Additive Manufacturing Demonstration Contest

SkillsUSA ILLINOIS CHAMPIONSHIPS

Purpose

To evaluate each team's preparation for employment and to recognize outstanding students for excellence and professionalism in the field of Digital and Additive Manufacturing.

Additive manufacturing embraces a wide range of materials and derivative processes building parts suitable for end-use service. The virtually unlimited design freedom enabled by additive manufacturing allows the creation of shapes and the integration of feature and function that previously required subassemblies. Employment opportunities for creative individuals are growing while industry adopts AM methods. Ready access to workstations and service providers makes the Internet a growing marketplace for public AM gadgets.

Clothing Requirements

Official Khaki dress, shirt, pants, black or brown leather work shoes,

-OR- Official Dress/Red Coats,

-OR- as close to Official Dress as possible.

Eligibility

Open to active SkillsUSA students if they are enrolled in Computer Aided Design classes, design classes, manufacturing, etc.

Equipment and Materials

1. Supplied by the technical committee:

a. All additive manufacturing equipment and material

2. Supplied by the contestant:

a. Design file must be emailed by 5pm on Wednesday, April 11, 2018 to:

jkopesky@haldemanhomme.com

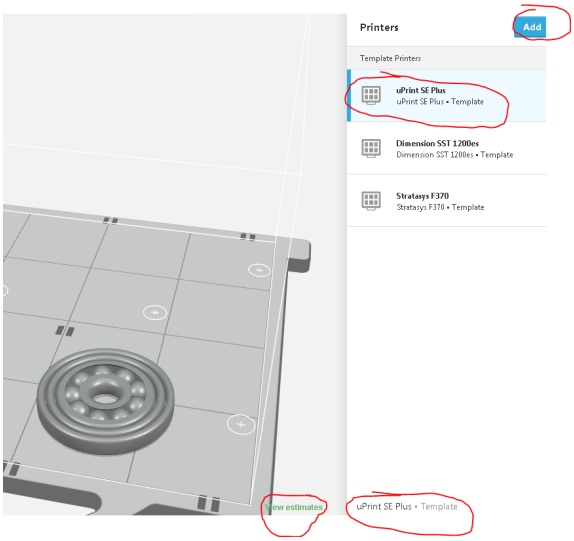
(Please request confirmation of file receipt)

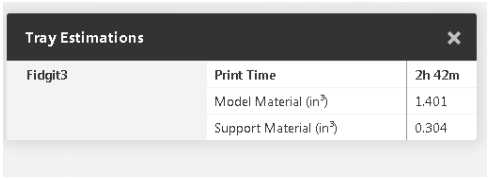
b. Personal computer system (Laptop) with a computer design system.

c. GrabCAD print software to virtually estimate print time downloaded to computer to use at contest. Software can be downloaded here:

https://grabcad.com/print

Once GrabCAD Print is downloaded, please open the program and load a template for a Stratasys Uprint SE Plus to check your build estimates. All material and time requirements must be estimated using a uPrint SE Plus template:





d. USB Drive for transferring STL file

e. Any tools required to provide a finished part

f. All competitors must create a one-page résumé and submit a hard copy to the technical committee chair at orientation. Failure to do so will result in a 10-point penalty.

Scope of the Contest

Knowledge Performance

This contest will include a written knowledge exam assessing general knowledge related to additive manufacturing technology in such areas as: direct digital technologies, basic design technologies, additive manufacturing materials.

Some Recommended Resources:

Gibson, I., and D. W. Rosen. *Additive Manufacturing Technologies Rapid Prototyping to Direct Digital Manufacturing*. New York: Springer, 2012. Print.

Hopkinson, N. *Rapid Manufacturing: An Industrial Revolution for the Digital Age*. Chichester, England: John Wiley, 2006. Print.

Jacobs, Paul F., and David T. Reid. *Rapid Prototyping & Manufacturing: Fundamentals of Stereolithography*. Dearborn, MI: Society of Manufacturing Engineers in Cooperation with the Computer and Automated Systems Association of SME, 1992. Print.

