Science, Technology, Engineering, and Math

STEM Expo an innovative alternative to the typical science fair

STEM Expo 2018-2019

Category Discussion Guides

Infernal Contraption

An **Infernal Contraption** is a deliberately over-engineered or overdone machine that performs a simple task in a very complex fashion, usually in a chain reaction. The category is fashioned after the American cartoonist and inventor Rube Goldberg (1883-1970).

Purpose	Create an over-engineered machine to perform a simple task
Thoughts and Ideas	Infernal Contraptions typically use a sequence and a combination of simple machines and forces to accomplish a relatively simple task that finally is completed at some time after the contraption is triggered. The six classical simple machines are the lever, wheel and axle, pulley, inclined plane, wedge, and screw. There are many types of forces, including: Normal, Pressure, Drag, Tension, Elastic, Centripetal, Gravitational, and Magnetic. Infernal Contraptions with themes can be a lot of fun to make...and view! Themes could include using only a certain type of thing to create, or all based around a color, or your imagination is the limit here! Please consider reset time. Dominos are great on infernal contraptions, but don't overuse them...they can take a long time to set back up. Will your machine work with little to no help from you? Infernal contraptions are always better when you don't have to touch anything to keep it going. Extra challenge: can you have multiple paths going at once that merge back together? Can you have elements of your machine get reused or have events that occur more than once?
"Must Haves" for an effective project	This is an audience appreciation category, the visitors to STEM Expo like seeing fun things and these projects definitely fit that description. Thus, at least a portion of a working model *must* be on display. If the whole thing is there, even better. If it can run a few times during the Expo, that's the best! Your display must feature a step-by-step, labeled diagram of your contraption. View some of Rube Goldberg's own drawings for inspiration. If you build the contraption completely, post a video of your working contraption to YouTube or similar video sharing service. Sometimes they can't operate during the event, and it's nice for viewers to see it in action. Share the link in your display, or consider providing a QR code. You could even have a laptop or tablet there running your video on a loop! Label all simple machines involved in your project directly on your contraption AND on your diagram. Make sure several types of simple machines are included. Label all physical forces acting on your contraption. Make sure to include as many types of forces as possible when building your contraption.

Intelligence and Behavior

The **Intelligence & Behavior** Category covers the study of the mind and its processes. This includes psychology, philosophy, linguistics, anthropology and neuroscience. Scientists in these fields study how human systems represent, process, and transform information.

Purpose	Develop an investigation to gain a better understanding of human behavior
Thoughts and Ideas	This category provides the opportunity to explore the way people think, feel, act, and react. A successful project in this category will present an idea, concept, or question about a specific intelligence and/or behavioral aspect, and then will attempt to prove that idea, and finally will present a conclusion. All aspects of the Science and Engineering Practices are part of this type of project. These eight practices (Asking questions, Developing and using models, Planning and carrying out investigations, Analyzing and interpreting data, Using mathematics and computational thinking, Constructing explanations, Engaging in argument from evidence, and Obtaining, evaluating, and communicating information) should be expressed as part of any project in this category. Keeping a journal of progress is an important part of this type of project. Journals or log books should include all aspects of the project: from daily notes of occurrences and ideas, to hand-drawn sketches, to photos of anything that is occurring (including white-board sketches, or discussion points, for instance.) Research is part of good scientific practice, but duplicating existing experimental works is frowned upon. All projects should have an original or innovative aspect to the work at least in either concept or approach. If a pre-existing experiment is modified or continued from a previous year, the original work should be credited and the expanded or innovative portions clarified or explained and documented.
"Must Haves" for an effective project	The project display is a summary of all the work done on your project. It should include an understandable description of the idea or concept being explored, the methods used in that exploration, and the conclusions generated. Most of the projects submitted in this category will be traditional scientific investigations. Good use of the Science and Engineering Practices should be very apparent in any entry in this category. Please include a log of your progress through your whole process. This can be in electronic form or using a log-book. Your display should summarize all of your work through the process and should highlight the practices involved. Please include graphs and/or images where appropriate. Include materials lists, cited sources for research, procedures, etc

The Living World

The Living World category includes anything to do with living organisms. This includes microorganisms, plants, animals, and human beings as well as bioethics, medicine, molecular biology and biotechnology, etc.

