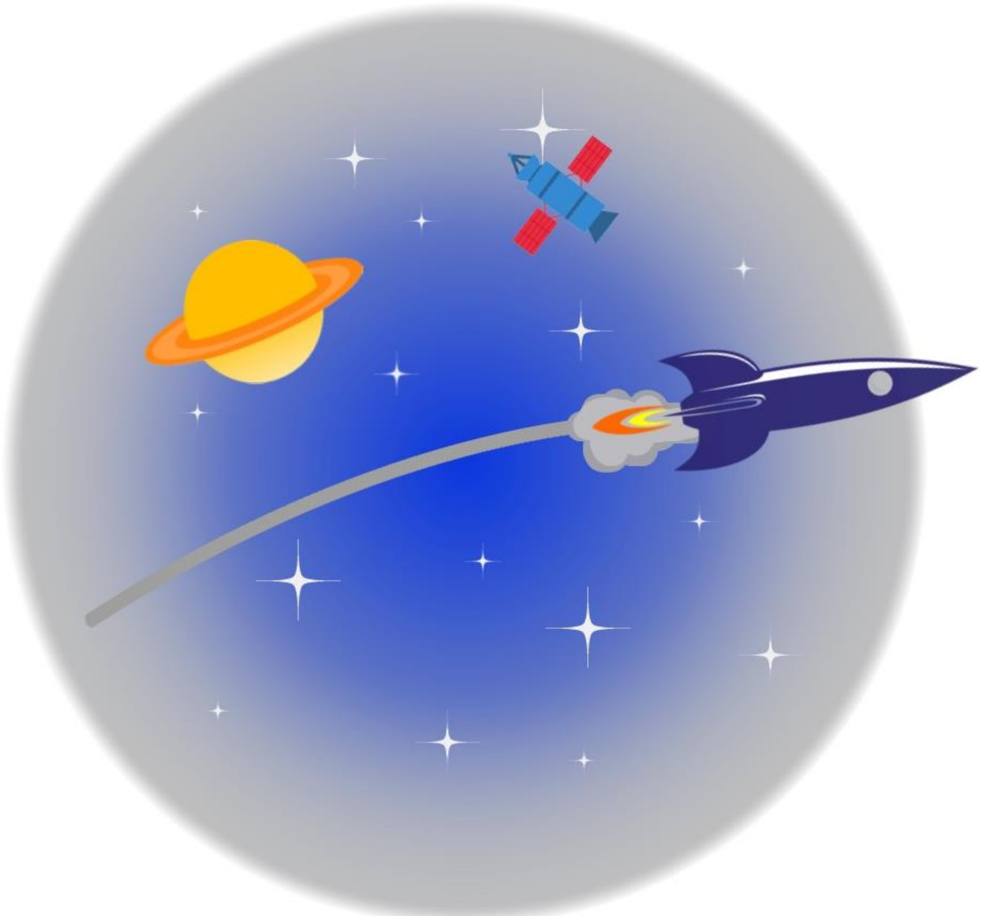
Exploration Into the Beyond

-2022 Rules Packet-



Scheduled for

October 20th, 2022

Hosted by the University of Kansas School of Engineering

Organized by the SELF Program's Class of 2024 Cohort

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Introduction:

Thank you for your interest and participation in the University of Kansas School of Engineering's annual High School Design Competition. We are so excited to see all your amazing projects! The competition day is October 20th, 2022. This packet will include competition rules and procedures for the day of the competition.

Accommodations:

If any students require accommodations to participate, we are dedicated to giving them an equal opportunity to engage in the competition, please reach out to highschooldesign@ku.edu and we will work with you to accommodate your students!

Theme:

This year's theme is "Exploration into the Beyond." As Neil Armstrong once said, "one small step for man, one giant leap for mankind." While this may be a small project in the course of your career, we hope this competition will be your first taste of the problem solving and creativity required to be a successful engineer. We want teams to push the boundaries of engineering and use their creativity to explore new solutions. Our goal is to provide competitions that prompt out-of-the-box thinking and reward ingenuity.

Scholarship Details:

For each of the six competitions, a $2,000 University of Kansas tuition scholarship will be awarded to the winning team. This scholarship will be divided between all winning team members equally. Scholarships will be contingent on student(s) enrolling at the KU School of Engineering. Students will know if they received a scholarship following the competition at the award ceremony, in which the HSD team will announce all first, second, and third place winners to all participants. Only the first-place team will be eligible for the scholarship in each of the six competitions. The scholarship is spread over the first two semesters at KU, 50% in the fall and 50% in the spring.

A Note on the Pandemic:

The University of Kansas and the School of Engineering are dedicated to the safety and comfort of all who work with us. As of now, we plan to have a fully in-person High School Design Competition. But, if we have learned anything from the last two years, it is that things are never certain. We will abide by KU's regulations in all matters.

Any changes, updates, or concerns will be shared as soon as they become available. For any questions, concerns, or accommodation requests, please reach out to highschooldesign@ku.edu.

Important Dates:

Registration Opens	May 1st, 2022
Registration Closes	October 1st, 2022
Competition Day	October 20th, 2022

Competition Rules:

The remainder of this packet will include the detailed rules of each of the six competitions. Each student may participate in only one competition. Students may be in teams of 1-4 and each school may enter as many teams as they please. As such, please let us know what events your school plans to participate in and how many teams you will be bringing per competition as soon as possible to secure a spot!

Questions Regarding Competition Rules:

If students or advisors have questions regarding the competition rules, they may reach out to their respective competition's representative (listed in their corresponding section of rules) and cc highschooldesign@ku.edu. Please be patient as our competition is run by full-time students, so if you do not hear back within 3 days, please send a follow-up email.

Expectations:

First, to maintain a safe and equitable competition environment, judges, volunteers, and faculty reserve the right to dismiss teams on the basis of disrespectful, discriminatory, or unprofessional behavior. This includes all communications, digital or in-person with the HSD team.

Second, High School Design is a design competition. As such, teams may only compete with designs that are overall unique to the team and not a purchased solution to the competition prompt.

Competition Leads:

Aerospace – Maggie Bonham | maggie.bonham@ku.edu
Bioengineering – Ed Luckie | ed.luckie@ku.edu
Civil – Phoenix Bialek | phoenixbialek@ku.edu
Chemical – Chase Harriman | chaseh@ku.edu
Computer Science – Joe Nordling | joenordling@ku.edu
Mechanical – Mike Slaney | mikeslaney@ku.edu

Aerospace Competition – Let's Glide!

Corporate partner: Textron Aviation

For questions regarding competition rules and specifications, please contact:
Maggie Bonham | maggie.bonham@ku.edu

Competition Objectives Overview:

A satellite has just detected a completely unexplored jungle, and they need to do some flyovers to gather more data. Due to strange electromagnetic frequencies, any electronic devices are rendered useless, meaning motors on a glider would be ineffective. Your job as a team is to create a glider that can fly long distances and accurately locate specific locations in the jungle without being powered.

Alongside the glider, your team must create a 3–5-minute presentation that demonstrates the functionality of your glider design. This presentation will include design, cost of materials, and answer questions for 3 minutes.

There are two objectives that must be kept in mind when designing your gliders. These objectives will be achieved through two different tasks as well as a presentation on the day of the competition:

1. Endurance:

This category measures the glider's distance and airtime. The key to this section is to find a balance between distance and time. Both throws will be scored, and the best of the two will be used for the final score.

