clear and thorough examples. Related to the challenges of living on the Moon.
 3. City services Could include healthcare, education, etc. Essential to city operations 	No city service examples.	Poor examples of services. Unrelated to city operations.	Some examples of services. Barely related to city operations.	Fairly clear examples of services. Slightly related to city operations.	Clear examples of services. Moderately related to city operations.	Clear and thorough examples of services. Essential to city operations.
 4. Transportation system Variety of transportation modes Transportation system(s) addresses the needs of the city and its residents 	No trans- portation system.	Poor description of one mode of transportation. Does not address the transportation needs of the city.	Fair description of one or two modes. Overall system does not meet the needs of city.	Good description of one or two modes of transportation. Overall system meets most needs of the city.	Very good description of at least two modes of transportation System addresses needs of city and its residents but could be more thorough.	Excellent description of two or more modes of transportation. System fully and thoroughly addresses needs of city and its residents.
 5. Living on the Moon: Example 1 Shows how city uses a Moon resource to keep residents safe and healthy 	No descrip- tion of the first Moon resource and its use in the city.	Poor description of the first Moon resource and its use in the city.	Fair description of the first Moon resource and its use in the city.	Good description of the first Moon resource and its use in the city.	Clear description of the first Moon resource and its use in the city, including how it keeps residents safe and healthy.	Clear and thorough description of the first Moon resource and its use in the city, including how it keeps residents safe and healthy.

CONTINUED ON NEXT PAGE



DOWNLOAD THIS RUBRIC at futurecity.org/resources (filter for Rules and Rubrics).



Appendix: Deliverables City Model

City Model Rubric	0 No Points Requirements missing.	1 Poor Poor–Fair quality. Fulfills at least 20% of requirements.	2 Fair Fair–Average quality. Fulfills at least 50% of requirements.	3 Good Average quality. Fulfills at least 85% of requirements.	4 Very Good Above average quality. Fulfills 95% of requirements.	5 Excellent Excellent quality. Fulfills 100% of requirements. Additional distinctive features.
 6. Living on the Moon: Example 2 Shows how city uses a Moon resource to keep residents safe and healthy 	No de- scription of the second Moon resource and its use in the city.	Poor description of the second Moon resource and its use in the city.	Fair description of the second Moon resource and its use in the city.	Good description of the second Moon resource and its use in the city.	Clear description of the second Moon resource and its use in the city, including how it keeps residents safe and healthy.	Clear and thorough description of the second Moon resource and its use in the city, including how it keeps residents safe and healthy.
ll. Build lt: Quality, Scale, & Materials (20 Points)	0	1	2	3	4	5
 7. Innovative construction Variety of materials Imaginative, unusual, or noteworthy materials Creative modifications of recycled materials 	No creativ- ity or inno- vation. No recycled/ repurposed materials.	Very little creativity and modification of materials. Very little variety of materials. Many materials are purchased.	Fairly creative modifications. Some variety of materials, but could be improved. Few recycled/ repurposed materials.	Good creativity shown via modified materials. Good variety of materials. Features recycled/ repurposed materials.	Very good creativity. Very good variety of materials that are creatively modified. Many materials are recycled/ repurposed.	Excellent creativity. Wide variety of materials that are creatively modified. Few purchased items. Most materials are recycled/ repurposed.
 8. Appearance Use of color, graphics, shapes, etc. Realistic elements landscapes/geography Age appropriate for 6th, 7th, 8th grades 	No aes- thetics.	Poor aesthetics.	Fair aesthetics. Age appropriate.	Good aesthetics. Age appropriate.	Very good aesthetics that enhance overall city feel. Age appropriate.	Excellent and realistic aesthetics that enhance the overall city feel. Age appropriate.
 9. Model scale Accurate demonstration of scale 	Scale not provided.	The scale calculations as provided are grossly inaccurate.	Choice of scale is fair. Only minor calculation errors, if any.	Good scale. Calculations are accurate and choice of scale is somewhat reasonable.	Very good scale. Calculations are accurate and examples demonstrate an appropriate scale.	Calculations are flawless and choice of scale is excellent.
 Moving part Related to design or function of city Quality workmanship, durability Description of moving part Successful demonstration of movement 	No moving part.	Moving part cosmetic; not related to city function. No description of how the team built the moving part.	Moving part not relevant to city function. Unclear or confusing description of how the team built the moving part.	Moving part somewhat related to city function. Good description of how the team built the moving part.	Moving part is related to city function. Very good description of how the team built the moving part.	Moving part is essential to city function. Excellent description of how the team built the moving part.

_ _
City Model 0 3 2 5 1 4 **Ruhric No Points** Poor Fair Good Very Good Excellent Requirements Poor-Fair Fair-Average Average quality. Above average Excellent quality. Fulfills at least 85% missing. quality. Fulfills quality. Fulfills guality. Fulfills 95% Fulfills 100% of at least 20% of at least 50% of of requirements. of requirements. requirements. requirements. Additional distinctive requirements. features. **III. Judge Assessment** 0 1 2 3 5 of Model (15 Points) Appendix: Deliverables City Model 11. Overall innovation Underdeveloped Good amount Very innovative No in-Fair innovation Extremely Creatively solves design of city and creativity, of innovation and creative. innovative novative but design of and creativity. Clearly and creative. problems of living on the services or services and Moon systems that city services Moderately developed Thoroughly systems. • Effectively utilizes and systems developed design of city developed lacks innovation. available resources could be design of city services and design of city for city services and improved. services and systems. services and systems systems. systems. 12. Application of No Poor futuristic Fair futuristic Good futuristic Very good Excellent futuristic, advanced futuristic examples. Not examples. examples. futuristic futuristic technologies examples. important to the Somewhat Related to examples. examples. Very important to the Includes futuristic function of the related to function of the Important to the technologies, city. function of the city. function of the function of the components, city. city. city. infrastructure Important to function of • the city Ineffective **13. Model effectiveness** Poor Fair Good Very good Extremely · Functions as standalone represenrepresentation of representation representation representation effective a city. For many representation of city of a city, but of a city. A few representation tation of a of a city, · Function and purpose elements, one however the purpose/ elements not of a future city. city. of model elements and asks, "What is function of some Function and function and obvious. relationship to each this and why is it purpose of purpose of elements not other is evident here?" elements easy many of the evident. Accurate spelling and elements is not to understand. arammar evident.



Appendix: Deliverables City Presentation

City Presentation

DUE: BEFORE REGIONAL COMPETITION

50 POINTS

Students record an up-to-7-minute video presentation that showcases their future city and solutions to the Living on the Moon challenge.

Engineers communicate with a variety of professionals every day. Being able to talk about their ideas clearly and succinctly is an important skill that engineers and technical professionals use throughout their careers. For this deliverable, students develop these communication skills by creating and delivering a recorded video presentation that brings their future city to life and showcases their innovative solutions to this year's Living on the Moon challenge.

