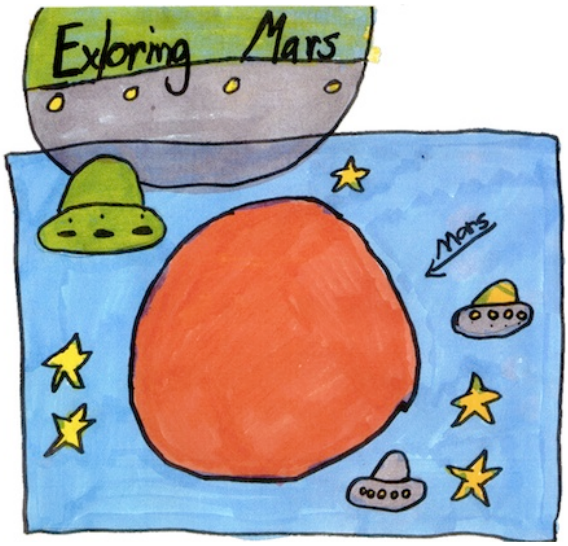
Idaho TECH



NASA IDAHO Space Grant CONSORTIUM

2019 - 2020

MARS ROVER CHALLENGE MANUAL

--For Teachers and Parents--

Engaging youth in hands-on engineering, technology, and space exploration in collaboration with parents, teachers, and community members.

Idaho State University

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OVERVIEW

What is Idaho TECH?

Idaho TECH is an intensive program which requires a high level of both coach and student dedication. Also, parental and community support is key to any Idaho TECH team's success. By including parents, teachers, and students in a meaningful, hands-on educational activity, Idaho TECH seeks to answer the question: "How can schooling be a collaborative venture among parents, teachers, and students?"

Students will design and construct Mars Rover models following the Engineering Design Process. Rovers will then be tested at Engineering Design Competitions (EDC). The EDC allows each team to display their design and demonstrate their Rover's capabilities on Martian Test Courses. Students also have the opportunity to examine the design and performance of Mars Rover models constructed by other engineering teams. Furthermore, numerous hands-on and informational activities are open to all participants and attendees at the EDC. Participants may also have the opportunity to meet a NASA scientist or engineer.

The **NASA Idaho Space Grant Consortium (ISGC)** is the primary sponsor of this program. The ISGC is a NASA grant-funded, statewide program that supports research, higher education, K-12 education and community outreach in the state of Idaho.

The ISGC strives to keep Idaho TECH participant expenses at a minimum. Participant expenses include expenses associated with registration, additional LEGOs and display materials, travel expenses to and from the EDC, shipping costs involved with returning the LEGO® kits, and any costs incurred for late, missing or damaged LEGO® components upon kit return.

THE CHALLENGE

Design and construct a Mars Rover to navigate the challenging Martian terrain by following the Engineering Design Process.

(1) *WEIGHT:* In order for NASA to meet launch weight restrictions, payloads must be as lightweight as possible. Likewise, weight must be considered in your rover design and construction. Your team's rover should be **as lightweight as possible**.

(2) *ROCK COLLECTION:* The vehicle **MUST** be able to **collect and store rock samples**. Nothing smaller than a marble or larger than a golf ball will be used to represent Martian rocks on the **Idaho TECH** competition courses. The rock collection device MUST be controlled remotely and ***cannot*** be controlled manually, such as through pulling a wire or string, etc. If a rover does not include a rock collection and storage device, the team will not be eligible to receive any awards at the competition. However, they will still be able to participate in all events.

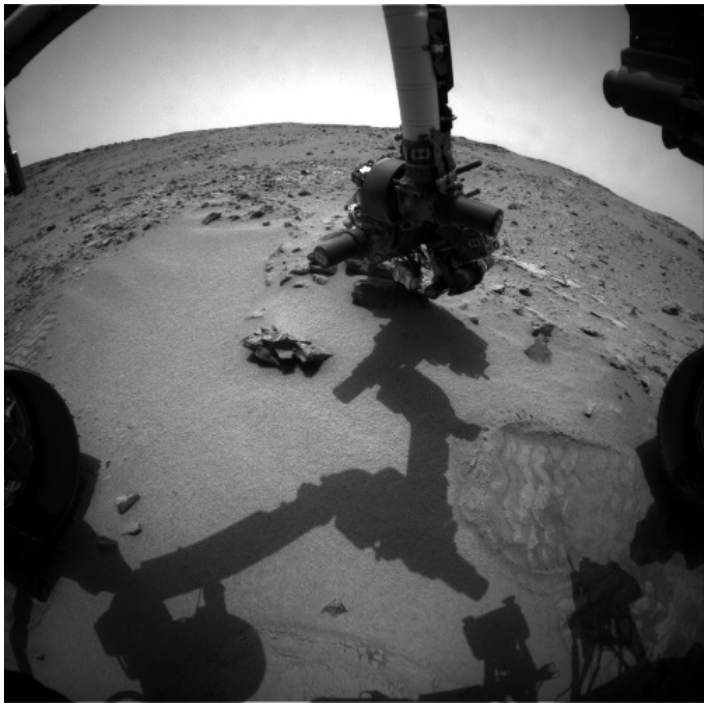
(3) *NOTEBOOK:* The team **MUST** maintain a **Lab Notebook** of the design process and expenses.