2. Accuracy:

This category tests the team's ability to control their vehicle's flight path. Teams will earn a higher score by landing their vehicle closest to a target that is 50ft away from the thrower. Points will be awarded based on how close the vehicle lands to the center. Scoring for this task is listed in the competition scoring in more detail. Both throws will be scored, and the two scored will be added for the final score in this task.

3. Presentation:

The presentation consists of an explanation of the team's glider, and explains in detail the prototyping and build process, a list of materials used as well as the cost with each material, the final dimensions of the glider, and the reason why the team decided on the final design. Scoring for the presentation includes a rubric and will be 10% of the total score for the competition.

Competition, Vehicle, and Material Specifications:

Specifications for Vehicle:

1. Vehicles must be designed and built by a team of students, no kits or outside assistance.
2. Vehicles must be identifiable as gliders and demonstrate glider flight. For example, no baseballs, frisbees, bean bags, or other similar vehicles are allowed.
3. Vehicles must not return to thrower (boomerang).
4. There is no material requirement, but the vehicle must not contain any dangerous materials such as sharp edges that could puncture someone or something (example being the tip of a dart), chemicals, heavy wood/metal etc. that could cause bodily harm or damage to the test site.
5. No paper airplanes allowed. Competitors are allowed to use paper in their designs, but it must be their own original design, not just a folded piece of paper.
6. No power sources such as rubber bands, launchers, motors, or propellers may be added to the aircraft.
7. The total wingspan must have a width under 3 feet and a length under 5 feet.
8. Must have a weight under 3 lbs.
9. The aircraft must not be deformed during flight, (for example, deployed parachutes, unfolding wings, etc.)
10. Judges as well as coordinators reserve the right to disqualify any vehicle that violates the spirit of the competition or exemplify unprofessional behavior.

Specifications for Competitors:

1. Students will be responsible for throwing their vehicle for the tasks.
    a. Students may not switch throwers in the middle of a task but are allowed to switch for a different task. For example, one student may throw both attempts for the endurance task, and another student on that team may throw for the accuracy task.
2. Students must stay behind a designated line during throws. Volunteers will be responsible for retrieving the vehicle after an attempt.
3. Do not attempt to touch another team’s vehicle.
4. Do not throw vehicles at people, animals, equipment not used in the task, or at other vehicles. Vehicle may be thrown towards map placed on the ground for the accuracy task.
5. The thrower must count down from 3 and say “launch” to ensure that times can be collected accurately.
6. All competitors must be attentive during a launch in case a glider behaves unpredictably.
7. All throwers must wear safety glasses/goggles, which will be provided by KU.
8. Failure to follow these guidelines may result in point deductions or disqualification from the competition.

What to Bring on Competition Day:

Your team is expected to have your vehicle complete prior to your arrival at the University of Kansas. All materials brought in will be inspected to make sure they meet the required specifications listed above. All materials that do not pass inspection will not be allowed in the competition. Items brought to repair your vehicle can be utilized between tasks and not between throws.

A list of what materials to bring on competition day:

1. Your vehicle
2. Your presentation
3. Total bill of materials/itemized project budget
4. Any materials needed for repairs

Competition Procedure:

Endurance Task:

1. Two attempts to throw, the best of the two throws will be scored.
2. Throw must be made from a standing position (no running start allowed)
3. The thrower must throw overhand
4. Must be standing on the ground (no stool or chair)
5. The time will start once the thrower releases the vehicle until it contacts the ground.
6. The distance will also be measured from the line to where the plane impacts the ground. The distance will not consider any deviation to the left or right.
7. Disqualified throws may occur when:
    a. A vehicle collides with any other objects while in the air (people, other vehicles). If this occurs, the throw will be disqualified.
    b. If the thrower crosses over the line at any point during the toss.
    c. If a throw is disqualified, the thrower will have a chance to redo that throw. Only one redo will be allowed for each team. Redos will not be allowed if a throw is not disqualified.
    d. If more than one throw is disqualified even after a redo is done, the disqualified scores will be listed as N/A.

Two SELF volunteers or judges will be taking time. The best time will be taken. A video will also be taken to eliminate any discrepancies between the times.

Students will have a maximum of 5 minutes to repair any damage done to their vehicle between tasks, but not between throws for a specific task. The repairs must not alter the original design of the vehicle, only repair damages sustained in competition.

Accuracy Task:

1. Two attempts to throw, both throws will be scored. The number of points for each throw will be added to equal the total score for this task.
2. Throw must be made from a standing position (no running start allowed).
3. The thrower must throw overhand.
4. Must be standing on the ground (no stool or chair).
5. The distance will be measured from the target to where the vehicle comes to a complete stop.
6. Deviations to the left and right will be considered.
7. Disqualified throws may occur when:
    a. A vehicle collides with any other objects while in the air (people, other vehicles). If this occurs, the throw will be disqualified.
    b. If the thrower crosses over the line at any point during the toss until the vehicle has come to a complete stop.
    c. If the thrower leaves the designated area before the vehicle comes to a complete stop.
    d. If a throw should be disqualified, the team will be allowed one extra throw with no penalty. If another disqualified throw occurs, the team will not get another chance to make up for the disqualified throw.

Presentation:

The presentation must include:

1. Name of all team members and team name in a title slide.
2. An explanation of a prototyping process and/or design process.
    a. This may include a drawing of a projected design or a few prototype gliders.
3. A list of all materials used, including cost and total cost.
4. The dimensions of their glider.
5. An explanation of why the team chose the final design.

Students are welcome to add any more information about their glider, if the presentation remains within the 3–5-minute window and is relevant to the competition.

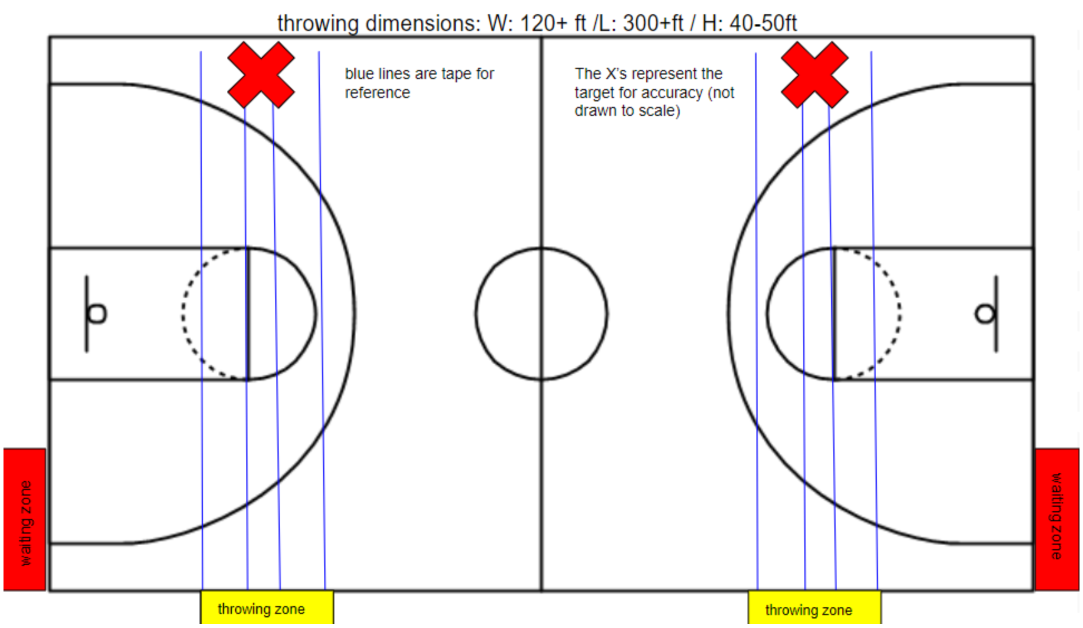
The students will bring their poster or submit their presentation by email to maggie.bonham@ku.edu the night before the competition. The students will be given 3-5 minutes to present, and judges will make notes and ask questions after the student has completed.