Purpose	Develop an investigation to explore aspects of the living world
Thoughts and Ideas	This category is for exploring all aspects of life and living things. An effective project in this category will usually be based on a question about a plant, animal, or some other living thing (or about something that affects living things). It will offer an explanation to answer the question and, finally, will present a conclusion. All aspects of the Science and Engineering Practices are part of this type of project. These eight practices (Asking questions, Developing and using models, Planning and carrying out investigations, Analyzing and interpreting data, Using mathematics and computational thinking, Constructing explanations, Engaging in argument from evidence, and Obtaining, evaluating, and communicating information) should be expressed as part of any project in this category. Keeping a journal of progress is an important part of this type of project. Journals or log books should include all aspects of the project: from daily notes of occurrences and ideas, to hand-drawn sketches, to photos of anything that is occurring (including white-board sketches, or discussion points, for instance.) Research is part of good scientific practice, but duplicating existing experimental works is frowned upon. All projects should have an original or innovative aspect to the work at least in either concept or approach. If a pre-existing experiment is modified or continued from a previous year, the original work should be credited and the expanded or innovative portions clarified or explained and documented.
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Science Fiction

Science Fiction is a genre of fiction dealing with imaginary, but more-or-less plausible content such as future settings, futuristic technology, space travel, aliens, etc. Exploring the consequences of scientific innovations is one purpose of science fiction, making it the true future of STEM.

Purpose	Develop a story or concept in which science extends beyond our current understanding
Thoughts and Ideas	Science fiction includes an imaginative vision of the possible future of science and technology. Good science fiction tells a story or raises questions to show the concept of where we have expanded beyond our current understanding. This category includes presentations in the form of stories, graphic novels, two or three dimensional artworks, comic books, plays, videos, etc. There is no length limit for any written story, but the quality should be 'grade level appropriate'. Illustrations for written stories and/or storylines for non-written entries are appreciated, and collaborative efforts to provide those are welcomed. Science Fiction uses and relies on the concept of “Willful Suspension of Disbelief”. This concept is a reader’s or viewer's ability to accept what they know to be untrue (or not yet proven) to be real for the duration of the story/viewing of the piece. The best works establish this adjusted reality early on, and don’t introduce changes or violate the principles that are set. Science Fiction is not the only type of speculative fiction. Although fantasy (for instance) is a similar genre, it is not the same - anything that relies on magic, or phenomena that cannot be explained by the scientific reality as described will not be rated at the same level as those that follow the principles that are established. Basically: science fiction is possible, fantasy is impossible.
“Must Haves” for an effective project	An electronic version of a story entry (not the display) must be submitted no later than five days prior to the STEM Expo event. If the entry is graphical in nature, a photograph with the explanatory text of the presentation display is acceptable. As in all categories, the general requirements must be followed for this category as well, including some form of display for the day of the event. This display may be simple or complex, it may include: • A copy of the actual story or entry, • A description of the entry (an outline, a storyboard, etc. as appropriate), • References to supporting or similar works, • Illustrations or images that represent the story or concept.

Reverse Engineering and Invention

The **Reverse Engineering and Invention** category involves the understanding of how things work together in either a creative or evaluative manner. Reverse Engineering is to take something apart and analyze its workings, while Invention involves creating something new. Both aspects focus on a product that solves a specific problem or need.