"Inside ExOne." *ExOne Home*. Web. 24 Apr. 2015. <http://www.prometal-rct.com/eng/process.html>.

"Worldwide Guide to Rapid Prototyping." *Rapid Prototyping and Solid Freeform Fabrication*. Web. 24 Apr. 2015. <http://www.additive3d.com/>.

"Additive Manufacturing Glossary." *SME* -. Web. 24 Apr. 2015. <http://www.sme.org/additive-manufacturing-glossary/>.

ASTM Standard: Standard Terminology for Additive Manufacturing Technologies

Skill Performance

This contest will be a team-oriented event. Teams will consist of two contestants for the same school in the same division. This contest will consist of (1) an original design using the specifications that follow to be turned in by 5pm on April 11, 2018, (2) finishing original design to present a piece free of burrs, ridges, etc. (3) an onsite design modification challenge, (5) engineering notebook, and (6) presentation to judges.

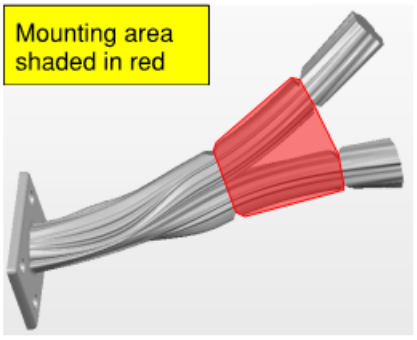
Contest Guidelines - 2018

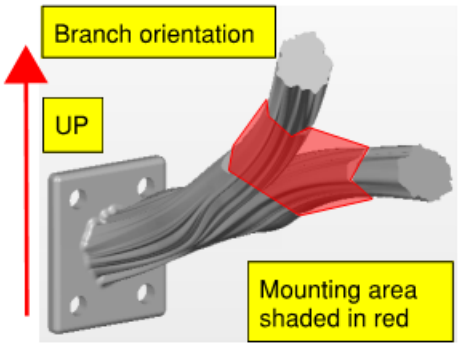
(1) The original design, to prepare in advance of the competition, will be:

- To create a FIXTURE that connects a hanging object to a tree branch, as well as a creative object that is connected to it, and will be hanging from the branch. The fixture should be designed to be secured to the branch so that if force is applied to the hanging object (wind, light pressure from a hand or finger), that the fixture stays securely and snugly connected to the branch. In essence, the fixture should move as little as possible when the hanging object has force applied to it in any direction. Guidelines regarding the object hanging from the tree branch are open to competitor imagination. **It should be noted that the focus of the challenge is the form, fit, and function of the fixture, and thus scoring will be heavily weighted on that portion of the design.** However, consideration and points will be given for the complete model, especially where showcasing the benefits and advantages of Additive Manufacturing (the ability to print a part as a completed assembly with interlocking or movable parts that DO NOT need to be assembled after printing. Models should actually contain example(s) of this that cannot be disassembled or taken apart, and that would otherwise be impossible (or very difficult) to create using traditional subtractive manufacturing methods.

- Moving parts that move and function freely must be part of the design. The design will show the benefits of additive manufacturing by incorporating complex geometric features. The geometry of the design must be defined within a three-dimensional (3D), computer design system capable of rendering files in STL format.