Launch Sequence:

After registration closes, each team will receive a competition day schedule that determines the order they compete in. Teams will complete all their tasks in the designated time.

When it is time for a team to compete, only members of the team will be permitted on the launch ground. All other teams must be on the side out of the way. Other teams must be respectful of teams throwing. Once given a signal, the thrower will be allowed to throw the vehicle. When the vehicle is retrieved, the thrower can continue with the second throw. This procedure is followed for both the endurance and accuracy tasks. Also, the thrower must follow all protocols described above (competition procedure).

After this task is complete, students should prepare for their presentation. This may occur before they complete their endurance and accuracy tasks, depending on the schedule. More information will be given on the day of the competition.



Competition Scoring:

Within this competition there are three tasks, (endurance, accuracy, and presentation), that will be scored independently of each other. The final score will be weighted as follows:

Endurance: 45%

Accuracy: 45%

Presentation: 10%

The cost of the materials will be used as a tie breaker. The team with the lowest cost of materials in the case of a tie will be declared the winner of the aerospace competition.

Endurance Task Scoring:

This section is scored using a geometric mean between distance and time. Notice a factor of 10 is also multiplied to flight time. The following equation will be used to assign points. The final score will be multiplied by 10 to account for weighting.

$$P = \sqrt{\left(\frac{d}{10}\right)^2 + (t)^2}$$

P= Total points earned

d= distance (ft)

t= time (s)

Accuracy Task Scoring:

Accuracy will be scored by measuring the distance between the center of the target and the tip of the fuselage or “nose” of the plane. Points will be awarded based on a designated radius. The final score will be multiplied by 10 to account for weighting.

0-5 ft: 10 points

5-20 ft: 5 points

20-50 ft: 2 points

50+ ft: 1 point

Presentation Scoring:

Presentation Rubric	**Outstanding**	**Competent**	**Developing**
Points	**3**	**2**	**1**
Time	Time of presentation falls within allotted 3-5 minutes.	Time of presentation is 30 seconds over or under the allotted time.	Time of presentation is 1 minute over or under the allotted time.

Content	Includes detailed information about the materials, dimensions, cost and timeline.	This includes some information about the necessary content, but some information is missing.	Includes little to no necessary information is given.
Design	Includes detailed information about prototyping process, current design. This includes why the team chose the design.	Includes some information about the prototyping and design process but missing important details.	Includes little to no information about the prototyping process and/or current design.
Context	Demonstrates understanding the entire design process and gives well thought out reasons for the chosen design. Citations are provided where needed.	Demonstrates some understanding of the design process and/or gives some reasons for the chosen design but may be missing some information.	Demonstrates little understanding of the design process and/or gives few reasons for the design choice.
Presentation	Overall organized, detailed, clear. Has diagrams/images of vehicle that fit well with the context.	Slightly unorganized, diagrams/images do not fit in context.	Unorganized, little detail included. Diagrams/images are hard to read or non-existent.
Questions	Answers questions to satisfaction.	Leaves some questions remaining.	Leaves most questions unanswered.

Example Questions:

Would it be possible to mass produce your design?

If budget was not a constraint, what materials would you use and why?

How would you improve your design down the road?

What principles of aerospace engineering did you use in your design?

Bioengineering – Preventing Muscle Atrophy in Space

Corporate Partner: BARKLEY

For questions regarding competition rules and specifications, please contact:
Ed Luckie | ed.luckie@ku.edu

Introduction:

During space travel, astronauts face a process known as atrophy, when their muscles deteriorate and weaken due to the lack of gravity in their environment. Without gravity, astronauts lose muscle mass resulting in muscle atrophy. NASA is challenging teams to research, design and build a device that can fight the effects of muscle atrophy. Each team will design and build a piece of exercise equipment that does not rely on gravity to create the desired resistance in their muscles. The team members will be responsible for producing a mock-up of the project and creating a presentation on their process in designing the device, including a firm understanding of the behaviors of muscles under resistance and the functionality of the muscle group chosen.

Competition Specifications & Material Specifications:

1. Each team must submit their project with a one-page maximum description paper including the following information:
    a. School, teacher/mentor name, teacher/mentor email address, and a brief description of the project
2. Each team must turn in a bill of materials list explaining the cost of each component, the quantity of each component, and the purpose of components chosen
    a. Turning in the bill of materials will guarantee points (See point rubric); the purpose is to ensure the students think clearly about the design, the cost of the components, and that the students do not use premade mechanisms
3. Each team must turn in a simple user guide describing the proper use of the project and any precautions when using the mechanism
    a. Must be on an 8 x 11" piece of paper
    b. Must be less than 2 pages
    c. Double-spaced, 12 pt font
4. Any projects that are deemed dangerous for operation and hazardous to the team will not be tested but may still be scored on all other specifications. Such safety issues include:
    1. Any sharp exposed parts
    2. Unstable structures
    3. Any exposed electrical components
    4. Anything that positions a body part in a situation where is at risk of crushing, cutting, electrocution, snapping, blinding, breaking, (etc.)
5. Must be built by the students only and not any parental/mentor interference

   a. Parent/mentors are allowed to guide and assist with the construction of the device but are not to build it for the students nor interfere with the student's creative license.
6. No standalone prebuilt exercise equipment of any kind may be used.
   a. For example, teams cannot just buy an exercise band for their project, but an exercise band used as part of a larger device is permissible.
7. While operating the device, all team members, judges, and observers will be required to wear safety glasses, which will be provided by KU. If the team feels that additional safety equipment is needed, this must be clearly communicated to the competition judges (see Rule 4).
8. The project must be able to be transported by the team in elevators, through doors, and for moderate distances on foot.
9. The project must be able to attach to the provided testing arm rig.
   a. The arm rig will be actuated using a pneumatic bicep muscle with a pressure gauge.
   b. Project must fit within the 3m x 3m platform.
      i. The platform includes four attachment points at each corner which, if needed, may be used to attach the device.
      ii. These points may be moved anywhere within the 3m x 3m area
      iii. NOTE: A visual representation is located in the resources section of the rules.
10. If any of the above rules are violated, it is up to the judges' discretion whether to disqualify the team from competing.
11. If the team's violation is regarding illegal mechanisms or components, the teams will receive a warning and the opportunity to remove the said violation.
    a. If the team is unable to do so before testing, the team will be given a score of zero for the project portion of the competition.

Competition Procedure:

During the competition, students will enter the testing room with their project and meet with the judges to discuss the team's project and begin testing. In the room, there will be a 3m x 3m platform with four hook points at each corner and a standing arm rig in the center. The team's project will be attached to the rig, and hooks if needed, to begin testing. The leads and/or volunteers will begin testing the project once the team gives the affirmation that the device is prepared. Three tests will be run and, during scoring, only the highest pressure will be scored. The volunteers will then take the score and calculate the relative force exerted by the project. The team will then be evaluated and given feedback as the scores are noted down according to the rubric and will be given a brief demonstration on how their device might be tested in an ideal setting. The team will then remove the project from the rig and leave to continue their day and allow the next team to enter.