City Presentation Requirements

- **Time allowed:** The video presentation can be up to 7 minutes.
- **Presenters:** Three students will represent the team in the video presentation.
- Visual aids and props: The model or model segments should be the primary visual aid in the video. Other visual aids might include posters, graphics, costumes, or photographs of the model. No copyrighted materials (such as music, photos, and videos) may be used. Be sure your chosen visual aids are clear and legible for the online audience.
- **Teamwork:** The three presenters should share equal time during the video and demonstrate similar levels of knowledge of their future city.
- **Scoring:** Scores are based on the quality of presentation content rather than elaborate video production. Review the rubric for guidance.

City Presentation Resources

Use these resources to help students create their video presentations and practice them.

- How to Make a City Presentation Video student handout: on page 73 and at futurecity.org/resources (filter for Handbook & Student Handouts). The ideas in this resource can serve as a starting point for your team to discuss how to format and film the presentation video.
- Past Presentations: Videos from past Champions and Runners-up can be found online at futurecity.org/gallery. While the format of the deliverable is different this year, past presentations can provide ideas and inspiration.
- City Presentation Tips student handout: on page 74 and at futurecity.org/resources (filter for Handbook & Student Handouts).

Competition Scoring

Teams can earn up to 50 points for their City Presentation. Make sure students have thoroughly covered all categories in the rubric to maximize points:

Total	50 points
Engineering and Technology	15 points
Content & Delivery	35 points

Scoring Deductions

15 points Points will be deducted for crude, offensive, or otherwise inappropriate language and behavior.



How to Make a City Presentation Video

Teams will record an (up to) 7-minute video that presents their future city and solutions to the Living on the Moon challenge.

KEEP IN MIND:

- Scores are based on content rather than production. A more expensive or professionally produced video won't earn points based solely on production!
- Review the deliverable requirements and rubric with your team to ensure you meet the content expectations.
- Visual aids such as greenscreens, background images, or slideshow images can be used.
- Only three student presenters can appear in the video.
- Make sure the audio for each presenter is clear and audible.
- Teams can deliver their presentation as if they were in a room with the judges or they may choose a narrative/ sketch structure where they move around, enter and exit the screen, etc.

Example Formats:

This list is not exhaustive. Other formats are allowed as long as they follow all rules and requirements. If you have questions about the City Presentation Video, please check the rules or email Info@FutureCity.org.

EXAMPLE 1 ZOOM, GOOGLE, OR SIMILAR VIDEO CHAT PLATFORM:



If your team is socially distancing, you might choose to record your three presenters during a video chat. Model segments or other visual aids can be held up to the camera by the

presenters.

Don't forget that many platforms have mobile apps. If a presenter doesn't have access to a computer with a webcam, they may be able to record on a cell phone.

EXAMPLE 2 PRESENTERS TOGETHER/ONE CAMERA:



If your three presenters are physically together, you may choose to record them all at once. This can be done with any available tools (cellphone camera, computer webcam, etc.).

EXAMPLE 3 RECORD SEPARATELY:



You may choose to have each presenter film themselves separately, then have a team member edit the segments into one video. Remember that this editing needs to be done by a student member of the

team (not an adult).





City Presentation Tips

This year, presentations will be given via recorded video rather than in person. The presentation will not be followed immediately by Ω &A with the judges – that's a separate deliverable!

Prepare the Presentation:

- Review the How to Make a City Presentation Video student handout on page 73 and online at futurecity.org/ resources (filter for Handbook & Student Handouts).
- Create an outline of the main points your team wants to make. Your City Essay outline is a good starting point. Remember to review the rubric as you design your video presentation.
- Write a script based on your outline. The script is what each member of the team will say during the presentation. It needs to sound natural and not as if you're reading your essay out loud.
- Decide which team presenter will say which part of the script. Write each person's lines on note cards and practice, practice, practice! Get really comfortable with your part so that you don't spend the whole presentation staring at your note cards! They're just there if you forget something.
- Take advantage of moments to be especially creative. In the beginning, you want to grab the attention of your audience. Then enthusiastically share details about your future city and its innovative and futuristic features. At the end, you want to make the audience members wish they could live in your city!
- Use your City Model segments. Point out innovative features and interesting landmarks in your city. You can also use other visual aids during your presentation, such as posters, slides, and props. Review the rules starting on page 81 of the Handbook.
- Dress appropriately for your presentation. You can wear costumes that work with the role that you're playing.

Practice the Presentation:

- Rehearse the presentation until the three presenters feel confident.
- Practice giving your presentation in a virtual environment. You might need to define cues among team members to ensure a smooth recorded video.
- Have friends or family members record your practice and then review it with your team and make adjustments as needed. Reviewers can use the rubric to help give good feedback.
- Take turns being coach and presenter. After each practice presentation, have peer coaches discuss the following:
 - What parts of the presentation were clear and informative?
 - Were there any points they didn't understand?
 - What was one thing they liked about how their peers presented?
 - Did the presenters look into the camera? How were their gestures, tone of voice, and pace of the delivery?
 - How did the presenters use the model and other visual aids?

Record the Presentation:

- Speak clearly and audibly.
- Look into the camera and be confident.
- Share your enthusiasm about your future city and solutions to the Living on the Moon challenge.
- Remember to have fun!



City Presentation **Rubric**

0	1
No Points	Poor
Requirements	Poor-fair
missing.	quality. Fulfills
	at least 20% of
	requirements.

Fair Fair-average quality. Fulfills at least 50% of requirements.

2

3 Good Average quality. Fulfills at least 85% of requirements.

Very Good

4

Excellent Above average Excellent quality. . Fulfills 100% of quality. Fulfills 95% requirements with of requirements. additional distinctive fosturos

