Event Specifications
Sustainable Skyscraper
MESA Day 2021

Inspired by

LEVEL:	Middle School/High School
NUMBER OF TEAMS:	One (1) team per school can participate at the MESA Day state competition. Up to Three (3) teams can participate at MESA Regionals. Subject to change.
TEAM MEMBERS:	Two (2) to six(6) students
OBJECTIVE:	Students will design a skyscraper while considering sustainable engineering, existing techniques civil engineers use for sustainable development, and how they can improve a project overall. Teams should use Goal 11 of the UN Sustainability Goals as a resource while creating their design. More info can be found at https://sdgs.un.org/goals/goal11 Students will submit a Video Journal that tells the story of their design process.

DESIGN PARAMETERS

1) The Skyscraper must be:
   a) At least 150 meters(492 feet) in height in real life
   b) Be either a scale model or digital representation (i.e. CAD file, Minecraft build, etc.) This will be referred to as "model" throughout the specifications.
   c) Representation of interior (apartments, businesses, etc.) for at least 2 different floors
   d) LEED Certified
   e) Located in either metro Tucson or Phoenix in a current empty space
   f) Be near public services including transportation
   g) Have parking available (parking lot, garage. etc.) for potential users
2) **High School Only**: Have an analysis of potential lateral forces on building.

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TESTING PARAMETERS

1) Two (2) team members are required to be present during testing
2) Team will present their skyscraper and explain the layout of their building, purpose (apartments, offices, combination, etc.), access to public services, and LEED certification.
3) The judges will ask questions about the building and features

JUDGING

1) Team will arrive at testing site ten (10) minutes prior to testing time
2) Team will have, at maximum, seven (7) minutes to present their skyscraper
    a. Teams that go the seven minutes will be assessed a penalty.
3) Judges will have, at maximum, three (3) minutes to ask questions about the building and features

SCORING

Teams will be judged on:

1) Presentation Skills (40 points)
2) Building Features (72 points)
3) LEED Certification (40 points)
4) Video Journal (multiplier)

RESOURCES

How to establish a scale:
https://www.wikihow.com/Draw-a-Floor-Plan-to-Scale
LEED:
https://www.usgbc.org/?utm_medium=ppc&gclid=Cj0KCQjw7Nj5BRCZARIsABwxDKIv5JoloQgK0BL98qmWkkQ2hI5uOyNFOyk3ufgNJ497aZDIClw6y6YaAuCNEALw_wcB

GLOSSARY

- Arch - A curved symmetrical structure spanning an opening and typically supporting the weight of a bridge, roof, or wall above it.
- Brick - A small rectangular block typically made of fired or sun-dried clay, used in building.
- Builder - Student members of a team who are within the construction site at the start of timed construction.
- Building - A structure with a roof and walls, such as a house, school, store, or office.
- Building Footprint - The outline of the total area of a site that is surrounded by the exterior wall of a building.Skyscraper - A continuously habitable high-rise building that has over 40 floors and is taller than 150m(492ft).
- Column - An upright pillar, typically cylindrical and made of stone or concrete, supporting an entablature, arch, or other structure or standing alone as a monument.
- Concrete - A heavy, rough building material made from a mixture of broken stone or gravel, sand, cement, and water, that can be spread or poured into molds and that forms a mass resembling stone on hardening.
- Crosswalk - A marked part of a road where pedestrians have the right of way to cross.
- Dead Load - The intrinsic weight of a structure or vehicle, excluding the weight of passengers or goods.
- Deck - A flat surface capable of supporting weight, similar to a floor, but typically constructed outdoors, often elevated from the ground, connected to a building.
- Deflection - The distance, perpendicular to the load, at which a structure displaces under said load.
- Door - A hinged, sliding, or revolving barrier at the entrance to a building or room.
- Earthquake (Seismic) Load - Application of an earthquake-generated agitation to a building structure.
- Entablature - A horizontal, continuous support on a building supported by columns or a wall.
- Entrance - An opening, such as a door, passage, or gate, that allows access to a place.
- Exit - A way out, especially of a public building, room, or passenger vehicle.
- Floor - The lower surface of a room, on which one may walk.
- Floor Plan - A drawing to scale, showing a view from above, of the relationships between rooms, spaces, traffic patterns, and other physical features at one level of a structure. Dimensions are usually drawn between the walls to specify room sizes and wall lengths.