Competition Scoring:

Bill of materials: Did the team turn in a bill of materials? (+5)

- Includes the item name, quantity, description/application, and the price of each component as well as the price of the entire project
    - NOTE: If the team fails to turn in a bill of materials, the points will not be awarded as well as the project will be ineligible for the simplicity category

Simplicity: The team's ability to produce the project with the least number of components

- Points will be rewarded based on the team's ability to build a project within one of the three budget zones
    - (+5) < $25
    - (+3) $25 - $50
    - (+1) $50 – $100
        - NOTE: anything above $100 will receive no points for this section
- To receive these points, the project must:
    - Function according to its design
    - Activate the muscle group
    - Not depend on gravity
        - NOTE: The project does not need to function effectively but simply function to receive points in the simplicity category

Effectiveness: The range of force created and muscle activation

- Judges will approximate an offset for these values due to the presence of gravity (i.e.. A device that requires the user to move tangent to the ground will have a larger offset than a device where the user moves parallel to the ground)
- Points will be awarded in terms of the team's ability to effectively recreate 15 lbs of force on the muscle group
- This measurement will be taken via a pneumatic arm rig, taking the reading of air pressure (pascals) and the approximate area of the muscle (m^2) and translating it into relative force exerted on the rig (N)
    - 15 lbs exerts approximately 147.15 lbm on Earth, thus, teams should aim to score ~654.556 N)
- Student should NOT attempt to go above said value as exceeding the range will also result in point reduction
- Points will be rewarded based on the team's ability to meet one of the four force ranges
    - (+10) Project meets the 15 lbs of force target by a margin of +/- 0.1 lb

- (+5) Project meets the 15 lbs of force target by a margin of +/- 1 lb
- (+3) Project meets the 15 lbs of force target by a margin of +/- 3 lb
- (+1) Project meets the 15 lbs of force target by a margin of +/- 5 lb
  - NOTE: Any range below/above the +/- 5 lb margin will be rewarded 0 points

Total available points: 20

Resources:

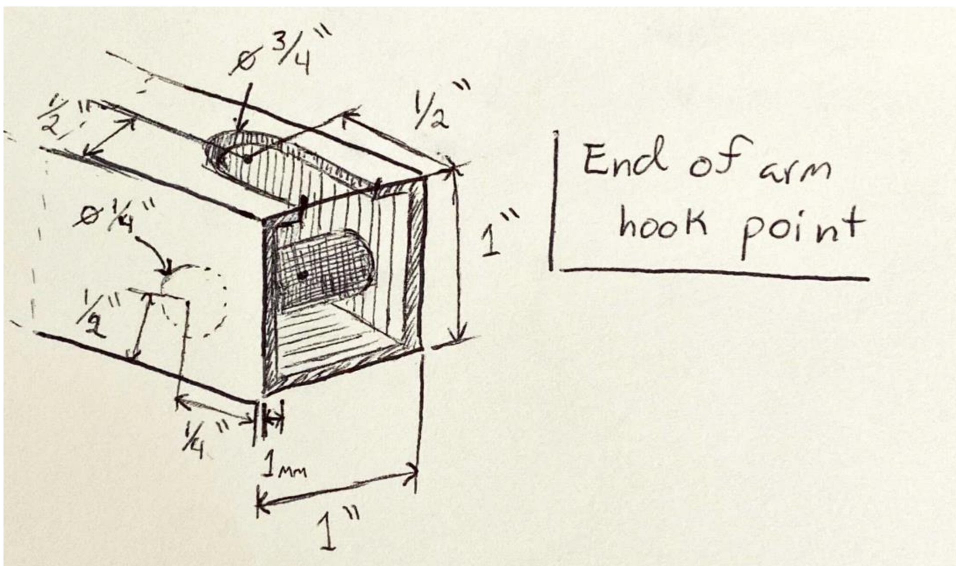
To help the students come up with some design ideas and start thinking about what the exercise equipment would look like, below we have provided some educational videos and links! Please feel free to take inspiration from the videos to prompt your research and design process:

https://www.theverge.com/2017/8/29/16217348/nasa-iss-how-do-astronauts-exercise-in-space

Space Station Live: The ISS Workout Plan

Former NASA Astronaut Explains How Workouts Are Different in Space | WIRED

Below is an image of the end of the arm so teams may design accordingly:



Presentation Rules:

Teams will be tasked to present their projects for 5-8 minutes discussing the applications of the device in a space station, how the device affects and combats muscle atrophy, and the process of designing their mock-up. After which, they will be asked to answer questions from the judges and/or leads regarding their project.

The Presentation Scoring:

- Visual aids will be allowed (i.e., PowerPoints, pamphlets, etc.)
    - There will be a projector with an HDMI adaptor for laptop connection available for students
- Presentations must be limited to between 5 – 8 minutes
    - Students must come prepared to present to ensure the competition runs on schedule

Category:	**Description**	**Points**
Depth of understanding (biological)	Students demonstrate a solid understanding of the function of the bicep muscle and the movements necessary to prevent atrophy	+10 Strong +7 Intermediate +5 Beginner
Depth of understanding (mechanical)	Students demonstrate a solid understanding of the function of their project, specifying the purpose of each component and explaining their reasoning for their design	+10 Strong +7 Intermediate +5 Beginner
TOTAL POSSIBLE POINTS:		**20 Points**

Chemical Competition Rules - Fueling Exploration

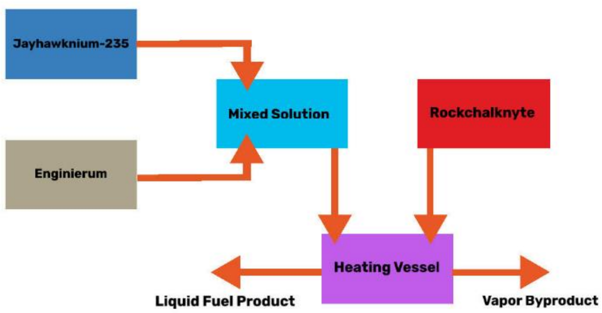
Corporate Partners: Burns & McDonnell, Kiewit

For questions regarding competition rules and specifications, please contact:
Chase Harriman | chaseh@ku.edu

Challenge Overview:

The rocket to Mars is almost complete and the launch is set for next week - but wait! There is one last piece that needs to be finished: the fuel system. In order to make it to Mars a revolutionary new fuel has been developed. While extremely efficient, the fuel is so volatile that it could potentially destroy the rocket if stored in its most reactive state. Therefore, the fuel must be mixed and delivered to the combustion system in the rocket. You and your team of engineers have been assigned to design this mixing system according to the process specifications. In order to get your design approved you must present a brief design presentation and a functional fuel mixing model to the rocket design committee.

