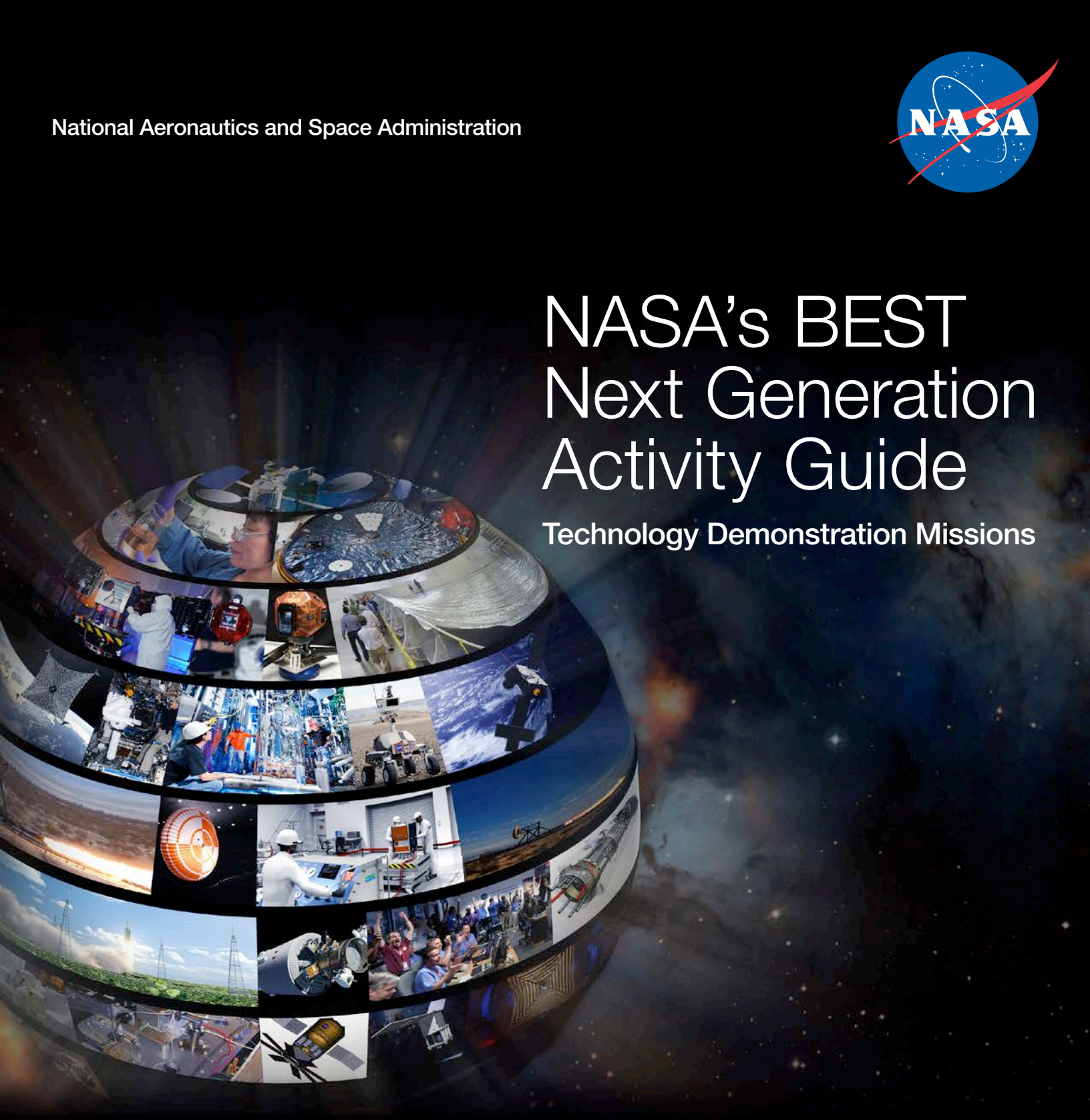
National Aeronautics and Space Administration



NASA's BEST Next Generation Activity Guide

Technology Demonstration Missions

NASA'S BEST STUDENTS

BEGINNING ENGINEERING, SCIENCE, AND TECHNOLOGY

Educational Product	
Educators	Grades 5–8

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NASA's BEST Next Generation

Technology Demonstration Missions

For the Teacher

Introduction

This NASA BEST Activities Guide has been developed in support of NASA's **Technology Demonstration Missions (TDM)**. TDM's mission is to provide revolutionary, crosscutting technologies—ones that could radically advance NASA's mission in space and reap untold benefits for science and industry here on Earth. These technologies will allow future NASA missions to pursue bolder and more sophisticated science, enable safe and rewarding human missions beyond low-Earth orbit, and enable entirely new approaches to U.S. space operations.

