PEAK ENGINEERS

SkillsUSA

Robert Parks

Contest Chair

1/22/2026

Additive Manufacturing Update

Advisors and Students,

Below are a few updates regarding the Additive Manufacturing competition:

Deliverables

Items that students will be expected to submit prior to competition or bring on competition day. All digital submissions should be uploaded to team's google drive folder prior to competition. These folders will be assigned once team numbers have been created.

- Engineering Notebooks (See guidelines below)
- CAD (.step, .sldprt, etc.) and mesh (STL, 3MF, OBJ, etc.) files for all physically submitted parts.
- Final assembly
- Presentation

Engineering Notebooks

I would like to remind everyone of the guidelines around engineering notebooks. The state issued competition has a section with specific details, but I would like to share notebook formatting rules based on confusion in previous years.

- Teams are required to keep an engineering notebook in either handwritten(preferred) or digital format.
  - If a digital notebook is created, a PDF of the notebook should be uploaded to your team's google drive folder prior to competition.
- The notebook must be from the current school year, in which the project is being presented.
- The notebook will be submitted to the judging team after the team's review.
- The notebook shall chronologically document the engineering process used to design and prototype their project.
  - Entries for handwritten notebook must be written in permanent ink, not pencil.

- Corrections to entries must be crossed out initialed and any pictures or sketches must be properly mounted and initialed to “marry” the item to the notebook. This can be glue or tape.
- The notebook must have a table to contents.
- Every page must be numbered.
- Every entry must be dated and signed.
- The entire process should be documented, including but not limited to sketches, notes, calculations, evidence of research, photographs, test results, code, project management documents, marketability study with cost and profit analysis.

Some examples of engineering notebooks can be found at the VEX Engineering website: https://v5rc-kb.recf.org/hc/en-us/articles/9662127437591-VEX-Engineering-Notebook-Examples

Please check back for future updates.

If you have any questions, feel free to reach me at mr.parks44@gmail.com

Thank you,

Robert Parks

SkillsUSA 2025/2026 Additive Manufacturing State Challenge

Have questions: mdangelo@sme.org Coming soon website link team resources.

Welcome to the "Mini-Figure Catapult/Trebuchet Challenge" challenge!

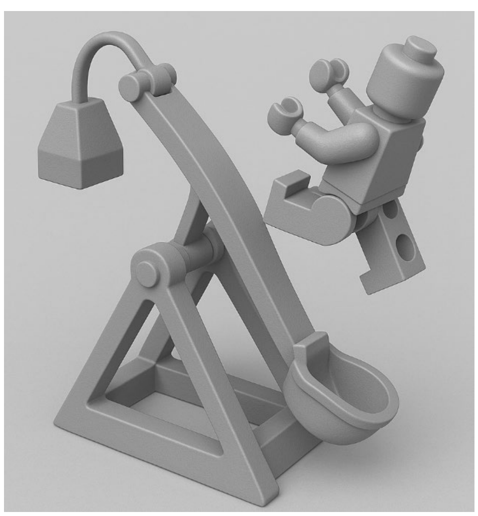
The Additive Manufacturing (AM) contest evaluates students' ability to design, prototype, validate, and communicate a functional mechanical device using **only 3D-printed components**.

Competitors must design a **catapult or trebuchet** capable of **launching a standard LEGO® minifigure** using **no added materials**, relying exclusively on the **properties of 3D-printed plastics**

Competitors create a **fully additively manufactured launcher**—catapult or trebuchet—where all energy storage and mechanical action originate from **3D-printed geometry alone**, including:

- Printed torsion beams
- Printed elastic flexures
- Printed springs or spring arms
- Printed counterweights (printed material only)
- Printed tension/flexural systems

No external rubber bands, cords, metals, or weights may be used.



Competition Requirements

Design Requirements

Each team must design a launcher that:

1. **Launches a standard LEGO® minifigure** (supplied by contest judges).
2. Stores and releases energy **using only 3D-printed material behavior**:
   - Elastic bending
   - Torsional flexure
   - Printed leaf or coil springs
   - Beam deflection
   - Printed counterweight (printed plastic only)
   - No metal, rubber, glue, magnets, or external energy inputs.
3. Operates using **a catapult or trebuchet mechanism**:
   - Catapult: energy stored in flexural or torsional arms.
   - Trebuchet: energy stored in printed counterweight or pendulum motion.
4. Has a locking trigger mechanism
5. Is safe and stable during operation.
6. Requires no fasteners—**all connections must be printed or snap-fit**.
7. May be a **single print** or **multi-component assembly** (can use multiple 3D printed material):
   - **Bonus points** for functionally integrated, single-print solutions.

Size & Print Constraints

- Fully assembled launcher must fit inside: **150 × 150 × 150 mm**
- All components must be **100% 3D-printed**
- **Any** 3D printer technology may be used:
  - FDM, SLA, DLP, PolyJet, SLS, SAF, MJF, etc.
- **Any printable material** is allowed:
  - PLA, ABS, TPU, Nylon, resin, PA11/12, etc.
- If multiple materials are used, all still must be 100% AM-produced.