(4) *OTHER EXPENSES:* The Engineering Team may ***not*** exceed $50 in additional LEGO® components in their Rover design or $30 for poster display materials.

(5) *PRESENTATION:* The Engineering Team must present with the aid of PowerPoint or similar software and prepare a poster display that showcases the Engineering Design Process.

(6) Control of the Rover must be remote, using the LEGO® battery box, infrared receiver, and pneumatics supplied for RN & YN kits, or the LEGO® 9V battery box and motors and pneumatics supplies for RO & YO kits. During the competitive events, it is allowable for a team member to hold the pneumatic tubing out of the way ***and*** to flip the pneumatic pump switch, whether this switch is on the control panel or on the Rover itself.

(7) Each team MUST arrive at the EDC with its Rover assembled and ready to compete. **The Rover must remain intact throughout the entire competition for all events** (i.e. do not remove a pneumatic arm or collecting apparatus when completing one event and then reattach it for another; do not move gears manually on an axle for the hill climb, then move them back for other events, etc.). ANY MODIFICATION OF THE ROVER IN ANY FORM AT THE COMPETITION WILL RESULT IN IMMEDIATE DISQUALIFICATION FROM THE IDAHO TECH COMPETITION.



THE ENGINEERING TEAM

- The Student Engineering Team is limited to four to six members that are currently in 4th - 6th grade in Idaho or bordering states. ANY VIOLATION OF THIS RULE WILL RESULT IN IMMEDIATE DISQUALIFICATION FROM THE IDAHO TECH PROGRAM
- ***Only*** members of the Student Engineering Team are allowed to participate in the actual construction of the Mars Rover model and display
- ***Only*** the Student Engineering Team is allowed to control or repair the Rover at the EDC
- IF IT IS DETERMINED THAT PERSONS ***OTHER*** THAN TEAM MEMBERS HAVE BEEN INVOLVED WITH THE CONSTRUCTION OR THE REPAIR OF THE ROVER, **IMMEDIATE DISQUALIFICATION** FROM THE IDAHO TECH COMPETITION WILL RESULT.

For each of the four driving events *(speed, blind driving, rock collection and hill climb)*, each team must select a Rover Driver, a Rover Assistant, and an Emergency Mechanic. Each role has specific responsibilities, which are described on the next page.

Rover Driver

The Engineering Team must appoint a driver to control the Rover for the four separate driving events *(speed, blind driving, rock collection and hill climb)*. Note that:

- A different Rover Driver must be used for each driving event.
- Only Engineering Team members are allowed to give advice or driving instructions to the Rover Drivers during the course of the various events.

Rover Assistant

A Rover Assistant is required for each driving event.

- A different Rover Assistant must be used for each driving event.

This individual is responsible for:

- Guiding the Rover Driver through the "Blind Driving" test
- Assisting with pneumatics or other driving tasks
- Uprighting or moving the rover in the event that the Rover turns over or becomes stuck

The Rover Assistant is the ONLY team member who is allowed to *physically* handle the vehicle during the test, unless a breakdown is called.

Emergency Mechanic

An Emergency Mechanic is required for each driving event. This person will be responsible for:

- Declaring a "break down" during an event (after confirming with all team members)
- Making necessary repairs in the event of a Minor Breakdown.

It is to be noted that the Emergency Mechanic is the only person who may complete repairs in the event of *minor* damage on the event course.

In the event of a Major Breakdown, all team members may contribute to the repairs.

Sponsors, Coaches, & Mentors:


Teacher Sponsors and Coaches:

Each team must have a teacher sponsor. The sponsoring teacher does not have to be the head coach for the team but will be held responsible for the LEGO® kits. Coaches can be a parent or community member who will assist and encourage the students to learn about applicable science and engineering concepts, present guiding questions, make sure that construction guidelines are followed, and aid in the overall organization of the team.

A variety of team building and Mars related activities have been posted on the **Idaho TECH** website http://ed.isu.edu/Idaho_TECH

Note the following guidelines concerning coach involvement with the Engineering Team:

- Coaches are **NOT ALLOWED** to construct or assist in the construction of ***any*** portion of the Mars Rover model, poster display, or PowerPoint presentation
- A maximum of **two** coaches may be used for *each* **Idaho TECH** team; however, a single coach may serve as the sponsor for more than one team

Team Advisors and Mentors:

Team Advisors and Mentors can be parents, community members, professional engineers, or students who assist the coach in supporting the team. They add expertise and are an invaluable resource. However, **Idaho TECH** is primarily intended for 4th through 6th grade students and advisors may provide input and feedback to the Engineering Team, but the Team must be responsible for overall prototype design and refinement.

- Team Advisors and Mentors are **NOT ALLOWED** to directly assist in construction of the Mars Rover model, poster display, or PowerPoint presentation. At the Competition, Advisors and Mentors are observers ONLY, like coaches, and ***are not allowed*** to influence the team during ***any*** event.
- Team Advisors and Mentors must NOT tell students how to design their Rover. They should be available to answer questions that students may have, but are NOT to decide which direction the team should take in the Engineering Design Process.

Although it is ***highly encouraged*** that teams have Team Advisors and Mentors, they are an ***optional*** component of your **Idaho TECH** team.