For each of the nine projects within Technology Demonstration Missions (TDM), there is now an associated middle school-level engineering design challenge activity that will help students understand NASA's latest cutting edge technology developments. The student challenges focus not just on the engineering design process but also on bringing real world science, math, and technology to the middle school classroom.

The first NASA's BEST Activity Guide was designed for grades K–8. It focuses on humans' endeavor to return to the Moon, but can easily be adapted to a Mars theme.

The Guide can be found here: *http://www.nasa.gov/audience/foreducators/best/activities.html*

How do I teach the Engineering Design Process?

The NASA BEST Activity Guides were designed to teach students the Engineering Design Process (EDP). EDP is a series of steps engineers use to guide them in problem solving. Engineers must ask a question, imagine a solution, plan a design, create that model, experiment and test that model, then take time to improve the original—all steps that are crucial to mission success at NASA. To learn more about teaching the Engineering Design Process at the middle school level, and as outlined in this guide, there are educator and student videos available at: *http://www.nasa.gov/audience/foreducators/best/edp.html*

If you have questions, please contact your local NASA Educator Resource Center: *http://www.nasa.gov/offices/education/programs/national/ercn/home/index.html*

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What makes this guide different from others?

- There are no specific instructions or "recipes" for building the products. Students will work together to come up with the best solution given the materials and constraints of the challenge. This can be challenging for teachers and students at first, but once the students start thinking this way, it will come naturally.
- There are no given drawings. The emphasis is for students to understand that engineers must "imagine and plan" before they begin to build and experiment. Often engineers just know the problem they would like to solve and are not sure what it will look like when they first start working.
- These activities develop a unique combination of 21st century learning and innovation skills of creativity, critical thinking, problem solving, communication and collaboration.
- NASA's latest technological developments can be brought to the middle school classroom in real time. These projects have mission launch dates in the next few years and will engage students in the excitement of NASA for years to come as testing continues, launches happen, and data is analyzed.

What is included in this guide?

Each activity features a challenge, a list of materials, educator information, procedures, and student worksheets. When appropriate, the guide provides images, charts, and graphics for the activities.

Career Connections

Here are some suggestions of roles for students:

Data Analyst	Project Manager
Equipment Engineer	Technician
Structure Engineer	Public Relations

The **challenges** are worded simply to allow the teacher some flexibility for time or material constraints, students abilities, and resources. This also is helpful for adding cross curriculum engagement, such as including the use of available technology, writing reports, budgets, historical background, etc.

Mass vs. Weight

Many of the challenge activities require that students keep up with the overall mass of their product. If your students need a review of this concept please see this NASA education website for more information.

http://education.ssc.nasa.gov/massvsweight.asp

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The **list of materials** is provided to help in planning. There is more information about materials on the *Suggested Materials* page. Most items can be found in the classroom, purchased for very little cost, or recycled from other activities. Feel free to modify materials based on what is available. Sometimes plastic tablecloths can be used instead of plastic bags or an oatmeal container used instead of a potato chip can. Just be consistent between the teams.

For the Teacher pages are provided to help prepare the teacher to teach the activity. Information is provided on pre-set up of materials, modification suggestions, as well as details on how to engage the students throughout the Engineering Design Process. Links to other related activities and resources are provided. Safety information is also provided in the teacher pages.

Student Pages are included with each of the challenges to help facilitate process skills, organize student thoughts and data, and help in the progression through the experiment phase.

Background provides a short summary of the Technology Demonstration Mission and information about the challenge. This information can be copied for each team or just incorporated into your presentation.

Our Team's Plan is for students to document the Engineering Design Process steps as they work them. More room can be used on additional paper or in scientific notebooks/journals.

Experiment and Record page should be either provided to each team or used as an outline for their scientific notebooks/journals.

Quality Assurance pages are provided for each challenge so students can exchange work and use for assessment.

More Fun with Engineering page is to offer extension activities for use in the classroom or the students with parents at home.

Activity Management

- Intend for students to work in small teams of 3–4.
- Plan for each activity to take at least two 60 minute class periods, but can also be stretched out over several days.
- Every challenge can be made more difficult by having a budget limit or time constraint.
- Allow the students to solve their own problems. There can be a "Technical Advisor" charge added every time they need to ask the teacher a question!
- Designed for use during the school day or as activities in after-school clubs.
- Activities can be done as stand-alone activities or as part of a complete unit.

Suggested Materials

Below is a suggested list of materials needed to complete all activities in this guide for a group of 24–32 students (about 8 teams of students in small groups of 3–4). Most items should be commonly found at home or in the classroom. Encourage using recycled materials. Most materials can be reused for another activity.