Purpose	Determine a real-world problem and create something new or deconstruct something old to find how to solve it.
Thoughts and Ideas	This category focuses on the exploration of problem solving in the physical world. Invention and Reverse Engineering are two faces of the same subject. In both cases the project creator must learn or define how something works. The category is specifically focused on physical devices and products. The projects in this category must describe what problem is being solved. They must also show how the project's device solves the problem. A *Reverse Engineering* project will have enough complexity to allow the student to gain an understanding of how something works, in detail, without being overwhelming. In the process of understanding how something works, different, maybe better, means of accomplishing that job may be discovered, which can lead to the project being both Reverse Engineering and Invention. An *Invention* project may be simpler than an equivalent Reverse Engineering project because the invention itself may be something simple that no one else has yet created. Sometimes unique or innovative methods are used in the solution or the creation of the solution. These methods are what makes it exciting.
"Must Haves" for an effective project	A complete 'mock-up', prototype, or construction of all or part of the device should be presented. If this is an invention this is the key physical portion of the project. The project display must have a description of the use of the device, and the benefits associated. The display should have a disassembly of the completed device showing the components and/or subcomponents with a description of their purpose and how they work. If this is a reverse engineering project, this is the key physical portion, and these pieces are expected to be the centerpiece of the display. If an invention, this portion may consist of photographs, drawings, or textual descriptions of the components (and sub-components, if any) of the device. The display should also have a description of the tools (simple or complex), methods, and sequences required in the construction or deconstruction. Marketing material is often key in describing a product or device and its inclusion is appreciated and recognized.

The Physical Universe

The Physical Universe category covers the broad fields of chemistry, physics, earth science and space science.

Purpose	Develop an investigation to explore physical aspects of the world around us
Thoughts and Ideas	This category is for explorations of the physical aspect of the world around us. A successful project in this category will commonly ask a question of a non-biological nature, then using research and experimentation it will attempt to answer the question and, finally, will present a conclusion. Often this category will lead to a demonstration of a scientific concept. Efforts should be made to change the demonstration to an experiment. This can usually be done by asking what would happen if a single aspect of the demonstration was changed. All aspects of the Science and Engineering Practices are part of this type of project. These eight practices (Asking questions, Developing and using models, Planning and carrying out investigations, Analyzing and interpreting data, Using mathematics and computational thinking, Constructing explanations, Engaging in argument from evidence, and Obtaining, evaluating, and communicating information) should be expressed as part of any project in this category. Keeping a journal of progress is an important part of this type of project. Journals or log books should include all aspects of the project: from daily notes of occurrences and ideas, to hand-drawn sketches, to photos of anything that is occurring (including white-board sketches, or discussion points, for instance.) Research is part of good scientific practice, but duplicating existing experimental works is frowned upon. All projects should have an original or innovative aspect to the work at least in either concept or approach. If a pre-existing experiment is modified or continued from a previous year, the original work should be credited and the expanded or innovative portions clarified or explained and documented.
"Must Haves" for an effective project	The project display is a summary of all the work done on your project. It should include an understandable description of the idea or concept being explored, the methods used in that exploration, and the conclusions generated. Most of the projects submitted in this category will be traditional scientific investigations. Good use of the Science and Engineering Practices should be very apparent in any entry in this category. Please include a log of your progress through your whole process. This can be in electronic form or using a log-book. Your display should summarize all of your work through the process and should highlight the practices involved. Please include graphs and/or images where appropriate. Include materials lists, cited sources for research, procedures, etc

Robotics and Computation

The **Robotics and Computation** category includes robotics and computer science. This includes such applied sciences as engineering, programming, and mechanical design and such formal sciences as mathematics, logic, and statistics. Entrants in this category design, build, and operate mechanical and/or software constructions.

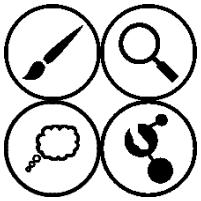
Purpose	Create all or part of a working software program or automated device.
Thoughts and Ideas	*Computer science* is the study of the principles and use of computers. Included in that is the design of software that performs tasks. *Robotics* often involves computer science but adds the design, and application of physical components that perform tasks. When thinking about design, the focus is on the physical design (user interface) of the entry. Sensors or operator input must be appropriate and understandable for the planned purpose(s). Manipulators and/or displays should be used as needed to accomplish the desired tasks. Physical or interface construction also should be appropriate and elegant. Functionality is also a key part of this category. Operational methods of the software or robot should be complete and appropriate for the purpose. The design should allow for variables in the operating environment and error handling. Operation should be repeatable and consistent with the planned function. In the process of creating a Robotics and Computation project, it is usually necessary to define how to determine if the project was a success. This can often be done with a formalized test plan that not only provides a means of testing the success of the project, but also can offer an additional definition of what is important within the project.
"Must Haves" for an effective project	The display should show a working robot or sub-assembly or, if software, the working software should be presented. Some of the display should be descriptive so that people can understand the function or purpose of the robot or software, and how it is, or could be, used. Included in that the description and clarification of any sub-components should be explained. The display should help the viewer understand the way the entry relates to real-world application (if it does). A written document that defines the functional specification of the entry, and documented code listings may also be part of the project presentation.