5



Appendix: Deliverables City Presentation

						leatures.
I. Content & Delivery (35 Points)	0	1	2	3	4	5
 Overall presentation content Major elements: intro, body, and conclusion Logical flow and transitions Supporting details 	Disorga- nized and no major elements addressed.	Poorly or- ganized and missing major elements. Few supporting details.	Fair organiza- tion. Contains most major elements. Some details and transi- tions but ideas could be more developed.	Contains all major elements and good transitions. Details could be clearer.	Well organized and contains all major elements. Very good support- ing details.	Extremely well organized. Ef- fective variety of supporting details. Overall presentation is thoroughly developed.
 2. Overall presentation delivery Clear and audible Confident and creative Onscreen balance of people and visual aids 	Unclear and inaudible. Delivered with no confidence or creativ- ity.	Not very creative. Needs more practice. Poor balance of student presenters and visual aids.	Somewhat creative. Some presenters lack confi- dence. Poor balance of stu- dent present- ers and visual aids.	Creative but confidence could be improved. Good balance of student presenters and visual aids.	Very creative and confident delivery by most of team. Good balance of student presenters and visual aids.	Extremely cre- ative and con- fident delivery by entire team. Good balance of student present- ers and visual aids.
 3. City overview & daily life Location, terrain, and benefits Description of residents and daily life Recreation Why do people want to live in your city? 	No de- scription.	Underdevel- oped overview does not provide basic information.	Fair overview. Lacks suffi- cient details.	Good overview supported by sufficient details.	Very good overview sup- ported by many details.	Excellent overview sup- ported by a vari- ety of thorough details.
 4. Infrastructure & services Futuristic city features and infrastructure Innovative city services (could include education, healthcare, fire, etc.) 	No de- scription.	Underdevel- oped descrip- tion. Lacks detail about infrastructure and services.	Fair descrip- tion. Some details about infrastructure and ser- vices. Not very futuristic or innovative.	Good descrip- tion. Many details about infrastructure and services. Somewhat futuristic.	Very good de- scription. Many details about infrastructure and services. Futuristic.	Highly detailed and thorough description of infrastructure and services. Very futuristic.
 5 Use of Moon resources How resources are collected How resources are used in the city Problems/challenges they address 	No de- scription.	Briefly men- tions chal- lenges. Does not describe how any Moon resources are used in the city.	Fair expla- nation of challenges and how one Moon resource is used in the city. No real supporting details	Good descrip- tion of chal- lenges and how at least one Moon resource is used in the city. Supporting details could be improved	Very good description of challenges and how two Moon resources are used in the city. Many support- ing details.	Excellent description of challenges and how two Moon resources are used in the city. Variety of thor- ough supporting details



DOWNLOAD THIS RUBRIC at futurecity.org/resources (filter for Rules and Rubrics).

CONTINUED ON NEXT PAGE

Appendix: Deliverables City Presentation

City 2 0 1 3 4 5 Presentation **No Points** Poor Fair Good Very Good Excellent Requirements Poor-fair Fair-average Average quality. Above average Excellent quality. quality. Fulfills quality. Fulfills Fulfills at least 85% Fulfills 100% of missing. quality. Fulfills 95% **Rubric** at least 20% of at least 50% of of requirements. of requirements. requirements with requirements. additional distinctive requirements. features. I. Content & Delivery 0 1 2 3 4 5 (35 Points) (Continued) 6. Use of demonstration Model not Model is not Model is par-Good use of the Model used Extremely creaids referenced. used effectially effective model as an effectively to ative, integrated • Use of model No other tively. Other at enhancing use of model illustration of illustrate city • Additional visual aids (if visual aids. demonstration the presentacity design and design, funccontributed to used) are well-prepared, aids poor or tion. Other function. Other tion and innothe understandlegible, and relevant. nonexistent. visual aids are visual aids are vations. Other ing of city design Enhance rather fair to good. effective and visual aids are and function • than distract from generally add very good and and innovations. enhance the Other visual aids presentation to presentation.

					presentation.	are excellent.
 7. Teamwork Team members supported each other Team members shared time equally 	No evidence of teamwork.	A small amount of collaboration among team members but more support of one another is needed; one or two tend to dominate.	Some collabo- ration, support and sharing among some team mem- bers. Amount of knowledge appears unequal. One or two tend to dominate.	Good col- laboration, support and sharing among most mem- bers. Some have more knowledge and dominate.	Very good collaboration, support and sharing among the team. Equivalent knowledge level for most of team.	Excellent collaboration, support, and sharing among team members. All members display thorough knowledge.
II. Engineering and Technology (15 Points)	0	1	2	3	4	5
 8. Engineering design process Discusses the application of the engineering design process to their project 	No discus- sion.	Little or no discussion of engineering design process.	Underdevel- oped discus- sion of engi- neering design process.	Good dis- cussion of engineering design process and how they applied it.	Very good discussion and understanding of engineering process and application to Future City project.	Excellent discussion and understanding of engineering design process and application to Future City project.
 9. Engineering and roles Demonstrates Anowledge of engineering roles in city design and operation 	No mention of engi- neering roles.	Mentions en- gineering, but little discussion of roles.	Demon- strates limited knowledge and understanding of engineering and roles.	Demonstrates good knowl- edge and understanding of engineering and roles.	Demonstrates very good knowledge and understanding of engineering and roles.	Demonstrates excellent and thorough knowledge and understanding of engineering and roles.
 10. Risks, tradeoffs, & compromises Discusses potential risks and benefits Analyzes tradeoffs 	No mention of risks or tradeoffs.	Little men- tion of risks or benefits. No tradeoffs.	Some discus- sion of risks, benefits or tradeoffs.	Good analysis of risks and benefits. Mentions tradeoffs.	Very good analysis of risks, benefits, and the tradeoffs made.	Excellent and thorough analysis of risks, benefits, and tradeoffs.

DELIVERABLE #5:

City Q&A

25 POINTS DUE: LIVE SESSION SCHEDULED BY REGION

Three students will represent the team during a live 10-minute virtual question and answer session about their future city with judges from engineering and technical fields. Students should strive to demonstrate knowledge and understanding of all aspects of their project. Judging sessions will be scheduled by your local region.

Engineers must understand the projects they are working on and be able to answer questions clearly and concisely. For this deliverable, students develop critical thinking and communication skills by answering questions that demonstrate an understanding of engineering and their future city.

City Q&A Requirements

- Time allowed: Teams will have 10 minutes to answer questions from a panel of judges during the virtual Regional Competitions.
- **Teamwork:** The three student representatives should share time equally and display a similar amount of knowledge and understanding of topics.
- **Team members:** The three representatives may be the same or different students who represented the team in the City Presentation.

City Q&A Resources

Use these resources to help students prepare to answer questions from the judges.

- City Q&A Practice Questions student handout: Students can get a sense of the kinds of questions the judges may ask by practicing with these questions. Available on page 78 and online at futurecity.org/resources (filter for Handbook & Student Handouts). Students should also feel confident answering questions like those found in the Living on the Moon: Questions to Consider student handout, available on page 57 or online at futurecity.org/resources (filter for Handbook & Student Handouts.
- Simulated Q&A sessions: Practice answering questions via a virtual video conferencing platform so the students can figure out how to share time equally and develop a system to answer questions without speaking over each other.

Competition Scoring

Teams can earn up to 25 points for their City Q&A. Make sure students are able to show both knowledge and understanding of the concepts in the rubric in order to maximize points:

Demonstrated Knowledge & 25 points Understanding





City Q&A Practice Questions

During the City Q&A, judges will ask teams a variety of questions like the ones below. Refer to the City Q&A rubric for more information on how teams will be judged.