Competition Specifications:



1. The process must be able to be steady state (no accumulation) given the proposed flow rates of each component
2. The fuel's components consist of Jayhawknium-235 (15 ml/s) (represented by blue dyed water), Rockchalknyte (25 ml/s) (represented by red dyed water) and Enginierum (8 ml/s) (represented by Isopropyl Alcohol)
3. Equal flow rates of Jayhawknium-235 and Enginierum must be mixed in a volume and flow out at a rate equal to the combined entering flows (Process 1)
4. The combined Jayhawknium-235 and Enginierum flow and a separate Rockchalknyte flow must flow into a volume where all components are mixed and heated to 85 Deg C (Process 2)
5. From the heated chamber there must be a pipe to remove the vapor (byproduct) and another to remove the remaining liquid (final fuel)
6. The product stream must be removed from the system into a vessel for judges to examine the properties of the final fuel
7. The byproduct stream has unreacted elements of the fuel – it can either be cooled into liquid removed or made into a stream that is recycled somewhere* in the process

*****If this option is chosen there must be a way to view or otherwise measure the amount recycled

Competition & Judging Procedure:

1. On the day of competition, the competing team will bring their fuel system into the competition and set it up to be functional
2. The team will give their brief proposal presentation followed by an inspection of their system and a Q and A period about the design and choices made
3. Following the inspection, the fuel components provided by us will be poured into the system (simulating one second of system function). The pour will be done by our volunteers, and to maintain heat safety any manual component of the system will be operated by us as well. The final product will be collected and examined to see if it matches the correct volume given the initial materials and the correct mixture ratio through use of a colorimeter
    - To make the representations of both Jayhawknium and Rockchalknyte we will be adding 5 drops of Mccormick food coloring to 30 ml of water

What To Bring:

1. Your fuel system* (labelled with a team name and contact information)
2. A printed excel sheet containing materials used and cost of each must be given to us along with your device. This must be sent along with receipts or photocopies for **every item that went into the construction of the fuel system**.
3. Your proposal presentation

*We will supply a heating element (typical hot plate) and each of the fuel components for the test

Fuel System Specifications:

1. The fuel system must contain separate containers for each component of the reaction and a transport from chemical reservoir to clean reaction chamber and thruster (similar to a more complex version the figure above)
2. System materials can be moved by pumps or gravity; however, no part of the system can be subjected to significant pressure*
3. Piping and chambers can be made of any material, but any piece in contact with heat or heated material must be heat safe
4. System should be made to support continuous flow of each of the fuel components, but the testing will only consist of pouring equivalent amounts of each component into the system at the same time.

5. System is allowed to be touched during the presentation, any manual valves, pumps, etc. you decide to include can be operated during the test. However, as volunteers will be conducting this, please be prepared to instruct us on how to operate the system.

*This must be considered especially for process 2, as it is subject to heat – we will not test a system that we think will break and potentially harm Judges and Team Members

Proposal Presentation:

- The proposal presentation must consist of your reasoning and process of designing the fuel system such as material choice considering the mission or style of piping considering space on the rocket
- The Mars rocket committee wants to make sure any fuel system added to the rocket will be successful, and therefore are looking for the exact specifications of the system – how much fuel can it make at a time? How fast do you expect the fuel to be able to be pumped through?
- Please include a diagram showing each process and where each component flows (including maximum possible flow rates given size of pipes/chambers)
- The committee also wants to be efficient on costs, they are looking for an explanation of how the system is cost efficient while maintaining effectiveness
- Be sure to cite any sources used
- Presentations should be between 2 and 5 minutes in length, and all team members should participate.

- See the rubric below for full scoring.

Grading:

Grading will give points in between the exact values – each section is a guideline

Category	Developing	Competent	Exemplary	Points (Total)
Presentation (2-5 min)	Limited group members speaking (1)	Few group members were present. (2)	All group members participate in the presentation. (4)	**Group Participation __/4**
	Gaps in understanding and little to no confidence with the material (1)	Basic understanding and some confidence in material (2.5)	Expert understanding and confident in the material (5)	**Confidence in Material ___/5**
	Diagram is either missing or lacks significant information (entire processes, all stream information) (1-2)	Diagram is either slightly incorrect (Streams incorrect, processes do not have all materials included) or Missing a few pieces (stream information missing for one stream) (4)	Diagram is fully drawn out with each process and stream labeled correctly (streams have maximum capacity of material flows, all materials and processes accounted for) Bonus: 1 point for visual appeal (color coding, clean presentation)	**Material Balance Diagram __/7**
	Formatting in the presentation is not efficient in displaying the material. (0.3) Visual is not engaging (0.3) Hard to follow. (0.3)	Formatting is not efficient in displaying material. (1) Visual not thoroughly engaging. (1) Slightly difficult to follow. (1)	Formatting is efficient in displaying material. (2) Visually engaging (2) Easy to follow. (2)	**Overall Presentation__/6**

Category	Developing	Competent	Exemplary	Points (Total)
Design & Research	Not able to explain concepts behind the project (0)	Basic explanation of some concepts/ideas behind the project. (5)	Thorough documentation of design and build process (10)	**Design Concepts __/10**
	No citations (0)	Some citations included for outside sources(1)	Thorough Citations included (2)	**Citations __/2**
	One member of the group did all the research. (0)	Some delegation between team members (1)	Explanation or work and leadership system delegation (3)	**Group work__/3**
	Not able to answer questions asked during Q & A session after presentation (0)	Able to answer some questions asked during Q & A session after presentation. (2)	Able to answer all questions asked during Q & A session after presentation (4)	**Q/A __/5**
	No or very spotty documentation – entirely unjustified cost (exorbitantly expensive, many unneeded costs) (1)	Documentation has some mistakes, some unneeded or expensive costs (3)	Documentation includes all costs, and all components are justified (5)	**Cost Effective __/5**

Category	Developing	Competent	Exemplary	Points (Total)
Fuel System	Not every aspect of the process is accounted for, or some are nonfunctional (5)	Every aspect of the process is accounted for, but some aspects don't function fully (liquid accumulation, final product doesn't match materials put in) (10)	Every aspect of the process is accounted for, and every aspect works nearly perfectly – no liquid left in any chamber, all aspects heat safe (15)	**Fuel Mixing _/15**
	Piping does not function or consistently malfunctions (2)	Piping is effective, but has some issues (inconsistent rates, some leaks or other malfunctions) (4)	Piping is near perfect with no leaks and minimal liquid left after flowthrough – all aspects heat safe (8)	**Piping _/8**
	System is oversized and takes significant effort to make function (1)	System is either too large or takes too much effort to function (2)	System fits comfortably on a card table (~ 3 sq ft or less) and easily activates and stops (3)	**Ease of Use _/3**
	The volume of final fuel mix is off expected result (1+ ml) Color is visibly incorrect and far off wavelength (80+ NM) (2)	Volume of final fuel mix is close to expected result (within 1 ml) Color is visibly correct and is close to correct color wavelength (within 80 NM) (4)	Volume of final fuel mix matches expected result (within 0.5 ml) Color is visibly correct and matches correct color wavelength (within 30 NM) (7)	**Proper Mixing & Efficiency _/7**

Civil Engineering Competition – Building into the Beyond

Corporate Partner: TREKK Design

For questions regarding competition rules and specifications, please contact:
Phoenix Bialek | phoenixbialek@ku.edu

Introduction:

It is the year 3000 and the world has become an unsustainable place to live. Scientists and Engineers for generations have explored various planets and galaxies in space, and the time has come to leave Earth. The government is in dire need of a safe, sound, and sustainable living community on Mars that will withstand the test of time. This is where you and your team come in. You must present a sustainable and sturdy design for communal living on Mars (think apartments, retirement home, dorms, etc.) Despite this being a time-sensitive project, you are not the only firm competing for this bid, so you will really have to wow the judges on your structure and design. Ensure them that not only is your building strong (able to withhold a substantial amount of weight) and effective (able to house a large amount of people), but that the aspects of the building (some of the design choices) were decided so the building would fit right in on Mars. The government has left this portion of the project up to the imagination of each team. However, they have stressed the importance that during the presentation, the team discusses how these design choices were implemented during the design process. (Details on how the competition will run are discussed further down in this document)

Your structure MUST follow ALL specifications listed below in order to compete in the competition. Additionally, there will be three aspects contributing to the overall grading of your project: 1) Load/Mass Ratio Testing, 2) Presentation, and 3) Aesthetics.