Required for all Challenges

Digital scale or balance (1–2 for the class)
Meter sticks (1 per team)
Measuring tape (1–2 per class)
Metric rulers (1 per team)
Stopwatches (1 per team)
Thermometers (2 per team, not required for all challenges)
Scissors (2 per team)
Tape (clear & heavy duty, 1 roll per team)

General Building Supplies

These materials are for common use, so depending what students select to use for the challenge, amounts will vary class to class. Refer to the material list within each challenge for more information. Materials can be found in local hardware stores or online.

Aluminum foil
Baking soda
Balloons, assorted
Bamboo skewers
Bubble wrap
Cardboard (recycled)
Card stock
Cardboard boxes (recycled)
Clear/white film canisters—purchase online
Colored pencils and crayons
Cotton balls
Effervescent tablets
Embroidery thread
Empty paper towel tubes (recycled)
Empty toilet paper tubes (recycled)
Fishing line, ~20 lb. test
Fun size candy bars
Hairdryer (2–3 per class)
Hand sanitizer
Drop cloth
Index cards
Modeling clay
Oatmeal canister
Paper clips, assorted
Plastic trash/grocery bags
Plastic wrap
Pipe cleaners
Safety goggles
Sealable storage bags—sandwich size
Staplers and staples
Stirrer sticks
Straws
Small weights/washers
Thermal/stryofoam cups
Vinegar
Wire mesh

Safety

Keep safety a priority with all activities!

- Wear safety goggles!
- Approve all drawings before students start building. Look for potentially hazardous combinations of chemicals or flimsy designs of structures.
- Do not allow students to bring additional materials for their designs without your prior approval.
- Be sure materials students are using are not damaged or in disrepair.

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Next Generation Science Standards

Practices

1. Asking questions, defining problems
2. Developing and using models
3. Planning and carrying out investigations
4. Analyzing and interpreting data
5. Using math and computational thinking
6. Constructing explanations and designing solutions
7. Engaging in arguments from evidence
8. Obtaining, evaluating, and communicating information

Crosscutting Concepts

1. Patterns
2. Cause and effect
3. Scale
4. Systems and system models
5. Energy and matter
6. Structure and function

Core & Component Ideas Physical Science

PS2: Motion and Stability
PS2.A: Forces and motion
PS2.B: Types of interactions

Earth and Space Science

ESS1.B: Earth and the Solar System

Engineering, Technology, and Applications of Science

ETS1.A: Defining and delimiting an engineering problem
ETS1.B: Developing possible solutions
ETS1.C: Optimizing the design solution
ETS2.A: Interdependence of Science, Engineering, and Technology

Common Core State Standards—Mathematics

Standards for Mathematical Practice

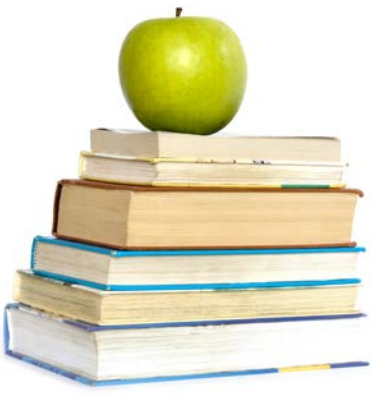
MP1: Make sense of problems and persevere in solving them
MP2: Reason abstractly and quantitatively
MP3: Construct viable arguments and critique the reasoning of others
MP4: Model with mathematics
MP5: Use appropriate tools strategically
MP6: Attend to precision

Grade 6–8

Expression and Equations—Reason about and solve one—variable equations. Represent and analyze quantitative relationships between dependent and independent variables.

Geometry—Solve real-world and mathematical problems involving area and surface area

Statistics and Probability—Develop understanding of statistical variability. Summarize and describe distributions.



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Summary of Activities

Materials ISS Experiment-X (MISSE-X)
Students will test a variety of materials used in the other challenges and determine if they would be suitable for long-term space use.

Low Density Super Sonic Decelerator
Students will design a parachute drag device for a spacecraft.

MEDLI-Mars Science Laboratory Entry, Descent & Landing Instrumentation
Students will design a heat shield to protect fragile instruments (candy bar).

Solar Sail Demonstration (the Sun Jammer Project)
Students will design a solar sail that will open and remain upright.

Cryogenic Propellant Storage Transfer
Students will design a storage container and transfer system for "cryogenic" fuel.

Green Propellant Infusion Mission
Students will design a "green" fuel to power a film canister spacecraft.

Laser Communication Relay Demonstration
Students will design a simple communication system using string and cups.

Deep Space Atomic Clock
Students will design a water clock to record precise time.

Human Exploration Telerobotics (HET)
Students will design and program a robot to perform a series of tasks like Robonaut 2.

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Student Name

for achievement in understanding and implementing the Engineering Design Process in the

Challenge

Date

Teacher Signature

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