Engineering & Technology

- Did anything you learned about engineering surprise you?
- What types of engineers were involved in designing your future city on the Moon?
- How did you design and build the moving part for your model?
- How did the engineering design process help you create and develop your future city?
- What is an example of innovative technology in your team's lunar city design?
- What resources did your team use to learn about engineering? Share something your team learned and how you applied it to your project.

Teamwork & Collaboration

- Did your team have any disagreements about your project? How did you solve them?
- What was the most difficult challenge you encountered while building the model segments or creating the video presentation? How did your team overcome this challenge?
- How did you divide responsibilities among your team members?
- Describe the process and schedule that your team used to create your future city.

City Systems & Operations

- What industries drive the economy in your city? What types of jobs are available?
- How does your city support low-income or vulnerable residents?
- What measures does your city take to prevent pollution and ensure sustainability?
- Describe your city's transportation system. Is it public (like today's trains and buses) or private (like an individual car) or a combination?
- What foods do your residents eat and where does the food come from?
- How do residents in your city communicate with each other?
- What does your city offer for entertainment and culture—arts, music, theater, dance, cinema, sports?

City Design

- What factors did you consider while laying out the zones in your city? Are the zones separate or mixed-use?
- Why is it important for a city to have a diverse population of residents?
- How does your city design ensure equal access and opportunity for people with disabilities?
- How does your city support a healthy lifestyle for its residents?

Living on the Moon

- What is something you learned about the Moon? How did you apply it to your future city?
- Where on the Moon is your city located? What are the benefits and drawbacks of your chosen location?
- How will your residential designs create comfortable places for people to sleep, eat, relax, and exercise?
- What two Moon resources did your team choose? How is your city's use of these resources futuristic and innovative?
- How does the city obtain the two resources?
- How does your city protect your citizens against Moon hazards?

Appendix:

Deliverables City Q&A

City Q&A 0 –1 2 3 4 5 **Ruhric** Poor Fair Good Very Good Excellent Poor quality; Poor-fair quality. Fair-average quality. Average quality. Above average Fulfills at least 85% requirements Fulfills at least 20% Fulfills at least 50% quality. Fulfills 95% missing. of requirements. of requirements. of requirements. of requirements. I. Demonstrated 0–1 2 3 4 5 **Knowledge &** Understanding (25 Points) 1. Engineering & Provides little Answers questions Answers questions Answers questions Answers technology or no detail with limited details. adequately but clearly with questions clearly • Demonstrates and shows no Understanding of details could be sufficient details. and thoroughly. understanding of concepts seems to Elaborates understandbetter. Decent Good understanding with related engineering and ing. be lacking. understanding of of concepts. technology concepts. details. Excellent Innovation understanding. Plausible solutions 2. Living on the Moon **Provides little** Answers questions Answers questions Answers questions Answers • Demonstrates or no detail with limited details. adequately but clearly with questions clearly sufficient details. understanding of Moon Understanding of details could be and thoroughly. and shows no issues understandconcepts seems to better. Decent Good understanding Elaborates Innovation . ing. be lacking. understanding of of concepts. with related • Plausible solutions concepts. details. Excellent understanding. 3. Teamwork & **Provides little** Answers questions Answers questions Answers questions Answers Collaboration or no detail with limited details. adequately but clearly with questions clearly • Demonstrates and shows no Understanding of details could be sufficient details. and thoroughly. Elaborates understanding of understandconcepts seems to better. Decent Good understanding with related teamwork be lacking. understanding of of concepts. ing. details. Excellent concepts. understanding. 4. City Design, Systems, & Answers questions **Provides little** Answers questions Answers questions Answers **Operations** or no detail with limited details. adequately but clearly with questions clearly Demonstrates and shows no Understanding of details could be sufficient details. and thoroughly. Good understanding understanding of understandconcepts seems to better. Decent Elaborates components that make a understanding of with related be lacking. of concepts. ing. city livable details. Excellent concepts. understanding. 5. Q&A skills Provides little Some collaboration, Good collaboration, Very good Excellent • Team members or no detail support and sharing support and collaboration, collaboration, displayed similar and shows no among some team sharing among support and support, and amounts of knowledge understandmembers. Amount most members. sharing among the sharing among · Team members shared of knowledge Some team team. Equivalent team members. ing. time equally appears unequal. members have knowledge level for All three team One or two tend to more knowledge most of team. members dominate. and dominate. display thorough knowledge.



DOWNLOAD THIS RUBRIC at futurecity.org/resources (filter for Rules and Rubrics).

Appendix:

Deliverables City Q&A



Final Checklists

These checklists are in order of when deliverables are typically due. Make sure you have the correct deadline from your educator or mentor for each deliverable.

City Essay Checklist

- Include the name of your city on each page of your City Essay. Remember that the name of your future city needs to remain the same throughout the competition.
- Check the word count: 1,500 words is the maximum number allowed. Word count does not include the title and reference list but does include captions and words that appear within a graphic, illustration, or table.
- Count the graphics. A maximum of four graphics/ illustrations are allowed.
- Cite your sources. Use the Modern Language Association (MLA) format.
- Spell check and grammar check your City Essay.
 -] Upload your City Essay as a Word document to the Online Portal at futurecity.org.

City Model Checklist

- Double check your City Model against the Competition Requirements on page 65.
- Your slideshow cannot exceed 25 slides.
- Convert the slideshow to a PDF before uploading.
- Upload the slideshow to the Online Portal at futurecity.org.

City Presentation Checklist

- Make sure your presentation video does not exceed the 7-minute limit.
- Ensure any visual aids in your video are clearly visible to online viewers and that your audio is clear and strong.
- Fill out the Competition Expense Form with all of the materials used to build the model and the materials that appear in the presentation video. Remember that you cannot exceed a combined total of \$100.

Project Plan Checklist

Make sure all four parts of the Project Plan are in one document, then save it as a PDF, and upload to the Online Portal at futurecity.org.

City Q&A

- Review the Practice Questions on page 78.
- Remember to have your model segments accessible– you might use them to illustrate an answer.
- Ensure you know the day and time of your team's live session with the judges.

Competition Forms Checklist

The following forms need to be submitted to the Online Portal at futurecity.org prior to the virtual competition:

Competition Expense Form & receipts

This form and accompanying receipts needs to be submitted to the Online Portal at futurecity.org by the deadline set in your region.

Honor Statement

The Honor Statement must be electronically signed by each student team member and the team educator and mentor prior to the virtual competition. Find the form at futurecity.org/resource/honor-statementform.

Media Waiver

The Media Waiver must be completed and electronically signed by the parent/guardian of every student team member prior to the virtual competition. Find the form at futurecity.org/resource/mediawaiver-form.