Specifications:

- MUST ONLY use ¼" width and ¼" thickness balsa wood for entire building (This does not include adhesives (glue, tape, etc.) or design materials (paint, markers, etc.) ...just no other material (wood, steel, plastic, etc.) for building)
- MUST have a **flat AND level** top with minimum dimensions of 6" x 6"
  - Can be square, rectangular, circular, etc. but MUST be flat, level, and have a minimum diameter/ side length of 6" on each side
  - MUST be able to place a 5 lb. bucket on top of building for load/mass ratio scoring
- No more than 4 students per team
- Total **height** range: min 1'- max 4'
- Total **width** range: min 6"- max 1'
- Minimum 2 stories (one story is defined by a floor separation)

- Building must be free-standing
  - no external support
  - base cannot be a solid platform
- Connections made *end to end* with balsa "sticks" are allowed a **maximum** 2 inch overlap
  - Reference Figure 1 below for what is acceptable
- **<u>CANNOT connect more than 4</u>** "sticks"/wood pieces *side by side* creating solid wall, platform, etc.
  - Reference Figure 2 below for what is acceptable
- Building and presentation must be completed prior to arrival at KU

MUST FOLLOW *ALL* SPECIFICATIONS IN ORDER TO AVOID DISQUALIFICATION!!!

Figure 1:

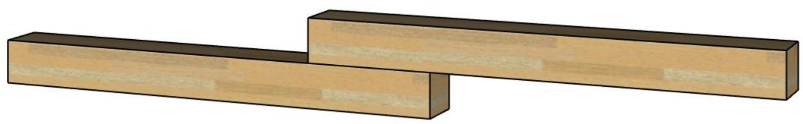
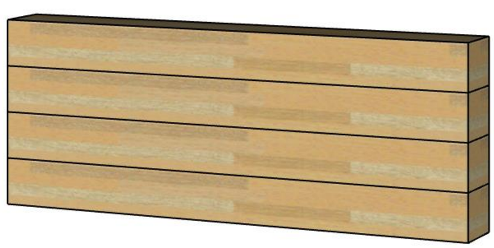
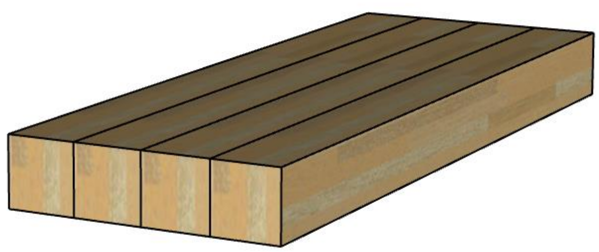
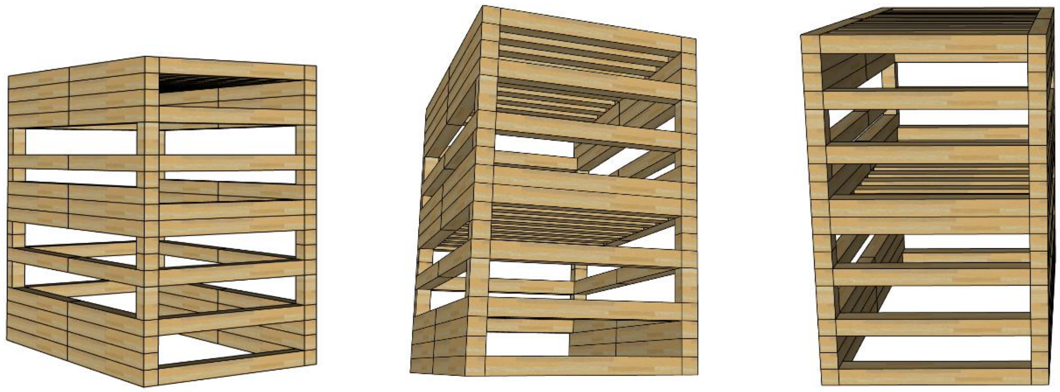


Figure 2:





Example of an Acceptable Building (CANNOT copy this exact design)



Examples of **UNACCEPTABLE** buildings

Load/Mass Ratio Testing:

- Your building will be tested by first weighing it, and then applying a distributed load to the TOP CENTER of your structure until any building member FRACTURES (**As soon as** a member fractures, (including but not limited to building collapse), the weight will be removed, and that will be used for scoring). This information will tell us how strong and sturdy your building is.
    - The weight will be applied by placing a thin piece of wood on the top of your building, and a large bucket on top of that. Then weight will be put in the bucket IN INCREMENTS (via 5 lb. bags of sand, and additional weights if necessary).
        - This is why your building MUST be flat and level at the top
- Load/Mass ratio is based on the load withstood before your building fractures, divided by the total mass of your building.
- Percentile range scoring is based off ranking the teams by which load/mass ratios are the highest at the end of the competition.

- For example, if my building weighs 0.15kg and it held 30kg before cracking/snapping/collapsing, it would fall in the 200% load/mass range and be awarded 15 points in this scoring category.

Load/Mass Ratio Percentile Range	**Points Awarded**
0-100%	5
100-200%	15
200-300%	25
300-400%	35
400-500%	45
500-600%	50
600-700%	55
700-800%	60
800-900%	65
900-1000%	70

Total Testing Points Available: 70

Presentation:

- Your group will create a short (maximum 5 minutes) presentation highlighting the choices made that contribute to the overall durability/strength of your building, living capacity per building, and Mars location.
- Include an explanation of what makes your building fit in on Mars
    - This could be unique building design, colors, features, etc. that would prevent the building from looking out of place in this location
- Include a brief explanation on ***hypothetical*** features you would add to make it sustainable on Mars (protection from thin atmosphere, cold surface, lack of gravity, etc.)
    - These features do **NOT** need to be implemented into your building

	Beginner 1 point	**Developing 2 points**	**Acceptable 3 points**	**Effective 4 points**	**Excellent 5 points**
Design Explanation (includes structural, living capacity, and design)	Failed to address prompt or only explained one part of prompt	Slightly addressed at least 2 prompts, but not fully	Addressed some portion of all 3 prompts with vague explanations	Addressed all 3 prompts effectively and with some level of detail	Full detail and explanation behind design choices, fully addressed each prompt
Sustainability Features	No hypothetical sustainability features explained	One – two features with vague explanation	One – two features with thorough explanation of how they make the building sustainable	Two or more features with good explanation	Two or more features with thorough explanation of their benefits on Mars
Presentation Skills	No eye contact, no team introduction, too quiet to hear, one person gives entire presentation	Minimal eye contact, barely/no team intro, barely audible	Some eye contact, good intro, good voice projection, only a few group members speaking	Good eye contact and intro, good voice projection, even distribution of speaking parts	Captivating presentation, great eye contact and voice volume, members present equally

Depth of explanation	No explanation of design/ build process, no enthusiasm	Vague description of design/ build process, little enthusiasm	Some explanation of design/build process, some enthusiasm	Good explanation, mostly enthusiastic	Fully explains the design process, enthusiastic about building

Total Presentation Points Available: 20

Aesthetics:

- Based on how neat/clean the project appears and how well the team incorporates the location of Mars
- By incorporating Mars' location, judges are looking to see if the color, design, etc. would be aesthetically fitting on Mars
    - For example, a pink beach house with lots of windows and patios would look out of place if it was built in Antarctica

	Beginner 1 point	**Developing 2 points**	**Acceptable 3 points**	**Effective 4 points**	**Excellent 5 points**
Location Incorporation	No design element with Mars in mind – looks the same as apartments we already have	Minimal effort towards incorporating location in aesthetic choices, basic style	Some effort put in towards connecting Mars location with design elements	Good effort put in to make the building fit in on Mars	Design was unique, realistic, and would fit in very well on Mars
Overall Look/ Neatness of Product	The final product is messy and incomplete, lacks creativity	The final product is finished but lacks creativity and neatness	The final product is neat and effort was put in to making building look presentable	Final product shows creativity and care taken to make it neat	The final product is very creative and appealing, the design is clean