- Force - Any action applied to an object which would cause the object to move, change the way it is currently moving, or change its shape. A force can also be thought of as a push (compressive force) or pull (tensile force) acting on an object.
- Force Vector - A force vector is a graphical representation of a force.
- Foundation - The lowest load-bearing part of a building, typically below ground level.
- Free body Diagram (FBD) - A graphical illustration used to visualize the applied forces, moments, and resulting reactions on a body in a given condition.
- Furnishing - Furniture, fittings, and other decorative accessories, such as curtains and carpets, for a house or room.
- Glass - A hard, brittle substance, typically transparent or translucent, made by fusing sand with soda, lime, and sometimes other ingredients and cooling rapidly.
- Going Green - To pursue knowledge and practices that can lead to more environmentally friendly and ecologically responsible decisions and lifestyles, which can help protect the environment and sustain its natural resources for current and future generations.
- Hallway - An area in a building onto which rooms open; a corridor.
- Lateral Force - The force that acts in the direction parallel to ground and perpendicular to the direction of gravitational pull of earth.
- LEED (Leadership in Energy and Environmental Design)- is an internationally recognized green building certification system, providing third-party verification that a building or community was designed and built using strategies aimed at improving performance across all the metrics that matter most: energy savings, water efficiency, CO_2 emissions reduction, improved indoor environmental quality, and stewardship of resources and sensitivity to their impacts.
- Lighting - Equipment in a building for producing sufficient and artistic light.
- Live Load - The weight of people or goods in a building or vehicle.
- Load - Forces applied to structural components or members.
- Masonry - The art and craft of building and fabricating in stone, clay, brick, or concrete block.
- Member - A rigid component composed of a strong material. A member shall retain its shape, dimensions, and rigidity during construction and load testing.
- Parking Lot - An area where cars or other vehicles may be left temporarily.
- Plexiglass - A transparent thermoplastic often used in sheet form as a lightweight or shatter-resistant alternative to glass.
- Roof - The structure forming the upper covering of a building.
- Scale - The relationship (or ratio) between distances, areas and/or volumes.

- Snow Load - The downward force on a building's roof by the weight of accumulated snow and ice.
- Space Planning - A fundamental element of the interior design process. It starts with an in-depth analysis of how the space is to be used.
- Steel - A hard, strong, gray or bluish-gray alloy of iron with carbon and usually other elements, used extensively as a structural and fabricating material.
- Storage - A space available for storing items for future use.
- Swimming Pool - An artificial body of water for swimming in.
- Tool - A device or implement, especially one held in the hand, used to carry out a particular function.
- Wall - A continuous vertical brick or stone structure that encloses or divides an area of land.
- Wind Load - The force on a structure arising from the impact of wind on it.
- Window - An opening in the wall or roof of a building that is fitted with glass or other transparent material in a frame to admit light or air and allow people to see out.
- Wood - The hard fibrous material that forms the main substance of the trunk or branches of a tree or shrub, used in building.

Explanation of MESA LEED Certification*

LOCATION AND TRANSPORTATION:

The building is in a space where it is easy for people to get to it while reducing their carbon footprint.

LEED for Neighborhood Development Location

The building is designed to be a gathering place for large numbers of people. Examples include: Community Center, Library, University building.

Sensitive Land Protection

The building is replacing an older building OR does not harm the environment (i.e. floodplain, critical habitats, bodies of water, etc)

Surrounding Density and Diverse Uses

The building is created to be both commercial (stores, restaurants, etc) and residential (living spaces) to be comfortable for all users (not overcrowded)

Access to Quality Transit

Access to public transit (bus, streetcar, etc) is within ¼ mile of the building. The access point needs to be a high traffic point

Bicycle Facilities

The building must have bicycle parking within 200 yards of the building for, at minimum, 5% of building users

Reduced Parking Footprint

The new construction does NOT have parking in front of building. Parking is ground level or below (if under building). Spaces for carpooling/shared use are in best parking locations

Green Vehicles

5% of parking spaces are for green vehicles (electric, hybrid, etc) with charging stations

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Sustainable Sites

The site has been checked to make sure it will be part of the natural environment and will not cause damage to the habitats around it.

Site Assessment

The designers look at topology (the shape of the land), climate (solar access, temperatures, etc), and human use (views, access to transportation, neighborhood)

Site Development - Protect or Restore Habitat

The building protects habitats of plants and animals within the building space OR works to restore habitats that are in danger of extinction

Open Space

The building's design creates exterior open space that encourages interaction with the environment, social interaction, passive recreation, and physical activities.

Rainwater Management

The building uses rainwater harvesting for watering plants and has a holding tank for excess to be used in times of little rain

Water Efficiency

The building is designed to be water efficient. Measures are in place to ensure this both inside and outside the building.