Appendix:

Competition Information

Official Competition Rules

General

- The Future City Competition is open to eligible 6th, 7th, and 8th grade students who are enrolled in a public, private, parochial, home school environment, led by a parent whose child is distance learning due to COVID-19, or are members of a nationally, regionally, or state-recognized organization, such as the Scouts, Boys and Girls Clubs, 4-H, etc. If you are unsure if your organization is eligible to participate, please contact info@futurecity.org. Future City has the sole and exclusive authority to determine whether an organization is eligible to participate and has the right to require additional documentation to verify eligibility.
- Student team members must be from the same school or organization, unless otherwise approved by a Regional Coordinator or Future City staff. Students cannot be on multiple teams.
- **3.** Organizations may register in only one region. If they wish to transfer to a different region, they must petition and obtain the approval of the Regional Coordinator and the Program Manager. Teams must commit to a specific region by October 31, 2020.
- 4. As many students may work on the project as you wish, but a limited number may appear in certain deliverables. Three students will represent the team in each of these instances: the City Presentation video, the City Q&A live session, and Special Award judging. These students may be the same or different. The three students who appear in the City Presentation, in addition to one educator and one mentor, constitute the official team of five members. The Educator and Mentor may not participate in the City Q&A, or Special Award judging.
- 5. All 2021 competitions will be virtual. The same three students who participate in the City Q&A at the Regional Competition will participate in the City Q&A at the Finals Competition. At the time of registering your team(s) for the Regional Competition, you may select one student to act as a Q&A alternate for both Regionals and Finals. The alternate may only be utilized if one of the original three Q&A students cannot compete due to illness or family emergency. The alternate may only compete upon the approval of the Regional Coordinator (for the Regional Competition) and the Program Manager (for the Finals Competition).
- **6.** At least 20 schools/organizations must be registered in a region by October 31, 2020 in order for that region's winner to advance to the virtual Finals Competition.
- 7. Home school educators must submit an affidavit to their Regional Coordinator stating that the students are covering material in the 6th, 7th, or 8th grades.
- 8. Deliverable deadlines vary by region. Contact your Regional Coordinator for specific dates. If deadlines are missed at the Regional or Finals level, points will be deducted.

- 9. At regional competitions, only one team from a school or organization can advance to the final round of judging. At competitions with a single judging round, only one team from a school or organization may be awarded a place in the top five overall teams.
- **10.** All team members must sign and submit the Honor Statement online prior to the regional deadline.
- Judges evaluate each deliverable in accordance with the rubrics. The score a judge assigns is final. Decisions are final. Teams will not receive raw scoresheets or be able to review scores from individual judges.
- 12. Actions or comments by any team member or any team supporter that maligns, disparages, or harasses other team members, Regional Coordinators, Future City volunteers, or Future City staff will result in the team's disqualification from that year's competition and could result in the school/ organization being ineligible to participate in the future.
- **13.** If a dispute or disagreement occurs at the regional level, an official Future City Team Educator shall bring the matter to the attention of the Regional Coordinator. An official Team Educator is the only person who may submit a complaint to the Regional Coordinator. The Regional Coordinator will thereafter conduct an investigation and make a determination regarding the complaint. All decisions by the Regional Coordinator shall be final and cannot be appealed.
- 14. In the case of a tie at the Regional Competition, the team with the higher Q&A score will be awarded first place. If the tie still remains, the team with the higher presentation score will be awarded first place.
- 15. Educators can see their team's average scores by logging into futurecity.org after the Regional and Finals competitions. Educators may download their team's score information by following instructions at www.futurecity. org/resources before April 30th, 2021. After April 30th, 2021 scores will be erased from the database.
- 16. A person who volunteers in the capacity of a judge (at any level) during the competition cycle may not serve as a mentor nor an educator during that same cycle. Nor may they provide guidance, coaching, tips, etc., to any active team member, teacher, engineer mentor, etc., during that same competition cycle. If violated, that judge's scores will be invalidated.
- **17.** If a team is located outside the typical geographical parameters of a region, whether or not they are permitted to participate in said region is at the discretion of the Regional Coordinator.
- **18.** The team's educator must be present any time team members meet virtually or in person with the team mentor.
- 19. Future City is an educational program established to encourage children to consider and explore careers in science, technology, engineering, and math. Future City participants and their supporters acknowledge that



Appendix:

Competition Information

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Appendix:

Competition Information participation in Future City is not a right. By participating in the Future City Competition, team members and team supporters agree and are bound to behave with respect and dignity for their team and for their fellow participants.

20. Future City reserves the sole and exclusive right to amend these rules at any time.

City Essay

- **21.** Students must submit a reference page citing at least three sources of information with the essay. (Note: Wikipedia cannot be cited as a reference.)
- 22. The maximum word count is 1,500. Initial tabulation is done by the "word count" tool within the word processing software. The final word count does not include the title and reference list but does include captions and words that appear within a graphic, illustration, or table. A maximum of four graphics or illustrations are allowed. A penalty will apply if word count exceeds 1,500.
- 23. The City Essay file must be uploaded as a word processing document, not a PDF.
- **24.** If any part of a team's City Essay is determined to be plagiarized, the team will earn zero points.

City Model

- **25.** Teams will build a single model or multiple model segments. Teams will submit a slideshow of photos and brief descriptions using the provided template and following instructions on page 65. The moving part will be demonstrated in a short video, whose link will be included in the slideshow.
- **26.** The slideshow should be completed in accordance with the template instructions and be submitted as a PDF.
- 27. Teams must design a new model/model segments. Teams may not use previous years' models. Previous models may be broken down and scavenged for materials including the bare model platform. Any previously used materials must be reconfigured in a new and original manner and assigned a current market value.
- **28.** Models have no physical size restrictions. Teams may create as many model segments as they want (provided they stay within the budget).
- **29.** Prohibited model items: live animals, perishables/food, drones or other flying objects, hazardous items (including dry ice) and fire.
- **30.** Each model must include a moving part. A team with multiple model segments is only required to create one moving part, not one for each segment.
- **31.** Each team will record one video (not longer than 1 minute) demonstrating their moving part, describing the role it plays in the city, and explaining how the team designed and built it. The video should be posted on any video platform that is publicly accessible (e.g. YouTube), and a link to the recording will be included in the slideshow.
- **32.** Power sources must be self-contained, (e.g., a household battery/simple circuit). Use of electrical wall or floor outlets is not allowed.