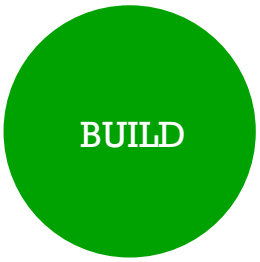
ENGINEERING DESIGN PROCESS

Idaho TECH teams are responsible for following the Engineering Design Process during the creation of their Rover. This process must be reflected in the Mars Rover Poster Display, Presentation, and Lab Notebook.

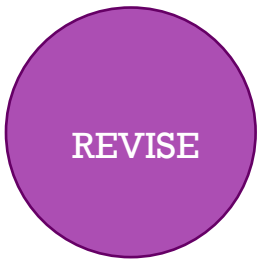
Ask questions and identify specific problems. In the Lab Notebook, include general statements or questions such as "How might a Rover store rock samples that it collects?" More specific problems will likely arise as a Rover is being constructed. Be sure to document the problems that are encountered as the design and construction continue. This could be construction issues or even team problems.

Goals should be as specific as possible and should address the general problems initially identified. One goal might be stated as follows: "Our Rover will be able to store a minimum of 5 rock samples."

The key to brainstorming is to remember that there are no bad ideas! Each idea, no matter how off-the-wall it seems, should be recorded during the brainstorming session. Be creative -- the more ideas generated, the more likely it is that a successful design will result.

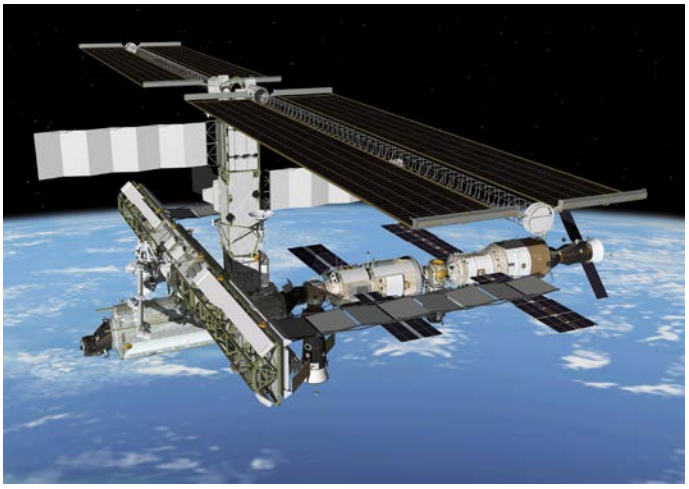


Identify the design that appears to solve the problems the best and that meets the team goals. Document why this design was chosen. Then construct a prototype based on these decisions.



Test the prototype to determine its strengths and its weaknesses. Identify problems, brainstorm, and revise the model. The process of testing and revising will undoubtedly have to be carried out many, many times! Be sure to document what works and what does not work in the Lab Notebook.

After the Rover has been exhaustively tested and countless revisions have been carried out, share your creation at the Engineering Design Competition.



COMPETITION OVERVIEW

Events

1. POSTER DISPLAY (10 pts) – Display of rover design, construction, and teamwork distribution.
2. TEAM PRESENTATION (15 pts) – Verbal presentation of engineering design process from beginning to finish. Team must use PowerPoint slides in presentation.
3. LAB NOTEBOOK (20 pts) – Detailed, handwritten account of team's design process, including timeline, three separate budgets, and pie charts.
4. MARTIAN ROCK COLLECTION (15 pts) – Collect and store one of each of the five different colored rocks.
5. BLIND DRIVING (10 pts) – Complete the course while blind-folded through navigational instruction provided by the Rover Assistant.
6. HILL CLIMB (10 pts) – Climb the steepest incline possible.
7. ROVER SPEED (10 pts) – Complete the course in the fastest time possible.
8. ROVER WEIGHT (10 pts) – Rover is to be as lightweight as possible.

MAXIMUM SCORE POSSIBLE: 100 POINTS

Rover Materials & Design

ISGC Supplied Materials

The NASA Idaho Space Grant Consortium provides two LEGO® kits for use by each Idaho TECH team. Teams are allowed to use any of the kit components in the construction of their Rover (it is *not* required to use every component in your design). Kits are to be returned to the ISGC at the end of the program (May 31) in the same condition as when they were received. Provided LEGO® kits include:

(1) **Kit "R"** – LEGO® Manufacturing Systems Kit (red container)
(2) **Kit "Y"** – LEGO® Pneumatics Kit (yellow container)
(3) **LEGO® Building Cards**

Do NOT glue or distort provided LEGO® pieces! All pieces *(except tubing and string)* must be returned in the same condition as provided. Any damage to provided LEGO® pieces will result in a charge to replace the damaged LEGOs®.

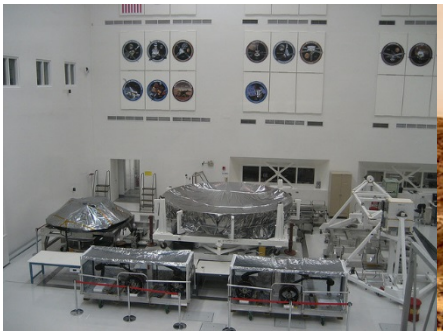
NO geared-down, gear reduction motors or alternate power sources are allowed! Teams **MUST** use the LEGO® motors as provided.