Outdoor Water Use Reduction – Use native/low water plants, rainwater harvesting, and other measures to reduce water usage
Indoor Water Use Reduction Building – Use low flow fixtures, gray water, and other measures to reduce water usage
Building-Level Water Metering

These plans need to be in place. The sections below expand on these.

Outdoor Water Use Reduction

The building does NOT need outside irrigation for the plants

Indoor Water Use Reduction

The building has plans to limit water flow and reuse water (if applicable)

Energy and Atmosphere

The building collects and uses energy from natural sources (solar, wind, etc)

Optimize Energy Performance
The building has systems in place (solar panels, windmill, etc) to harvest and store energy for the building's use.

Renewable Energy Production
The building has a high percent of its energy from natural resources

Green Power and Carbon Offsets
At least 50% of the power used by the building is from natural resources or carbon offsets (demonstrating the drop in carbon energy by 1 metric ton)

Indoor Environmental Quality
The interior of the building ensures that the environment is pleasant and safe for all users.

Environmental Tobacco Smoke Control
Controls to prevent any smoke from tobacco users enters the building are in place

Enhanced Indoor Air Quality Strategies
Main entry point is, at minimum, 10 feet long to control dust entering the building, natural ventilation is used as often as possible, and rooms where hazardous gases (car exhaust, printing, etc) are present are naturally ventilated.

Thermal Comfort
Users of the building have access to thermal controls (i.e. thermostat) to control energy efficient HVAC systems

Interior Lighting
The lights are designed for at least 90% of users to have access to controls. The lights are also energy efficient and simulate natural lighting

Daylight
Natural lighting is used to light spaces and reduce the need for artificial lighting in at least 25% of the building.

Quality Views
Users of the building have multiple views of nature with a 90 degree angle of view

Innovation
Innovation in design is evident in the building's design

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School:_____

Student Names:_____

_____

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Final Score:

Presentation (40 points)	+
Building Features (72 points)	+
LEED Certification (40 points)	*
Video Journal Multiplier (If no journal, multiply by .1)	=
Total (max 152 points)	

Lead Judge Signature:_____

Student Signature:_____

Comments:

Presentation:

Category	Exceeded Criteria (3 points)	Met Criteria (2 points)	Poor (1 point)	Not Present (0 points)
Introduction: The team introduced all members and their school			YES	NO
Flow: The ideas/concepts flowed well together				
Organization: The information presented was well organized and easy to follow				
Transitions: All transitions are smooth				
Teamwork: The team worked well together				
Professionalism: The team was professional during the presentation				
Content: The team provides thorough explanations of their design				
Extra Information: All information was related to the building and no extra information was present				
Knowledge: The team's knowledge of the concepts is strong				
Presentation: The presentation has style and creativity				
Model Usage: Models or digital representations were used effectively to highlight important points or features				
Model Integration: Visual aids fit into the presentation and enhanced talking points				
Sound: Voiceover was clear and easily heard				
Team Contribution: Each team member had a chance to speak or participate				
Column Totals				
Time Penalty: Team was over the 7 minute maximum				
SUBTOTAL				
Time Penalty(Subtract 10 pointes if over time)				
TOTAL SCORE (SUBTOTAL – PENALTY)				

Building Features

Category	Exceeded Criteria (3 points)	Met Criteria (2 points)	Poor (1 point)	Not Present (0 points)
Building: The building is a skyscraper (150 meters or 492 feet). The model is to scale	**Yes and matches city skyline**	**Yes**	Possibly but not definitely	**No**
Location: The building is demonstrated to be in a vacant space in Tucson or Phoenix where a skyscraper is appropriate. The model's location is clearly marked.				
Usage: The team explains the proposed usage of the building. The usage areas are clearly marked on the model				
Amenities: The building has appropriate amenities (shops, gymnasium. etc) that align with usage of building and are clearly marked on the model				
Public Spaces: The building is within 3 miles of public services (Examples include parks, schools, hospitals, etc.). Direction and distance are clearly marked on model.				
Transportation: The building is within walking distance of public transportation				
Parking: Adequate parking is present for the capacity of the building within 1 square mile of the building and is clearly displayed or marked on model.				
Disaster Consideration: The team describes how they designed the building for potential disasters (flooding, earthquake, etc.)				
Renewable Energy: The team renewable energy features as part of the building (solar panels, windmills, etc) Renewable energy features are clearly marked on model				
Local Ecology The team explains how the building integrates into the local ecology to maintain natural habitats. Ecology features are clearly marked on model				
Water Usage The team explains how water is conserved in the building (low flow fixtures, gray water, etc) Water conservation elements are clearly marked on model **(x2)**				
Column Totals:				
				SUBTOTAL:
				SUBTOTAL x2:
				FINAL SCORE