Total Aesthetic Points Available: 10

Final Grade Breakdown: Your Score /100

- In the case of a tie in overall scores, the higher score in Load/Mass testing will win. If teams have the same score in Load/Mass testing the next tie breaker will be Presentation, and lastly Aesthetics. In the case of a tie in every area, the judges will choose a winner at their discretion.
- Questions or concerns? Feel free to contact Phoenix Bialek, phoenixbialek@ku.edu

Computer Science Competition – CyberSpace

Corporate Partner: NEER.AI

For questions regarding competition rules and specifications, please contact:
Joe Nordling | joenordling@ku.edu

Introduction

The field of computer science is broad and multidisciplinary. This year's competition aims to allow for students to exercise their own creativity and personal interest through an intentionally broad scope. Student teams will consist of 1-4 students that will create a mobile app, website or desktop program that will solve a problem, explore a personal interest, or express creativity. Student teams can submit a project under one of three main categories. These categories are defined in the category section. Teams will be required to create a program to solve an issue, while also fulfilling certain design criteria (See Competition Rules) in addition to filling out written responses about your program. During the High School Design competition day, student teams will give a "shark tank" like pitch for their program with its pros and cons. This competition is inspired by the AP computer science performance task as well as Hackathon competitions. We decided to shift to this competition format in order to reflect the take home interviews that companies are shifting to.

Competition Rules

General Program Requirements

1. Must email all required documents to joenordling@ku.edu by 11:59pm on 10/13/22 or teams will be ineligible to compete.
    a. Required Documents

i. A google doc, word doc, or pdf with answers to all the written requirements
ii. Access to the source code via github or a zipped folder with all of the source code
    1. The judges recommend for student teams to create and maintain a github; if teams decide to use a github then a link to the public repository would be enough.

Overall Requirement

Your team works for an outerspace travel company, which has tasked you with developing an In-Flight Entertainment system. Our customers would like some entertainment while on their long space journey. Ideas include small games, shopping sites, multiple playergames, etc. If you're not sure if your idea fits in this category, please contact Joe Nordling (joenordling@ku.edu)

For this project we will require you to program in an Object Oriented Programming (OOP) Language. Languages that do not fit this category will result in an automatic disqualification from the competition. If you're not sure if your language fits in this category, please contact Joe Nordling (joenordling@ku.edu)

In Four Pillars of Object Oriented Programming are encapsulation, abstraction, inheritance and polymorphism. Your team will be graded upon effectively utilizing these pillars in your code.

Written Requirements

1. Problem Statement (~150 words)
    a. Clearly define the problem that the program is intended to solve
    b. Also express who might benefit from this problem being solved (elderly, kids, anyone)
2. Data Structure Section (~150 words without code)
    a. Screenshot or copy and paste a section of code that uses a data structure of some sort (List, Array, Queue, Stack, Tree, etc.)
    b. Describe why the team decided to select this data structure
    c. Were any other data structures considered for this role?
3. Algorithm Section (~200 words without code)
    a. Screenshot or copy and paste two sections of code - one section that shows a student-made function or procedure and another section that shows the function being used.
    b. Explain in general terms how the algorithm works and what purpose it solves within the team's code

   c. What was the thought process behind putting the algorithm into its own function instead of just keeping it within the rest of the code?
   d. For the second section of code, explain where the function is being called and how it fulfills the algorithm's purpose.
4. Four Pillars of Object Oriented Programming
   a. Screenshot or copy and paste sections of code that demonstrate each of the four pillars of encapsulation, abstraction, inheritance and polymorphism.
   b. Describe the advantages and disadvantages of using these pillars within your code.

Presentation Requirements

1. Student teams are required to give an approximately five minute presentation to the judges as well as the following competitors.
2. During the presentation teams are required to include
   a. What their selected problem was
   b. A short demo of their project working
   c. A summary of how their solution solves the given problem
   d. Reflection on how the project could be improved or what the team would have done differently
3. Directly after the presentation there will be an approximately three minute questioning period from the judges to clarify anything that might have been said about the presentation
4. Student team may use any additional presentation material such as powerpoints, poster boards etc. However no presentation points will be given for these presentation aids; they are simply to help the team present effectively.

Scoring

All student teams will be graded based on the rubric as seen on the last page. For any questions relating to scoring please reach out to - Joe Nordling - joenordling@ku.edu

Rule Changes

All rules are subject to change as issues arise. If any rules changes are made all teams will be notified via email.

Tips / Tricks from the Judges

1. Pick a problem with something related to what you are passionate about!
2. Problems can be created if you already have a project in mind
   a. Example - The team wants to create battleship
      Problem : “There are many battleship programs online; however none have (insert something that makes yours unique)”

3. Make sure your project is manageable. If your team is concerned with project scope, pick something small and expand upon it.
    a. Example - Start with Tic-Tac-Toe, if you finish early add a single player and multiplayer option. Or add a scoreboard with the most wins overall. Or add online play where two players could play together if they share a unique key.

Cheating / Disqualifications

1. Using code that was previously written by students prior to this competition is NOT allowed.
    a. Example taking a school project from last year and just adding extra features
2. Third party libraries ARE allowed if they handle an abstraction that would be too difficult for the student team to design themselves within the project timeline. Any search or sorting algorithms must be implemented by hand. All libraries must also be sources with links in comments to where the code was found
    a. If the team is concerned that a library they are using would not be allowed please reach out to Joe Nordling at joenordling@ku.edu to confirm whether or not a given library is legal
3. Taking code from open source sites such as github is NOT allowed.
    a. This is the team's project, not just adding on to something you found online.

General Section						
Scoring Section	0	1	2	3	4	5
Code Quality	The code submitted is designed poorly. There are many unused variables and unecessary repeated code sections.	Up to Judges Interpretation	Up to Judges Interpretation	The code submitted is designed cleanly. The Judges are not expecting professional quality but there should not be unused variables or unnecessary repeated code sections	Up to Judges Interpretation	The code submitted is designed in a nearly professional manner. The code overall maintains a high level of cleanliness, and is formatted properly.
Theme	The team's chosen problem does not fit the	The team's chosen problem attempts to fit		The team's chosen problem fits around the		The team's chosen problem fits around the High School Design's

	theme of Exploration into the Beyond	the High School Design theme, but has a broad and common solution.	[redacted]	High School Design's theme of Exploration into the Beyond.	[redacted]	theme of Exploration into the Beyond AND has a unique solution that is not found online.
Documentation	There is no documentation with the code.	Code has almost no documentation and does not provide much inside on how the code functions.	Up to Judges Interpretation	Code is adequately documented with comments explaining some sections of code	Up to Judges Interpretation	Code is well documented with comments explaining each section of code. Documentation provides insight and explains how the code functions.
Written Section						
Scoring Section	0	1	2	3	4	5
Problem Statement	Left Blank / Did not turn in	There is an unclear and weak problem defined. Does not go into detail.	Up to Judges Interpretation	There is a problem defined with few benchmarks for solution.	Up to Judges Interpretation	There is a clear problem defined with measurable benchmarks for solution. Also defines who are the potential benefactors of the problem being solved (elderly, children, anyone, etc.)
Data Structures Section	Left Blank / Did not turn in	Had explanation with no code examples	Only answered one of the two questions	Team answers both questions adequately but does not go into much detail in their response.	Team answers both questions successfully.	Team goes above and beyond giving an amazing example and explanation of how their chosen data structure impacted the outcome of the project. Also compared the selected data structure to other possible structures.
Algorithm Section	Left Blank / Did not turn in	Had explanation with no code examples	Only answered one or two of the three questions	Team answers all three questions adequately but does not	Up to Judges Interpretation	Team demonstrated their ability to design modular code through a well thought out and