Elements Not Supplied by the ISGC:

Other than the LEGOs® provided by the ISGC, the following elements may also be used in the Rover design:

1. **Additional LEGO® Components**: Each Engineering Team may purchase a maximum of **$50** in additional LEGO® components (**actual costs** or **estimated** costs if donated). Additional LEGO®s are purchased directly from the vendor by the **Idaho TECH** team.

2. **Non-LEGO® Allowable Elements**: Each Engineering Team is allowed to use an unlimited amount of materials on the following page in the construction of their Rover. Any non-LEGO® pieces not listed are **NOT** permissible in the construction of a Rover model. Funds for non-LEGO® elements are the responsibility of each Idaho TECH team. There is ***no*** limit on the amount of Non-LEGO® Allowable Elements that may be used; however, these elements should be **common household items** and **must** be itemized in the budget in the Lab Notebook using the categories listed on the following page. Batteries and pneumatic tubing also fall under this category.



NON-LEGO ALLOWABLE ELEMENTS

ELEMENT	DEFINITION
Cardboard	A cardboard product of varying qualities ranging from paperboard to corrugated
Fasteners & Adhesives	An item used to attach or bond one item to another *(Do NOT glue or damage provided LEGO® pieces)*
Paper	A paper product in varying thicknesses ranging from tissue paper to matte board
Springs	A metal or plastic coil
Metal	*Containers*: An aluminum or tin container *(steel containers are NOT allowed)* *Wire*: A pliable metallic strand in varying diameter ranging from twist ties and paper clips to cable *(may NOT be used as an electrical component)* *Sheets*: A flat, pliable metal product in varying thicknesses ranging from aluminum foil to sheet metal *(steel is NOT allowed)*
Wood	A raw wood product and/or any finished wood product and/or wooden component of a finished product

ELEMENT	DEFINITION
Fabric	A cloth, vinyl, or leather material
Foam	A light, porous, semi-rigid, or spongy material used for insulation or shock absorption
Rubber	A pliable, elastic-like material ranging from rubber gloves to a tire
Tethers	A rope, chain, or similar device varying from fishing line to strapping
Plastic	*Bags*: A plastic bag in varying thicknesses ranging from a sandwich bag to a bedding bag *Containers*: – A plastic item used as a storage device *Cylinders*: – A plastic pipe, straw and / or open ended tube *Utensils*: – Tools used in eating or food preparation *Sheets*: – A flat plastic product in varying thicknesses ranging from plastic wrap to a tarp

Any non-LEGO® element NOT on the above list is NOT allowed in the final Rover design. The NASA Idaho Space Grant Consortium will be the final determinate of what constitutes an allowable and unallowable item in the Rover design.

HELPFUL ADVICE

Inventory your kits upon receiving them and contact the ISGC if missing pieces are discovered. Missing pieces upon return of the LEGO® kits, *even if the parts were missing when the team received the kits*, will be the responsibility of the Idaho TECH team.

Build most, if not all, of the various models outlined in the building cards binder. This will provide students with the opportunity to discover how the pieces may be used and should also help generate ideas for their overall design.

The amount of rubber tubing supplied in the pneumatic kit will likely prove insufficient. Many hardware stores or pet stores sell tubing that is small enough to connect firmly to the pneumatic pumps and pistons. Tubing is **NOT** subject to the $50 additional LEGO® budget limitation.

Check each LEGO® battery box and remote control for **required batteries** (not provided). Batteries do **NOT** have a budgetary limit.

Although we realize that the list of "Non–LEGO® Allowable Elements" is rather limiting, it is designed to inspire greater creative use of materials by the student engineers.

Join the Idaho TECH Teachers & Parents Facebook Group to collaborate with each other on ideas! www.facebook.com/groups/IdahoTECH

When brainstorming ideas, be sure that students think critically about how the motors and pneumatics might best be used to meet all of the needs such as steering, power, and the ability to collect and store rock samples.

TEAM PRESENTATION

15% of composite score = 15 pts

Develop a verbal presentation that demonstrates how the Engineering Design Process was utilized. The presentation should also include the process involved in creating the Rover, strengths and weaknesses of the Rover, and the overall involvement by each team member in the process. The score received is dependent upon 3 variables – 1) required elements and content 2) visual appearance and organization of the presentation 3) quality presenting (clarity, eye contact, etc.). This area will constitute 15% of the total composite score.