Performance Requirements

During testing, each launcher must:

1. Securely hold and release the minifigure.
2. Launch the figure forward, not upward only.
3. Complete **three launches**, which are measured for:
   - Distance
   - Repeatability (all three launches must land within a 6-inch diameter of first launch.
   - Safety and stability (No part interference, damage during operation, or unsafe trajectories)

Design Considerations

4.1 Energy Storage Methods (Allowed)
Teams may use:
- Printed flexible beams (like bow limbs)
- Printed torsion rods
- Printed leaf springs
- Printed coil springs
- Printed counterweights (solid or hollow filled only with printed material)
- Printed whip-action arms

4.2 Energy Storage Methods (NOT Allowed)
- Rubber bands
- Metal or lead weights
- Ball bearings
- Strings or ropes
- Electronics
- External kinetic input beyond human-triggered release

4.3 Stability & Safety
- Broad base recommended
- Ensure center of mass remains within footprint
- Avoid high-tension prints that may crack explosively
- Ensure minifigure is not struck by structural components during firing

4.4 AM Material Behavior Tips
- FDM: stronger along filament path; avoid layer-splitting by orienting beams horizontally
- Resin: brittle; great for fine details but avoid ultra-high deflection
- SAF/SLS: excellent for small flexures; nylon is durable
- Multi-material: optimize stiffness vs elasticity

4.5 Recommended Geometries
- Arched, tapered arms for elastic bending
- Hollow counterweights (printed-only mass)
- Integrated bearings or bushing pockets
- Snap-fit axles and pivot joints
- Lattice structures for energy absorption

State Competition Procedure

Before or on contest day:
1. Students submit Engineering Notebook (Engineering notebook guidelines below)

2. Students submit print files in both CAD (.step, .iges, .sldprt, etc.) and mesh (STL, 3MF, OBJ, etc.) format to [State Designated File Share Site]
3. Students submit physical parts
4. Students submit final assembly if applicable
5. Students submit their Presentation

State Competition Judging Criteria

1. The Engineering Notebook should contain robust content, including at a minimum the following:
   1.1. Be clearly labeled with contestant name(s), date and page # on each page
   1.2. Begin with a problem statement
   1.3. Include discovery and documentation of approach to solve problem
   1.4. Include sketched design concepts with critical features labeled
   1.5. Critical dimensions clearly labeled in design sketch
   1.6. Considerations for designing for additive manufacturing distinctly addressed (i.e. part strength, part orientation) especially including any expected risks during printing
   1.7. Screenshots of the print time and material usage for all printed parts
   1.8. Design decisions and alternatives are documented and evaluated thoughtfully

2. The design must adhere to the Competition Requirements stated in the prior page.

3. Quality of final assembly
   3.1. Does it perform the function in the manner it was designed to do?
   3.2. Does it meet all requirements in contest guidelines?
   3.3. Do inserted components or multiple printed parts mates together properly?
   3.4. Did the students design the part with additive manufacturing in mind?
   3.5. Is there sufficient tolerance between parts for movement?

4. The design must illustrate best practices for "design for additive manufacturing (DFAM)". Below are some *potential* DFAM metrics to optimize for.
   4.1. Build Time
   4.2. Post-Processing/Support Removal Time
   4.3. Functionality Optimization (gear ratio, pliability, strength, etc.)
   4.4. Monetary Savings

4.5. Material Consumption
4.6. Energy Usage
4.7. Component Consolidation (lack of store-bought hardware)
4.8. Lightweighting for Ergonomics

5. **Presentation Criteria**
   5.1. The team clearly describes their understanding of the problem to be solved.
   5.2. Design Process: good design logic is used for key design choices. Intentional and well-communicated
   5.3. The presentation is professional and well-rehearsed
   5.4. The presentation emphasizes quantitative improvements (measured and estimated) of the time, quality, or cost of the improvement as well as any DFAM tactics employed.
   5.5. Practical evaluation: team demonstrates visually (videos, photos, drawings, animation, etc.) the task they improved, both before and after.

Grading Rubric

GR.1 Launch Performance — 35 pts

- Distance (best of 3 launches): 25 pts
  - Compare to peer competitors
- Consistency: 5 pts (all 3 figures land within a 6-inch diameter)
- Safe trajectory & controlled release (no interference or damage to parts while operating): 5 pts

GR.2 DFAM Execution & Print Quality — 20 pts

- Efficient use of AM geometry
- Thoughtful layer orientation
- Integrated mechanisms (springs, hinges, etc.)
- Complexity that adds functional value
- Built in locking trigger
- Clean print
- Quick assembly
- Good tolerance

GR.3 Engineering Notebook — 15 pts

- Completeness
- Technical clarity
- Analysis & iteration

- CAD quality

GR.4 Presentation — 15 pts
GR.5 Knowledge Exam — 15 pts
Pass with 70% or better or Fail