Things

The **Things** category focuses on the design and engineering of 3-dimensional physical objects. Primarily focused on engineering and design principles, this category provides a venue for everything from 3-D printing to architectural design, from woodwork to welding.

Purpose	Make (or design) something tangible in the real world
Thoughts and Ideas	As the name implies, this category is for those who make things. These 'things' can be of any style or type, as long as there are some engineering principles involved in the making. Projects in this category may not fit inside the typical Science Fair model. STEM concepts can be involved in all types of making, from sand sculpture to welding, from textiles to 3D printing, etc. As long as the thing is designed with a plan there's engineering involved. Part of the process of making something is designing it. This is such a critical component that the designs in and of themselves are acceptable as entries in the category, even if the thing is never actually physically made. Most commonly these 'things' will be original creations. But they can also be reproductions of existing items, as long as original work is done as part of the design process. Things can be made by any means, of any material. Keep in mind that "how" you make it is important. The process of what is involved in the creation of the 'thing' is critical. Documentation of the process of making the thing is a key component of this category. This documentation may consist of such things as design sketches, photos of build stages, a process description, bills of material, drawing revisions, etc.
"Must Haves" for an effective project	As in all categories, the general requirements must be followed for this category as well, including some form of display for the day of the event. Include copies of all documentation, preferably in printed form. The thing itself should be part of the project presentation. If the thing is too big, photos of it should be presented with enough detail so the judges and viewers can determine workings and workmanship. Keep in mind that larger spaces are available just by asking. If there was a log of progress in building or designing the thing, that log should also be included. Listings and descriptions of any tools that are (or should be) used in the build of the thing should also be included.

Special Categories



SPECIAL Categories: are provided to recognize projects that show special strengths in areas that may not be regularly awarded in other STEM competitions. These include the Creative Arts, Research, Imagination, CSEF Advancement, and Judges Awards.

No special selection is required as all entries are automatically qualified to be selected for these awards. Note that all of these awards are given at the discretion of the judging staff.

Creative Arts	The **Creative Arts** category focuses on the presentation from an artistic standpoint. The intent is to recognize the entry(s) that have artistry in their presentation. This artistry could be represented in one aspect (for instance a single drawing or graphical element) or as part of the project presentation as a whole.
Research	The **Research** category focuses on the research that an individual entrant did in the preparation of the entry. The intent is to recognize the value of the research as a separate context and appreciate an entrant who has gone above and beyond the normal level of research for their category. Research is applicable for all categories, and may be presented in any form as part of the entry.
Imagination	The **Imagination** award celebrates creativity and "thinking outside the box". This award is to recognize an entry that does things in a different manner. Whether it is the entrepreneurial spirit, the pioneer spirit, or just "it's the way I wanted to do it", these awards are presented to entries that the judges want to encourage because of the imagination involved in the project.
Advancement	Certain STEM Expo events are the local nominating affiliate for state and/or national STEM competitions. As such, all entries are considered for advancement to those events. STEM Expo is given a certain number of attendees that we may advance and they are expected to be the best representation of the standards at STEM Expo. This advancement is applicable for all categories, depending on the requirements of the next level competition.
Judges Consideration	Sometimes judges want to recognize outstanding work in an entry that doesn't quite fit into any other award category. Judges awards are presented at the request of the judging team, they are completely optional on the day of the event and can be presented to any entrant to encourage their continued work in the STEM fields.