				go into much detail in their response.		planned algorithm/function. Team carefully explains the importance of the algorithm and how it works.
Four Pillars	Left Blank / Did not turn in	Had explanation with no code examples	Only showed example of one pillar	Showed example of two pillars	Showed example of three pillars	Showed examples of all of the pillars and explained the advantages and disadvantages of object oriented programming
Presentation Section						
Scoring Section	0	1	2	3	4	5
Timing	No Presentation	Team were below 1 minutes or over 10 minutes	Team were below 2 minutes or over 9 minutes	Team were below 3 minutes or over 8 minutes	Team were below 4 minutes or over 7 minutes	Team fully presented within 4-6 minutes
Problem Statement	No Mention of Problem	Briefly mention problem	Up to Judges Interpretation	Team explain their problem and who it would impact	Up to Judges Interpretation	Team clearly states their problem, who it would impact, and why they chose this statement. It is understood the team thought out the problem before executing on it.
Live Demo	No Demonstration	Team attempts demo but fails	Up to Judges Interpretation	Live demo partially works within the presentation and is somewhat able to show the program's functionality	Up to Judges Interpretation	Live demo fully works within the presentation and shows most of the program's functionality
Reflection	No Reflection	Team has a weak reflection that does not promote how they can improve.	Up to Judges Interpretation	The team reflects on what went right with their project and what went wrong.	Up to Judges Interpretation	Team has a strong and thought out reflection that shows what they learned from their project. They go into detail about

				Finishes presentation with a "What I would have done differently" section		went right and wrong for them, and show how they can improve for the future.
Overall Presentation	Up to Judges Interpretation	Up to Judges Interpretation	Up to Judges Interpretation	Up to Judges Interpretation	Up to Judges Interpretation	The team is proud of their solution and is eager to share it with the group. All teams will start with a 5 in this category and points will be docked for sloppiness in presentation or being unprepared.
Bonus Points						
Scoring Section		+2		+1		+2
In-flight Entertainment		Fully functional game		multiple games		Graphics/visual effects present (If game is text-based, obvious attempts to stylize the user experience were made i.e. ASCII art, etc..)
* Scoring will be conducted by a panel of judge each of which will interpret the rules as they see fit.						

Mechanical Competition – Planetary Exploration

Corporate Partners: Black & Veatch, US Engineering

For questions regarding competition rules and specifications, please contact:
Mike Slaney | mikeslaney@ku.edu

Overview:

Your team of engineers is formulating a bid for a NASA contract to construct a hydraulic lifting mechanism capable of collecting geologic samples on the surface of a faraway planet. This task focuses on the principles of hydraulic pressures and other mechanical engineering concepts such as rotation and simple machines. The goal of this competition is for students to design and construct a machine to lift a weight to a maximum height. Your team will also have to present your solution to secure the contract for your firm.

Device Construction Rules:

The rules listed below explicitly address legal parts and materials and how those parts and materials may be used on a team's device. The goals of these rules are to create a reasonable design challenge that is safe and fair for all teams.

1. A team's device consists of 3 main parts, The Lifting Device, a Hydraulic Controller, and a Weight.
    a. The Lifting Device is the part of the device that uses hydraulic force to lift the Weight and must fit within a 50cm long by 50cm wide by 70cm tall space at the beginning of testing.
    b. The Hydraulic Controller is the part of the device that is intended to be used by the operator to control the hydraulics in the Lifting Device. Only one Hydraulic Controller may be used. It is to be connected to the Lifting device only through plastic tubes that transfer hydraulic power.

   c. The Weight is a removable static object that is to be lifted by the lifting device to score points.
2. Hydraulic components used to power a team's device must be made from commercially available plastic syringes and tubing. Examples of legal components are listed in the Materials Section.
3. Devices may be constructed out of any materials or fasteners.
4. Devices may only be operated via hydraulic power that is applied via the Hydraulic Controller.
   a. Non hydraulic sources of energy that may be used are listed below. For safety reasons teams must make sure that their devices do not contain excessive potential energy that could be released in an unexpected or unsafe manner.
      i. Gravitational potential energy.
      ii. Potential Energy in the form of springs or other deformation of parts.
5. In the physical position that the Lifting Device starts its testing, it must be within a 50cm wide by 50cm long by 70cm tall bounding box. The Hydraulic controller is not subject to any dimensional constraints at the beginning of testing.
6. Once the testing begins, the Lifting Device may expand to any dimension any distance
7. The Weight is to be provided by each team and must fit within a 15cm cube and may not change dimensions once testing begins. Teams can provide multiple weights or one configurable weight if they would like to be able to test at different weights.
8. The Weight must be removable from the team's device in order to be measured for scoring.
9. The Weight can at most weigh 2kg.
10. The Weight must not be launched, dropped, or released by the device at any point during testing.
11. Teams cannot spend more than $50.00 on materials used in their final product.

Testing Procedure:

Teams will be given 3 attempts to test their device and can choose any weight configuration they would like for each test.

The following steps must be completed to complete a successful test:

1. The weight lifted will be measured and manually placed where directed by the team's instructions.
2. The weight must start out as being fully supported by the table or floor, but can be attached to the device before lifting begins.
3. Once the Weight is in position and the Lifting Device is within it's starting limits the test can begin.
4. Using the Hydraulic Controller, the operator will lift the weight to its maximum height and hold at least 10 seconds while it is being measured.

5. The Weight must then be lowered back to its starting position for it to be scored.

Device Scoring:

Points given will be based on the weight lifted and height reached relative to the highest values achieved on the day of competition. The height of the weight is measured by its lowest point. All measurements for score will be determined by the judges and cannot be argued.

W = Weight of mass being lifted (kilograms)

W_{MAX} = Maximum Weight Lifted by any team (kilograms)

H = Height Lifted (cm)

H_{MAX} = Maximum Height Lifted by any team (cm)

Device Score = $((W/W_{MAX}) *100) + ((H /H_{MAX}) *200)$

Presentation Rubric:

Your presentation MUST include the following elements:

1. Itemized budget.
   a. Must include item, cost, and link to where purchased.
2. Design justification.
3. Reflection on ways to improve in future testing.

Presentations should be no longer than **5 minutes.**

	0 points	**10 points**	**20 points**
Budget	Budget is missing	Budget is present, but not complete	Budget is clear and shows exactly the materials purchased
Depth of design explanation	Design is not explained	Design is partially well-explained, but is missing the team's thought process	Lifetime of project is fully explained, and it is clear why the final design was chosen by the team
Future recommendations	No future recommendations are made	Future recommendations are	Recommendations are innovative and indicate creativity.

		present but are not innovative.	
Presentation Skill	Presentation is not well-rehearsed.	Presenters were not well-rehearsed and/or not every team member spoke.	Every team member showed understanding of their project and was confident in their presentation.

Final score:

Device Score + Presentation Score = Final Score.

Example Materials:

- Example of possible syringes to use: https://www.amazon.com/Buytra-Plastic-Syringe-Injecting-Drawing/dp/B078PGW8RJ/ref=sr_1_7?dchild=1&keywords=syringes+and+tubing&qid=1592350726&sr=8-7
- Example of a basic device: https://www.youtube.com/watch?v=P2r9U4wkjcc