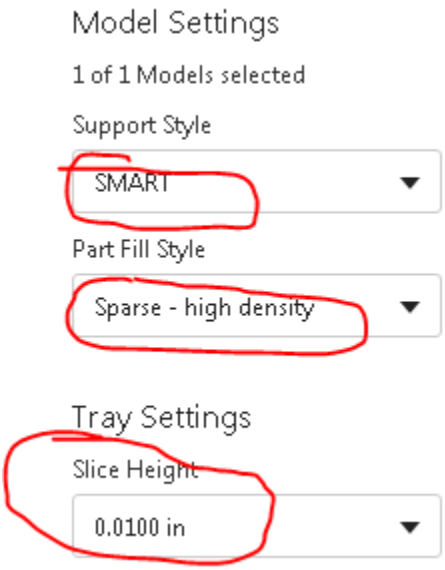
- The contest challenge is designed around a tree branch file that can be accessed on GrabCad Workbench here: https://grabcad.com/library/skillsusa-2017-additive-manufacturing-state-competition-file-1. The tree branch file has been prepared with a designated connection area. The designated connection point is an area where the designs must connect to the branch. The designated connection area is in between the notches on the branches—shaded in red in the images shown below:





- **Size limits** – parts (total assemblies) should fit in an envelope no greater than 5" x 5" x 5". Parts should be submitted as both a native CAD and STL file ready for printing. The volume of material usage for model and support must be no greater than 5 cubic inches. The build time must be no greater than 5 hours. Software to virtually estimate print time can be accessed here: https://grabcad.com/print

- When estimating, all parts must be processed in a uPrint SE Plus template with the following settings:
    - **Support Style:** SMART
    - **Part Fill: Sparse –** high density
    - **Slice height:** .0100 in



- All parts should be submitted as a single assembly as the printer is capable of building the entire assembly in one piece. Design file must be emailed by 5pm, April 11th, 2018 to: jkopesky@haldemanhomme.com

(Please request confirmation of file receipt)

- File name ***MUST*** be the school name of the schools you are representing. If your school has more than one team, please number your teams and include that in your file name.

- Stratasys FDM 3D Printers build parts by extruding a model material along with a dissolvable support material. The support material is used to fill in negative spaces in the part that is being built. This allows for complex geometries and moving parts. At the end of the build, the support material is dissolved away.

- Notes about the use of support material: If you would like support material to fill in a space to achieve moving parts or a negative space in your design, you must leave an opening of at least 0.023"

Process considerations:

A. Self-supporting angles are 45 degrees.

B. More support means longer build time because the machine takes time to switch from model to support on each layer.

C. Air gap for freedom of movement in parts ≥ 0.023".

D. How the file is oriented to be built will affect the amount of support material being built and the overall time of the build.

E. The processing software has 3 different internal fill patterns that will affect material usage and time of build.

F. See http://www.stratasys.com/3d-printers/technologies/fdm-technology/faqs

For additional information about the printers.

(2) Stratasys authorized dealer, Haldeman-Homme, will print the designs that were submitted by April 16th, 2018 and provide them to the teams the day of the contest. Teams will use any tools they personally bring to contest to finish their model so that it is free of burrs, ridges, etc.

(3) Onsite at the SkillsUSA competition, teams will receive a challenge to perform within a set timeframe involving a design change. Each team member will be required to participate in the design change to demonstrate design program competencies.

(4) Teams will present and turn in their engineering notebooks. Notebooks should include concept description, specifications, dimensional drawings, design tree, considerations of design for 3D, finishing aspects that impact design, and mistakes/lessons learned.

(6) The original printed design, design change in software, along with engineering notebook will be presented to judge.

Items on which contestants will be evaluated:

A. Original Design

B. Onsite Modification

C. Engineering Notebook

E. Presentation

F. Knowledge Exam

Standards and Competencies

ADMFG 1.0 – Design, sketch and plan machine work to U.S. National CAD Standards

1.1 Create CAD file for manufacturing using standard CAD terminology and standard practice

1.2 Initiate manufacturing documentation process

1.3 Export a CAD file to .stl format

1.4 Process Engineering Change Orders

ADMFG 2.0 – Perform and inspect part(s) using a Total Quality Management process

2.1 Verify part(s) to provided standards

2.2 Verify part(s) to ECO standards

2.3 Document process of verification and inspection

ADMFG 3.0 – Demonstrate safety practices in a working situation to the related duty tasks of the National Institute for Metalworking Skills (NIMS) Duties and Standards

3.1 Carry out assigned responsibilities while adhering to safe practices in accordance with OSHA requirements and guidelines

3.2 Document safety activities as required

ADMFG 4.0 – Provide an accurate quotation given an automated manufacturing technology simulated scenario

4.1 Solve various solutions to the process that is involved in quoting a job in a rapid prototyping environment

Committee Identified Academic Skills

The technical committee has identified that the following academic skills are embedded in this contest.