- **33.** The total value of the materials used in the Model, Presentation, Q&A, and special awards (including visual aids, costumes, color copying/printing, 3D printing, and other demonstration aids) may not exceed \$100.
- 34. All materials used must be listed on the Competition Expense Form and their value documented for the Model, Presentation, Q&A, and special awards. This includes donated and borrowed items at fair market value. This will be uploaded to the website.
- **35.** Each model or model segment must be consistent in scale. However, different segments (even among the same team) may use different scales.
- **36.** Use of 3D printers for any model materials must be assessed using the following values, which account for the cost of filament and the hardware/printer:
 - White 3D printing: \$2.00 per cubic inch
 - Color 3D printing: \$5.00 per cubic inch
 - All 3D printed materials used whether new or reused must be reported on the competition expense form using these values.
- **37.** Programmable circuit boards (ex: Raspberry Pi, Arduino) are permitted as long as the full cost is listed on the expense form. A minimum \$35 value is required to be listed for such boards.

City Presentation

- **38.** The Presentation may not exceed 7 minutes and only three student representatives may appear in the video.
- **39.** Presenters may use their model/model segments, photos of their model, posters, graphics, slides, costumes, and other visual aids.
- **40.** No copyrighted materials (such as music, photos, and videos) may be used.
- **41.** Materials used onscreen in the video (e.g. costumes and props) must be included in the \$100 budget. Items like cellphones used for filming, cameras, and editing software, if used, do not need to be included in the budget nor listed on the competition expense form.
- 42. Digital handouts/brochures are not permitted.

City Q&A

- **43.** Virtual City Q&A sessions will be scheduled by each region. Finals sessions will be scheduled by Future City Headquarters.
- **44.** At the virtual regional competitions and Finals, each team will have 10 minutes to answer questions from a panel of judges.
- **45.** Only three students may participate in the Q&A session with the judges.
- **46.** Teams may use their model/model segments and physical visual aids (e.g. posters) during their Q&A session. Screen sharing and videos are not permitted.

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Scoring Deductions

By completing all five deliverables, teams can earn up to 208 points. Judges evaluate each deliverable in accordance with the rubrics. The score a judge assigns is final. At the virtual Regional Competition, the Regional Coordinator has the final word on any dispute. At the Finals Competition, the judges' decisions are final. There is no appeals process at either level of competition.

Penalty	ltem	Description
5–10 points	Missing the submission deadline for a deliverable	The deliverables must be received in accordance with deadlines set by the Regional Coordinator. Check with your Regional Coordinator to determine if they accept late submissions.
10 points	Exceeding City Essay word count	Maximum of 1,500 words.
15 points	Competition Expense Form is missing or submitted late	The Competition Expense Form, with receipts, must be submitted by the regional deadline.
5 points	Missing team identification information in City Model Slideshow	Teams must identify their future city's name and school/organization.
15 points	Exceeding City Model Slideshow slide limit	Slideshows may not exceed more than 25 slides. Teams may not add any slides not included in the template.
15 points	Not adhering to City Model slideshow text boxes	Teams cannot change the sizes of text boxes nor include written content outside the approved text boxes.
15 points	Exceeding the \$100 limit or misrepresenting the values of materials used in the city model and/or video presentation	The total value of the materials used in the model, as well as those used in support of the video presentation (including visual aids, costumes, color copying/printing, three-dimensional printing, and other demonstration aids) may not exceed \$100.
2 points	Missing Honor Statement	Each student team member, the educator, and the mentor must electronically sign (and adhere to) the Honor Statement. Complete the form at futurecity.org/resource/honor-statement-form.
20 points	Unsportsmanlike conduct	Rude behavior or disruption of judging by any team member or guests.
0 points earned for deliverable	Plagiarism	If a team's deliverable is determined to be plagiarized, the team will earn zero points for it.
Disqualification	Destruction of another team's model or presentation materials or actions or comments from team members or team supporters that malign, disparage, or harass regional coordinators or volunteers	

QUESTIONS?

Check out the Frequently Asked Questions at futurecity.org. Don't see your question there? Email your Regional Coordinator or info@futurecity.org.





Appendix: Competition Information

Prizes and Awards

Future City Competition Virtual Finals

Teams that win their Regional Competition will represent their region at the virtual Finals. The Finals Competition will take place online in April 2021.

The Future City Competition Finals are generously sponsored by Bechtel Corporation, Bentley Systems, Inc., NCEES, Shell Oil Company, and DiscoverE.

Bentley

Advancing Infrastructu









Finals Prizes

The top prize at the Finals is \$7,500 for the organization's STEM program and a trip to U.S. Space Camp in Huntsville, AL for up to five people (including an adult chaperone), awarded by Bentley Systems, Inc.

Bentley[®] Advancing Infrastructure

2nd Place is awarded a \$5,000 prize for the organization's STEM program, provided by the National Society of Professional Engineers.



NATIONAL SOCIETY OF PROFESSIONAL ENGINEERS

3rd Place is awarded a \$2,000 prize for the organization's STEM program, provided by Shell.



4th and 5th place teams will receive \$750 for their organization's STEM program, provided by NCEES.



Regional Prizes and Special Awards

Teams that compete are also eligible for a number of special awards. For a complete list of the prizes and awards offered by your region, visit www.futurecity.org and click on Find My Region.

A region must have registered a minimum of 20 schools/organizations by October 31, 2020 to be eligible to participate in the virtual Finals. Regional eligibility is determined solely by Future City Headquarters. Prizes are non transferable or exchangeable. Prizes are subject to the discretion of the awarding organization.



Finals Special Awards

Unless otherwise noted, these special awards are specific to the Finals. Visit your region's website at www.futurecity.org to see what special awards are available in your region.