RECOMMENDED ACTIVITY

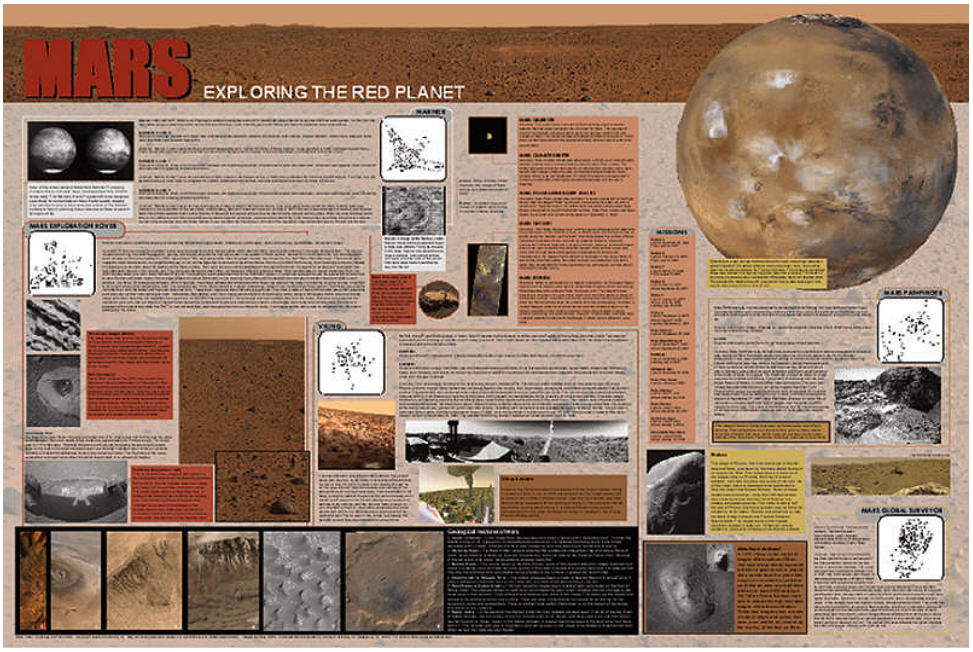
Have students practice their presentation in front of the entire class, with classmates judging the presentation and asking questions.

REGULATIONS

- All teams MUST develop a PowerPoint presentation to be presented to judges
- A maximum of 7 minutes will be allowed for the Team Presentation followed by 3 minutes of questions by the judges. ALL team members must participate in the team presentation.
- The presentation MUST demonstrate the components of the Engineering Design Process, reason for choosing specific designs, strengths and weaknesses of the Rover, and an explanation of the levels of team participation.
- The PowerPoint presentation is to be used as a visual aid to help guide the presentation. Students should not use the slides as a script. However, note cards are acceptable.
- A computer, projector and screen will be available in the presentation room. Teams are asked to bring their presentation to the competition on a USB flash drive. We encourage you to save the presentation to multiple sources in case there are technical difficulties.

POSTER DISPLAY

10% of composite score = 10 pts



Develop a poster display that shows how the team used the steps of the Engineering Design Process. The display should also include the process involved in creating the rover, strengths and weaknesses of the rover, and the overall involvement by each team member in the process. The score received is dependent upon 3 variables – 1) evidence of Engineering Design Process; 2) poster reflects cooperation and teamwork; 3) poster is aesthetically pleasing and easy to understand. This area will constitute 10% of the total composite score.

REGULATIONS

Note the following guidelines that must be followed when completing this event:

- The poster display will **not** be used in the team presentation portion of the competition.
- A table will be provided for each team's display at the Engineering Design Competition. Displays should be **freestanding** and **no larger than 3' wide X 2½' deep X 4' high.**
- The display may incorporate posters, photos, charts, illustrations, small 3D displays, etc. A maximum of $30 may be spent (***actual*** and/or ***estimated***) for materials associated with the construction of a team's Mars Rover display. This budget includes the value of poster board, paint, photographs, computer prints, wood, or other display construction expenses. This budget should be listed in the Lab Notebook budget section.

The display **MUST** illustrate the components of the Engineering Design Process followed (see p. 8). It must also illustrate the overall team workload distribution through a **group pie chart**.

LAB NOTEBOOK

20% of composite score = 20 pts

Create a detailed, handwritten record of your team's activities over the entire design process. Each team will be required to turn in its Lab Notebook after the Team Presentation & Display event is completed. The score received for the Lab Notebook will be dependent upon notebook content, organization, clarity, and proper expenditures, and will constitute 20% of the total composite score.

RECOMMENDED ACTIVITY

"3-2-1 Pop! An Effervescent Race"
"Earthling Exploration of Mars"
http://www.ed.isu.edu/Idaho_TECH/Activities.shtml

REGULATIONS

- The Notebook should be kept in a spiral or bound notebook or three-ring binder. You may use a word processor, or hand write. It is **NOT** to be a typed "paper" produced at the end of the design process. It is a record of the day-to-day activities the team completed over the course of the **ENTIRE** design process.

- The Lab Notebook **MUST** be labeled with appropriate team identifications (team name, team members, school, and coach) **on the front cover**.

- Entries **MUST** be **labeled appropriately** *(date, team members, activity and/or design process step).* Timeline and budget pages should be word processed.

- The Lab Notebook **MUST** contain the following components ***in order***:

(1) **TIMELINE:** Detailing when and in what order the team will complete all of the components of the Engineering Design Process and the **Idaho TECH** program. ***The timeline should be the first item included in your Lab Notebook.*** Refer to the activity "Earthling Exploration of Mars" online at the Idaho TECH website http://www.ed.isu.edu/Idaho_TECH/Activities.shtml

(2) **EXPENSES:** Expenses should be presented as **three separate itemized** budgets ***immediately following the timeline***. The three budgets are:

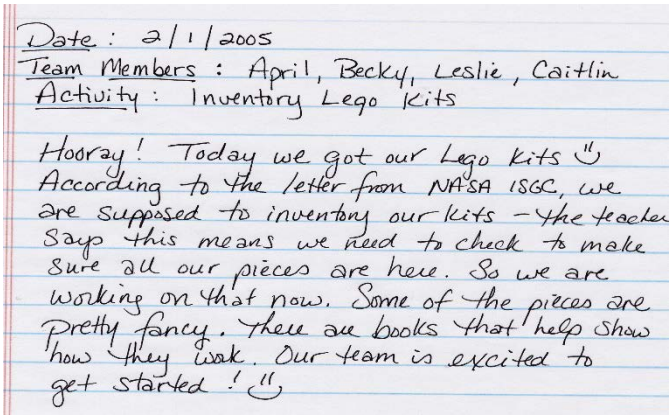
i) Additional LEGO® Components – $50 budgetary limit

ii) Use of Non-LEGO® Allowable Elements – No budgetary limit. Be sure to itemize this budget. Items used from the "Non-LEGO® Allowable Elements" list must be separated into the main categories with their estimated value listed individually. For example:

Cardboard	Fasteners & Adhesive
• Small Box $1.00	• Scotch Tape $ .50
Paper	Miscellaneous / Other
• Newspaper $ .50	• AA Batteries $5.00

iii) Poster Display - $30 budgetary limit

(3) **<u>Day-to-Day Entries and Notes</u>** Documenting the Engineering Design Process (see p.8), including the team's ideas, trials, successes, and errors, etc. Each recording should be detailed and must include the **date**, **name of team members present**, and the accomplishments of the meeting. Entries should adequately state what occurred at that meeting such as ideas and events of the team and/or individual, etc.


Date: 2/1/2005
Team Members: April, Becky, Leslie, Caitlin
Activity: Inventory Lego Kits

Hooray! Today we got our Lego kits ☺ According to the letter from NASA ISGC, we are supposed to inventory our kits - the teacher says this means we need to check to make sure all our pieces are here. So we are working on that now. Some of the pieces are pretty fancy. There are books that help show how they work. Our team is excited to get started! ☺

(4) Lab Notebook should demonstrate each individual's efforts to the project. As the students progress through the project, they will begin to discover areas in which they excel. Each student should individually track their progress in the areas they are contributing throughout the Lab Notebook.

The key to a successful Notebook is to make entries after each meeting. Keeping notes about the engineering design process, the activities you do, and the goals you make will help you. Consider taking photos of your design process, and including them in your Notebook. There is not a wrong way to complete the Notebook. Just make sure to include all of the elements, and to make sure it is organized.

MARTIAN ROCK COLLECTION

15% of composite score = 15 pts

Collect and store at least one rock of each color from the course (gold, silver, amethyst, blue, and red). The rover will be required to negotiate the course to locate, collect and store each rock in a storage unit on the rover. The score will be calculated on how many rocks are stored on the rover at the end of the event.

REGULATIONS

- A maximum of **5 minutes**, *including penalty seconds*, will be allowed to complete the course.
- Of the 15 points possible, 5 points will automatically be awarded to each team that successfully attempts to collect a rock sample *(an attempt is defined as the collection device **moving and touching** at least one rock on the course)*. The remaining points will be awarded dependent upon how many differently colored rock samples are present in the storage unit of the rover at the end of the event (2 points per color collected - see the scoring form for further details).
- The goal of the course is to **collect one rock of each color** (five colors in total). Teams may decide to attempt to collect additional rocks *only after one of each of the five colors is collected*. Additional rocks collected will be used to determine tiebreaker situations.
- ***Only rock samples present in the storage unit*** on the rover at the **END** of the event will count towards the final score. Rocks collected that fall out of the storage unit before the end of the event will NOT be counted towards the final score.
- The rock collection device **MUST** be operated under ***its own power*** – in other words, it ***cannot*** be operated manually through pulling a string or holding a wire in order to move the device (pumping the pneumatic pump and/or operation of the battery boxes is ***not*** considered to be manual operation).
- The Rover Driver is the **only** team member who is allowed to operate the rover during the event (this includes the pumping of the pneumatic pumps if necessary). The ***only*** exception to this rule involves the Rover Assistant flipping the pneumatic switch (valve) during the event, if necessary, whether the switch is present on the actual rover or on the rover control panel.
- Rovers should be capable of climbing a slope of 30° in order to navigate the course. There are some areas steeper than 30° that a team may decide to traverse in order to collect additional rock samples not accessible to rovers with lesser capabilities.
- The rock samples will weigh similar to Martian rocks in a "near-zero" gravity environment, be constructed of a rough texture, and range between marble and golf ball size. Rock sample colors will be easily distinguishable.
- The course is approximately 4 feet long and 4 feet wide. Rock samples will be located in valleys, on flat areas, and on top of mountains at random on the course.

ROVER BREAKDOWNS

- If a rover becomes stuck or is unable to navigate a given section of the course, the Rover Assistant will be allowed to advance the rover one vehicle length in any direction. ***One point will be deducted from a team's composite score each time that such advancement is needed.***

- An overturned rover may be turned upright by the Rover Assistant to its position prior to overturning. ***One point will be deducted from a team's composite score each time that such flip is needed.***

- If a ***Minor Rover Breakdown*** occurs and ***minor*** repairs are necessary, the Emergency Mechanic will be allowed to make repairs on the course (repairs are completed in "real time" with a running clock).