Math Skills

- Numbers and operations
- Algebra
- Geometry
- Measurement
- Problem Solving
- Reasoning and proof
- Communication
- Connections
- Representation
- Use fractions to solve practical problems
- Use proportions and ratios to solve practical problems
- Simplify numerical expressions
- Measure angles
- Use scientific notation
- Solve single variable algebraic expressions
- Solve multiple variable algebraic expressions
- Find surface area and perimeter of two-dimensional objects
- Construct three-dimensional models
- Apply Pythagorean Theorem
- Solve problems using proportions, formulas, and functions
- Find slope of a line
- Solve practical problems involving complementary, supplementary and congruent angles
- Solve problems involving symmetry and transformation

Science Skills

- Use knowledge of the particle theory of matter
- Describe characteristics of types of matter based on physical and chemical properties
- Use knowledge of physical properties (shape, density, solubility, odor, melting point, boiling point, color)
- Use knowledge of classification of elements as metals, metalloids, and nonmetals
- Describe and identify physical changes to matter
- Predict changes to matter (types of reactions, reactants, and products; and balanced equations)
- Use knowledge of potential and kinetic energy
- Use knowledge of Newton's laws of motion
- Use knowledge of work, force, mechanical advantage, efficiency and power
- Use knowledge of simple machines, compound machines, powered vehicles, rockets and restraining devices

Language Arts Skills

- Provide information in conversations and in group discussion
- Demonstrate comprehension of a variety of informational texts
- Organize and synthesize information for use in written and oral presentations
- Demonstrate knowledge of appropriate reference materials
- Demonstrate use of such verbal communication skills as word choice, pitch, feeling, tone and voice
- Demonstrate use of such nonverbal communication skills as eye contact, posture and gestures using interviewing techniques to gain information
- Demonstrate informational writing
- Edit writing for correct grammar, capitalization, punctuation, spelling, sentence structure and paragraphing

Connections to National Standards

State-level academic curriculum specialists identified the following connections to national academic standards.

Math Standards

- Numbers and Operations
- Algebra
- Geometry
- Measurement
- Data Analysis and Probability
- Problem Solving
- Reasoning and Proof
- Communication
- Connections
- Representation

Science Standards

- Understands the structure and properties of matter
- Understands the sources and properties of energy
- Understands forces and motion
- Understands the nature of scientific inquiry

Language Arts Standards

- Students apply a wide range of strategies to comprehend, interpret, evaluate and appreciate texts. They draw on their prior experience, their interactions with other readers and writers, their knowledge of word meaning and of other texts, their word identification strategies, and their understanding of textual features (e.g., sound-letter correspondence, sentence structure, context, graphics)
- Students adjust their use of spoken, written, and visual language (e.g., conventions, style, vocabulary) to communicate effectively with a variety of audiences and for different purposed
- Students apply knowledge of language structure, language conventions (E.g., spelling and punctuation), media techniques, figurative language and genre to create, critique, and discuss print and non-print texts

- Students use a variety of technological and information resources (e.g., libraries, databases, computer networks, video) to gather and synthesize information and to create and communicate knowledge. Students must present their report using PowerPoint.
- Students participate as knowledgeable, reflective, creative and critical members of a variety of literacy communities
- Students use spoken, written and visual language to accomplish their own purposes (e.g., for learning, enjoyment, persuasion, and the exchange of information)

If you have any questions, please contact:

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Also, please request confirmation of file receipt if participating in this contest. If not confirmed within 24 hours, please call.