Award Name	Award Criteria	Sponsor
Best Age-Friendly City	City that best exemplifies a great place to grow up and grow old. In- corporates age-friendly planning and design throughout city, such as walk- able streets, housing and transporta- tion options accessible to people of all ages and abilities, and opportunities to participate in community life.	AARP AARP is the nation's largest nonprofit, nonpartisan organization dedicated to empowering people 50 and older to choose how they live as they age. With a nationwide presence and nearly 38 million members, AARP strengthens communities and advocates for what matters most to families: health security, financial stability and personal fulfillment. www.aarp.org
Best Use of Aerospace Technology in a Future City	Teams should develop a clear statement of the use and benefits of aviation and/or space technology in their projects. Special consideration will be given to aviation and/or space technologies used in the displays.	American Institute of Aeronautics and Astronautics (AIAA) National Capital Section (NCS) The AIAA is one of the oldest and largest aerospace-related associations, with the National Capital Section (NCS) being the largest section. The mission of the AIAA National Capital Section is to serve the profession by acting as a catalyst for information flow and creative exchange. AIAA-NCS supports the educational process that promotes future generations of aviation and space professionals by nurturing interest among students. www.aiaa.org
#AQOLFA: Advancing Quality of Life for All	Design that best demonstrates advancing quality of life for all. Public works is advancing the quality of life for all every day through public services that improve mobility, provide clean water, reduce the use of natural resources, provide public places for people to come together, and provide a safer place to live, work, and play.	American Public Works Association (APWA) The American Public Works Association has a worldwide membership of more than 30,000 people. APWA includes personnel from local, county, state/ province, and federal agencies, and private sector personnel who supply products and services to those professionals. Membership in APWA is open to any individual, agency, or corporation with an interest in public works and infrastructure issues. www.apwa.net
Most Sustainable Food Production System	Design that provides the best sustainable food production system while conserving soil, water, and energy.	American Society of Agricultural and Biological Engineers (ASABE) The American Society of Agricultural and Biological Engineers is an educational and scientific organization dedicated to the advancement of engineering applicable to agricultural, food, and biological systems. Founded in 1907 and headquartered in St Joseph, Michigan, ASABE comprises 9,000 members in more than 100 countries. Agricultural, food, and biological engineers develop efficient and environmentally sensitive methods of producing food, fiber, timber, and renewable energy sources for an ever-increasing world population.
Best Use of Renewable Energy	Innovative and efficient use of renewable resources in energy systems.	American Society of Agricultural and Biological Engineers (ASABE) The American Society of Agricultural and Biological Engineers is an educational and scientific organization dedicated to the advancement of engineering applicable to agricultural, food, and biological systems. Founded in 1907 and headquartered in St Joseph, Michigan, ASABE comprises 9,000 members in more than 100 countries. Agricultural, food, and biological engineers develop efficient and environmentally sensitive methods of producing food, fiber, timber, and renewable energy sources for an ever-increasing world population.

Appendix:

Competition Information

Award Name	Award Criteria	Sponsor
Most Innovative Design of Infrastructure Systems	Design that accommodates the most innovative systems (e.g., transportation, water and wastewater) for a community.	American Society of Civil Engineers (ASCE) Founded in 1852, ASCE represents more than 123,000 civil engineers worldwide, and is America's oldest national engineering society. ASCE advances professional knowledge and improves the practice of civil engineering as the lead professional organization serving civil engineers and those in related disciplines.
Best Integration of Equity in Designing the Built Environment using Nature-Powered Solutions	Teams should show how landscape architects apply design thinking to harness the power of natural resources to solve sustainable development challenges so that all people can live in equitable, environmentally sound, and beautiful environments. Use creativity to apply nature-based solutions to address real-world problems such as gentrification, diversity and inclusion, climate change, air and water pollution, and threats to biodiversity while using fewer resources.	American Society of Landscape Architects ASLA is the professional association for landscape architects in the United States and represents more than 15,000 members. The Society's mission is to advance landscape architecture through advocacy, communication, education, and fellowship. Sustainability has been part of ASLA's mission since its founding in 1899 and is an overarching value that informs its programs and operations. ASLA has also been a leader in demonstrating the benefits of green infrastructure and resilient development practices. www.asla.org American Society of Landscape Architects
Best Futuristic City	Use of futuristic engineering concepts in the city's communications, energy, or transportation systems.	American Society of Mechanical Engineers Founded in 1880, ASME International is a nonprofit educational and technical organization serving a worldwide membership and sets many industrial and manufacturing standards. www.asme.org
Best Management of Water Resources	 Efficient design of water treatment and distribution for human consumption, agriculture, industry, recreation, and fire protection. Responsible sewage collection and treatment for environmental protection and community aesthetics. Innovative stormwater collection, treatment, reuse and/or discharge back into the environment. 	Bentley Systems, Inc. Bentley is the global leader dedicated to providing architects, engineers, constructors, and owner-operators with comprehensive software solutions for sustaining infrastructure. Founded in 1984, Bentley has nearly 3,000 colleagues in more than 45 countries, \$500 million in annual revenues, and, since 1999, has invested more than \$1 billion in research, development, and acquisitions. www.bentley.com
Best Residential Zone	Strategic placement of residential zones that allow maximum return for quality of life issues.	Chinese Institute of Engineers/USA (CIE-USA) The Chinese Institute of Engineers–USA is a professional nonprofit and non-political organization founded in 1917 in New York by a group of talented and forward-looking Chinese engineers who graduated from American colleges. Chinese-American engineers in the US have played a significant role in the rapid growth of technology and communications throughout the United States. The total membership is around 10,000 nationwide. www.cie-usa.org Chinese Institute of Engineers - USA
The City of the Future that Best Incorporates Cultural and Historical Resources	The city whose design best incorporates historical and cultural sites, buildings, infrastructure and customs.	Cuban-American Association of Civil Engineers, Inc. The Cuban-American Association of Civil Engineers Inc. is a non-profit corporation whose purpose is to assist members in maintaining and retaining the highest professional engineering skills; support the highest principles of professional engineering achievements; and advance the engineering profession. www.c-aace.org

Appendix: Competition Information

Award Name	Award Criteria	Sponsor
People's Choice Award	This award is given to the team that is voted by their peers to have the best model. Voting is done by ballot during the Model Showcase.	DiscoverE DiscoverE is leading a growing volunteer movement that inspires present and future generations to discover engineering. www.discoverE.org
Best City Presentation Award	This award is given to the team with the overall highest score as judged by the City Presentation Judges.	DiscoverE DiscoverE is leading a growing volunteer movement that inspires present and future generations to discover engineering. www.discoverE.org
Most Advanced Smart Grid	Best incorporation of Smart Grid technologies for the safe, efficient and reliable delivery of electricity throughout the city. A Smart Grid is the modernization of the electric power system by applying advanced software tools, computer controls, automation, and two-way communications.	IEEE-USA IEEE-USA advances the public good and promotes the careers and public policy interests of more than 215,000 engineers, scientists, and allied professionals who are U.S. members of the IEEE. IEEE-USA is part of IEEE, the world's largest technical professional society with 375,000 members in 160 countries. www.ieeeusa.org
Excellence in Systems Integration	Demonstration of excellence in the design of integrated systems of people, material, information equipment, and energy.	Institute of Industrial and Systems Engineers Systems world view. Productivity. Efficiency. These are words that describe the distinctive attributes of industrial engineering, and IISE is the world's largest professional society dedicated solely to the support of the industrial engineering profession and individuals involved with improving quality and productivity. www.iise.org
Best Transportation System for the Community	Design that thoughtfully integrates safe and equitable ways to move people around their communities. Considers multiple modes of sustainable transportation (with strong connections between different modes), prioritizes citizens' health and safety, and creates equitable access across the city. Uses advanced and futuristic technology in ways that support these overarching goals.	Institute of Transportation Engineers Founded in 1930, ITE is an international association of transportation professionals who work to improve mobility and safety for all transportation system users, and help build smart and livable communities. Their network is made up of more than 15,000 members working in over 90 countries around the world. www.ite.org
Best City Essay Award	This award is given to the team with the overall highest score as judged by the City Essay Judges.	NASA The material contained in this document is based upon work supported by a National Aeronautics and Space Administration (NASA) grant or cooperative agreement. Any opinions, findings, conclusions or recommendations expressed in this material are those of the author and do not necessarily reflect the views of NASA. www.NASA.gov
Best Land Surveying Practices This special award is presented at all Future City Regional Competitions and at Finals.	The design that employs the best land surveying practices, taking into consideration the high standards used by surveyors to help protect the public's safety and welfare.	NCEES NCEES is a national non-profit organization composed of engineering and land surveying licensing boards representing all U.S. states and territories. www.ncees.org