- If a ***Major Rover Breakdown*** occurs and ***major*** repairs are necessary, the clock will be stopped, the team will be allowed to make repairs off the course, and will have ***one*** opportunity to re-attempt the course. During the re-attempt, the team will be **completely re-scored** on the test (any penalty advancement points deducted during the initial test will NOT be taken into account). ***A 30-second time penalty will be assessed to any team needing to re-attempt the course as the result of a major rover breakdown.***

TIEBREAKER

In the event of a tie on the Martian Rock Collection Test, the **additional rocks collected** (and/or **Marvin the Martian**), **penalty points,** and **Rover weight** will be used to break the tie and determine the winner of the event. An attempt to collect Marvin the Martian can only be done after all the rocks on the course have been collected.

BLIND DRIVING

10% of composite score = 10 pts

Complete the course while blindfolded and following navigational instruction provided by the Rover Assistant. The course contains five different obstacles that must be completed without entrapment *or* disturbance in order to successfully complete the test.

RECOMMENDED ACTIVITY

"Copy Cat" – http://ed.isu.edu/Idaho_TECH/Idaho_TECH_Lessons.shtml

REGULATIONS

- A maximum of **5 minutes**, *including penalties*, will be allowed for each team's test.
- The Rover Driver will be blindfolded and follow verbal navigational instruction provided by the Rover Assistant. The Rover Assistant is the **ONLY** individual who may talk with the Driver during the test. The Rover Assistant will need to ensure that the Driver moves with the rover during the test and will need to give appropriate and safe instructions when doing so.
- Of the 10 points possible, **2 points** will be awarded for **each obstacle** successfully completed within the five-minute time limit.
- Rovers that attempt an obstacle and become stuck, overturned, or disturb the obstacle (such as knocking over a rock) will be advanced past the obstacle, and no points will be awarded for that obstacle.
- Rovers should be capable of climbing a slope of 30° in order to navigate the course. There may be some areas that are steeper than 30° that a team may decide to traverse in order to take shortcuts not accessible to Rovers with lesser capabilities.
- The course is approximately 8 feet long and 4 feet wide; width allowance on some areas of the course is approximately one foot wide.

ROVER BREAKDOWN

- If a rover becomes stuck, overturned, or is unable to navigate a given section of the course, the Rover Assistant will be allowed to advance the Rover one vehicle length in any direction. ***NO points will be awarded for the obstacle being attempted at the time of advancement.***
- If a ***Minor Rover Breakdown*** occurs and ***minor*** repairs are necessary, the Emergency Mechanic will be allowed to make repairs on the course (repairs are completed in "real time" with a running clock).
- If a ***Major Rover Breakdown*** occurs and ***major*** repairs are necessary, the clock will be stopped and the team will be allowed to make repairs off the course and will have ***one*** opportunity to re-attempt the course. During the re-attempt, the team will be **completely re-scored** on the test. ***A 30-second time penalty will be assessed to any team needing to re-attempt the course as a result of a Major Rover Breakdown.***

TIEBREAKER

In the event of a tie on the "Blind Driving" Test, the **course time** and **Rover weight** will be used to break the tie and determine the winner of the event.

HILL CLIMB

10% of composite score = 10 pts

Climb the steepest incline possible. The rover will be required to move a two-foot distance on the hill climb course. After successful completion of an incline, the angle of incline will be increased by 10 degrees for another attempt.

REGULATIONS

- There is no imposed time limit for this event. Generally, most teams are able to complete the event in five minutes or less.
- The incline will begin at a 20-degree angle. All teams that successfully climb the **minimum 20-degree incline** will be awarded 2 points. Remaining points are earned dependent upon the highest 10-degree incline increment completed.
- The **entire** rover must travel a total distance of **2 feet** on each climb attempt; only ***one attempt per incline increment*** is allowed. Rovers must start on the incline, and are **NOT** allowed to have a "running start" up the incline.
- When a rover attempts a 10-degree incline increment and is unsuccessful, the incline will be reduced by five degrees and another attempt may be made to complete the reduced-degree incline. The test is then concluded after this attempt has been made (the team cannot re-attempt a higher incline after a successful attempt at the reduced incline).
- The test is concluded when the rover *no longer can advance, overturns*, or after the five-degree reduced-incline attempt has been utilized.
- The course is approximately 4 feet long and 2 feet wide, and the hill has a rough, Martian-like surface.
- Components of the Rover **CANNOT** be removed during the hill climb test.

ROVER BREAKDOWN

- If the rover no longer can advance or overturns during the test, the incline will be reduced by five degrees, and the rover will be allowed to attempt to climb the reduced-degree incline; the test will conclude after this attempt.
- The same incline may **NOT** be attempted twice, except in the event of a ***Major Rover Breakdown***. In this situation, the team is allowed to make the needed repairs off the course, and the team will be allowed to resume the test ***at the same incline being attempted*** before the ***Major Rover Breakdown*** was called. ***Minor Rover Breakdowns*** are allowable, but repairs must occur on the course.

TIEBREAKER

In the event of a tie, the **rover weight** will be used to break the tie and determine the winner of the event.

ROVER SPEED

10% of composite score = 10 pts

Complete the course in the fastest time possible.