LEED	Certified (10 points)	Silver (20 points)	Gold (30 points)	Platinum (40 Points)
			Score	

MESA Mathematics Engineering Science Achievement

LEED v4 MESA for New Construction

Project Checklist

Project Name:

Date:

Key:
2 = Definitely present
1 = Is partially present
0 = Not present

2	1	0				
			Credit	Integrative Process		0
0	0	0	**Location and Transportation**			0
			Credit	LEED for Neighborhood Development Location		
			Credit	Sensitive Land Protection		
			Credit	Surrounding Density and Diverse Uses		
			Credit	Access to Quality Transit		
			Credit	Bicycle Facilities		
			Credit	Reduced Parking Footprint		
			Credit	Green Vehicles		
0	0	0	**Sustainable Sites**			0
			Credit	Site Assessment		
			Credit	Site Development - Protect or Restore Habitat		
			Credit	Open Space		
			Credit	Rainwater Management		
0	0	0	**Water Efficiency**			0
			Prereq	Outdoor Water Use Reduction		
			Prereq	Indoor Water Use Reduction		
			Prereq	Building-Level Water Metering		
			Credit	Outdoor Water Use Reduction		
			Credit	Indoor Water Use Reduction		
0	0	0	**Energy and Atmosphere**			0
			Credit	Enhanced Commissioning		
			Credit	Optimize Energy Performance		
			Credit	Renewable Energy Production		
			Credit	Green Power and Carbon Offsets		

0	0	0	**Materials and Resources**			0
			Prereq	Storage and Collection of Recyclables		
				Building Life-Cycle Impact Reduction		
			Credit	Building Product Disclosure and Optimization - Environmental Product		
			Credit	Building Product Disclosure and Optimization - Material Ingredients		
0	0	0	**Indoor Environmental Quality**			0
			Prereq	Environmental Tobacco Smoke Control		
			Credit	Enhanced Indoor Air Quality Strategies		
			Credit	Thermal Comfort		
			Credit	Interior Lighting		
			Credit	Daylight		
			Credit	Quality Views		
0	0	0	**Innovation**			0
			Credit	Innovation		
			Credit			
0	0	0	**Regional Priority**			0
			Credit	Regional Priority: Specific Credit		
			Credit	Regional Priority: Specific Credit		
			Credit	Regional Priority: Specific Credit		
			Credit	Regional Priority: Specific Credit		

0	0	0	**TOTALS**	Possible Points:	0

Certified: 30 to 39 points, **Silver:** 40 to 49 points, **Gold:** 50 to 64 points, **Platinum:** 65 to 74

Rubric for Video Journal (VJ)

Category	3	2	1	0
1. Define the Problem				
○ Problem is clearly identified ○ Definition of Problem aligns with problem statement in specifications ○ Definition of Problem matches solution	All	Most	Some	None
2. Initial Design				
○ Picture of sketch of initial design is present ○ Sketch can be clearly seen ○ Sketch is aligned to objective as specified objectives in specifications	All	Most	Some	None
3. Design 2				
○ Changes from Initial Design to Design 2 are visible and/or marked ○ Sketch/Prototype can be clearly seen ○ Design 2 is clearly marked as Design 2	All	Most	Some	None
4. Reasoning for change from Initial Design to Design 2				
○ Reason(s) for change(s) are based on testing ○ Reason(s) for change(s) make logical sense ○ Reason(s) for change(s) keep prototype aligned to Problems Statement	All	Most	Some	None
5. Design 3				
○ Changes from Initial Design to Design 2 are visible and/or marked ○ Sketch/Prototype can be clearly seen ○ Design 3 is clearly marked as Design 3	All	Most	Some	None
6. Reasoning for change from Design 2 to Design 3				
○ Reason(s) for change(s) are based on testing ○ Reason(s) for change(s) make logical sense ○ Reason(s) for change(s) keep prototype aligned to Problems Statement	All	Most	Some	None
7. Final Prototype				
○ Final Prototype addresses the problem statement ○ Final Prototype is clearly visible ○ Final Prototype is clearly marked as Final Prototype	All	Most	Some	None
Audio is clear and does not distract from video			Yes	No
Video Journal is 5 minutes or less			Yes	No
School name is part of journal			Yes	No
Competition name is part of journal			Yes	No
			Total	