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Appendix: Competition Information

Award Name	Award Criteria	Sponsor
Mission Possible: Positively Impacting the Community	This award is given to the team whose Future City design promotes the best overall quality of life and demonstrates the greatest potential to positively impact the community for a sustainable future.	National Society of Black Engineers (NSBE) The mission of the National Society of Black Engineers is to increase the number of culturally responsible Black Engineers who excel academically, succeed professionally and positively impact the community. www.nsbe.org
Professional Engineering Award	In planning, designing, building, and maintaining your city, please explain and give examples of steps you will undertake to: • Ensure your city's engineers are competent professionals; • Comply with engineering safety codes and technical standards; and • Reject behavior that misleads or deceives the public.	National Society of Professional Engineers NSPE is the only engineering society that represents individual engineering professionals and licensed engineers (PEs) across all disciplines by promoting engineering licensure and ethics, enhancing the engineer image, and advocating and protecting PEs' legal rights. www.nspe.org
Best Future City Project Plan This special award is presented at all Future City Regional Competitions and at Finals.	Teams should be able to explain how they followed the project cycle, including how they created their project schedule, assigned responsibilities, and monitored and controlled their work. Teams should be able to discuss their answers to the Team Reflection questions. Samples of work that highlight teams' project management activities are encouraged.	Project Management Institute With nearly 220,000 members in more than 150 countries, Project Management Institute (PMI) is the leading membership association for the project management profession. PMI is actively engaged in advocacy for the profession, setting professional standards, conducting research, and providing access to a wealth of information and resources. www.pmi.org Educational Foundation
Best City Model	This award is given to the team with the overall highest score as judged by the Model Judges.	Shell Oil Company Shell Oil Company is an affiliate of the Royal Dutch Shell plc, a global group of energy and petrochemical companies with 93,000 employees in more than 90 countries. In the U.S., Shell operates in 50 states and employs nearly 20,000 people working to help tackle the challenges of the new energy future. www.Shell.us
Best Application of Fire Protection Engineering Principles in City Design	Fire protection engineers use science and technology to make our communities safe from fire. Fire protection engineering features may include structural fire resistance, detection and notification systems, suppression systems, egress systems, and smoke management systems. The fire protection engineer ensures that these features all work together to protect people, property, and the environment from fire. Design that best incorporates an innovative approach for fire protection, to protect the public, property and environment.	Society of Fire Protection Engineers was established in 1950 and incorporated as an independent organization in 1971. It is the professional society representing those practicing the field of fire protection engineering. The purpose of the Society is to advance the science and practice of fire protection engineering and its allied fields, to maintain a high ethical standard among its members, and to foster fire protection engineering education. www.sfpe.org
Excellence in Resilience Engineering	Demonstration of excellence in the city design of resilient systems that withstand and quickly adapt to adverse circumstances and events like natural disasters.	UL UL solves the safety, security and sustainability challenges of the 21st century. UL tests, inspects, audits, certifies, verifies claims, advises and trains as well as provides software solutions. Around the world, UL employees share a common passion promoting safe working and living environments for all people.

Competition Expense Form Instructions

Provide a complete list of all items your team used in your model, appeared on screen in your City Presentation Video, and were used in any special award judging. Include actual cost if items were purchased or a reasonable cost estimate if items were donated or recycled. All materials used in the model/model segments (even if they don't appear in the template) must be listed. Tools used to film or edit the City Presentation Video (e.g. a phone/camera) should not be listed. Strive for accuracy and fairness when estimating costs. Misrepresenting the values of your materials will result in a 15-point penalty.

Commonly Asked Questions

1. Why is there a \$100 limit?

This rule was established to ensure equity among teams and to encourage students to creatively use recycled materials.

2. When can we assign a zero value?

Items that are allowed in a home or school recycling bin (such as paper, plastic bottles, glass jar, or metal cans) or items bound for the trash (like used-up batteries, bottle caps, used plastic utensils, etc.) can be assigned a zero value.

3. How do we figure out the fair market value?

Items that are donated or have been previously used but can't be recycled (such as mirrors, foam core, dowels, wood, magnets, holiday ornaments, old toys, lab coats, etc.) need to be assigned a fair market value. Fair market or salvaged value may be determined by pricing found at a yard sale, auction, classified ad, surplus store, e-recycling service, etc.

4. What about items we take apart?

Many teams take apart computers, electronics, or other items to "harvest" interesting parts. These items need to have a value assigned. Scrapmonster.com is an easy place to start.

Examples

Description of City Model Materials	Purchased	Donated	Recycled	Expense/Value
4' x 8' plywood sheet – \$20 (but only used half)	•			\$10.00
Assorted paint from parent's garage		•		\$2.00
Two one-liter soda/pop bottles			•	\$0.00
Egg carton			•	\$0.00
Toy train		•		\$0.50
Motherboard from scrapped computer			•	\$2.50
Green LED lights	•			\$4.50
Subtotal A—City Model Expenses:				

Description of City Presentation/Special Award Materials	Purchased	Donated	Recycled	Expense/Value
Foam poster board	•			\$9.00
5 pages of color printing	•			\$5.00
Top hat (costumes)		•		\$3.00
Lab coat (borrowed from teacher)		•		\$2.00
Subtotal B—City Presentation/Special Award Materials Expenses:				\$19.00

\$19.50 ____ + Subtotal B ___ \$19.00 = Total Expenses \$38.50 Subtotal A ____

Download the Competition

Expense Form from futurecity.org/resources (filter for Competition Forms & Project Plan).



Appendix:

Competition Information



Appendix: Competition Information **Regional Coordinators List**

US Regions

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Regional Coordinators

The Future City staff would like to thank and acknowledge the dedication of our tireless Regional Coordinators and their committee members. The countless hours that they contribute as they answer every question (big and small), match mentors to schools, fundraise, and host wonderful Regional Competitions is the foundation on which Future City rests. Thank you!

To contact your Regional Coordinator, visit www.futurecity.org and click on Find My Region.





Appendix:

Competition Information



Notes

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WORLD ENGINEERING DAY (MARCH 4, 2021)

Join DiscoverE and the World Engineering Federation for a day of global celebration of engineers and how engineering changes the world for the better.



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