REGULATIONS

- A maximum of **5 minutes**, *including penalties*, will be allowed to complete the course.
- Of the 10 points possible, 5 points will automatically be awarded to each team that completes the course within the 5 minutes allotted. The remaining points will be awarded dependent upon the minutes and seconds required to complete the course. The quicker the time the more points awarded.
- If a team is unable to complete the course within the 5-minute period, points will be awarded based upon the remaining distance to the finish point (up to 5 points maximum are possible if the rover does not complete the course).
- Rovers should be capable of climbing a slope of 30° in order to negotiate the course. There are some areas steeper than 30° over which a team may decide to traverse in order to take shortcuts.
- The clock will **NOT** stop for any vehicle that overturns, becomes stuck, or has a ***Minor Rover Breakdown*** during the running of the course.
- The course is approximately 8 feet long and 4 feet wide; width allowance on some areas of the course is approximately one foot wide.

ROVER BREAKDOWN

- The Rover Assistant may upright a rover to the original location if it has overturned. ***One point will be deducted from a team's composite score each time that such flip is needed.***
- If a rover becomes stuck or is unable to navigate a given section of the course, the Rover Assistant will be allowed to advance the rover one vehicle length in any direction. ***One point will be deducted from a team's composite score each time that such advancement is needed.***
- If a ***Minor Rover Breakdown*** occurs, the Emergency Mechanic will be allowed to make repairs on the course (repairs are completed in "real time" with a running clock).
- If a ***Major Rover Breakdown*** occurs, the clock will be stopped and the team will be allowed to make repairs off the course, and will have ***one*** opportunity to re-attempt the course. During the re-attempt, the team will be **completely re-scored** on the test (any penalty advancement points deducted during the initial test will NOT be taken into account). ***A 30-second time penalty will be assessed to any team needing to re-navigate the course as the result of a Major Rover Breakdown.***

TIEBREAKERS

In the event of a tie on the Rover Speed Test, the **completion time** and **rover weight** will be used to break the tie and determine the winner of the event.

+ WEIGHT

10% of composite score = 10 pts

The rover needs to be as lightweight as possible. Points will be awarded based upon a predetermined scale of appropriate weights.

REGULATIONS

- The rover must be **fully intact** for the official weigh-in. **NO** part of the rover may be removed when the weight is ascertained. Please note that this applies to **EVERY TEST** in the competition.
- The rover **will not** be weighed with the remote control and extended tubing (what is placed on each course for competition will be the item weighed).
- Rover weight will be recorded to the **nearest gram**, and points will be awarded dependent upon the placement of the rover weight on a predetermined scale (see the scoring form for further details).
- Prior to arriving at the weigh-in table, each Engineering Team will be required to list all of the Non-LEGO® Allowable Elements included on their rover on the back side of the Rover Weight scoring form.
- At weigh-in, the rover will be weighed and then examined to ensure that all components are included on the list, sorted into their correct category, and allowable for competition. If it is discovered that the rover has non-LEGO® elements that do not appear on the "Non-LEGO® Allowable Elements" list, does not include a rock collection device and/or rock storage unit, or appears to have exceeded the $50 extra LEGO®s budget, the **Idaho TECH** Coordinator will discuss the matter with the team and sponsor to determine if disqualification is warranted.

ROVER BREAKDOWNS

In each of the driving events, it may be necessary to repair your rover. If this happens, a Rover Breakdown may be declared. The Emergency Mechanic is the only person who can declare a Rover Breakdown to the event judge, but the decision to do so must be agreed on by the entire team. The Emergency Mechanic must indicate whether minor or major repairs are needed.

MINOR ROVER BREAKDOWN

Minor repairs include items such as wheels falling off, a wire becoming detached, or any other situation that calls for quick repairs. In the event that minor repairs are needed, the Emergency Mechanic will be allowed the opportunity to make necessary repairs on the course *during the event*. Note that *minor* repairs will be done in "real time" with a running clock, and there is not a limit on the amount of *Minor Rover Breakdowns* that can be called. There is no penalty assessed for *minor* rover breakdowns.

MAJOR ROVER BREAKDOWN

Major repairs include items such as a Rover separating into two or more pieces or any other situation that calls for repairs that may take a while to complete. In this event, the clock is stopped upon the calling of the *Major Rover Breakdown*, and the team is allowed to complete repairs off the course. The team is then allowed to re-attempt the event. Note that only *one* opportunity for major repairs will be given to a team for each event. Once a team has had the clock stopped due to a *Major Rover Breakdown*, any further repairs needed during the rerun of the event must be conducted with a running clock.

KIT RETURN

INFORMATION

Kits must be inventoried and returned to the NASA ISGC after the competitions. If missing or damaged pieces are found or the kits are not returned, the teacher sponsor's school or district will be invoiced for the cost of replacement of missing or damaged items. Please be sure all LEGO® parts are clean and free of tape or other sticky residue.

The following items MUST be returned:

Kit "R" – LEGO® Manufacturing Systems Kit (red container) (Cost: $150.00)
Kit "Y" – LEGO® Pneumatics Kit (yellow container) (Cost: $70.00)
LEGO® Building Binder

Please DO NOT return:

Any printed educational materials not included inside the LEGO® kits (such as posters, lithographs, etc.). We would like you to keep these educational materials for future classroom use.

Attn: Idaho TECH
Idaho State University
College of Education
921 S. 8th Ave, Stop 8081
Pocatello, ID 83209-8081