Put toothpaste on a toothbrush.
This Challenge
The first 4-H Rube Goldberg challenge is to design and build a Rube Goldberg contraption (RG) that squeezes toothpaste out of a toothpaste tube and on to a toothbrush. The toothbrush should be a standard adult size (≈19 cm) and the toothpaste tube should be 6 oz. You must also make sure your machine meets specifications listed on page 6.

Mission
The goal of Rube Goldberg is to encourage critical thinking, creativity, innovation, and problem solving in a non-traditional learning event and to have FUN in the process. Youth who have completed third through twelfth grades can compete in the Rube Goldberg Challenge. Youth will use their STEM knowledge and skills to solve problems, make a plan, and design a solution.

Rube Goldberg (1883-1970) was a Pulitzer Prize-winning cartoonist who was best known for the wacky inventions that appeared in his comics. His cartoons appeared in newspapers for more than 50 years.

A RG is an overly complex contraption that does a simple task. The RG contraption uses everyday items in a series of chain-reaction steps that accomplish a task. Rube Goldberg allows youth to use physics, engineering, humor, and storytelling. Teams are encouraged to create a theme for their RG and incorporate their theme in the contraption.

Teams that build a RG and complete the recordkeeping journal and a poster summarizing their work can compete or display their work at their county fair. Any team can participate in the state fair contest; teams do not have to win a county contest to enter the 2018 state fair challenge.
Contents

Who can be on a team?
Registration
RG specifications
Theme and story
Recordkeeping materials
Design Process Stages
Summary presentation
Frequently asked questions
Exhibiting your machine at state and county fairs
Fair judging
WHO CAN BE ON A RUBE GOLDBERG TEAM?

- A team must have at least three youth team members, but no more than ten.
- Youth who will have completed third through twelfth grades by the end of the 2017-2018 school year are eligible to be on a RG team. There will be a junior and senior contest. Youth who have completed any grade beyond twelfth are not eligible to be on a RG team, but they may act as youth mentors.
- The junior age group is 8 years- 12 years; the senior age group is 13 years- 18 years.
- In addition to the 3-10 youth, each team must have at least two adult volunteer leaders. Each volunteer must complete the 4-H volunteer screening process. One volunteer must be present at the state fair competition in order for the team to compete.
- All team members (youth and adult) must be enrolled in 4-H before the team registers for a RG contest.
- 4-H members above high school age cannot be team members, but they can work with teams as youth mentors. Youth mentors do not replace the adult volunteer leaders.

REGISTRATION

A. Team sign-up- This sign up serves as a notice to the state leaders that you have signed up as an RG team. This will allow the state staff to estimate contest participation and also email updates to teams.
   a. You can find this registration on 4HOnline under “Rube Goldberg Challenge”. Both adults have to register before any youth team members can register.
   b. After both adult volunteers have registered, we will list the team in 4HOnline and notify the adult volunteers that their youth team members can register. It may take a couple days for the adult volunteers to be notified that their team can register.
   c. If there are questions about this process, please contact Micki at 701-231-7259.

Due date to sign up

Teams should sign up as early as possible. We encourage teams to sign up by May 15 so they can be prepared for their county fair. The absolute deadline is June 30 or your county’s fair registration date, whichever is earlier.

B. County Fair Registration- If a team decides to show its RG at its county fair, registration for the county fair will be at the county level and carried out through the county fair registration process.

C. State Fair Registration- Teams that would like to compete at the state fair will sign up through the state fair registration process facilitated by the county 4-H agent.
### RG Specifications

<table>
<thead>
<tr>
<th>Machine Specification</th>
<th>Requirements or Limitations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Complete the official task (put toothpaste on a toothbrush)</td>
<td>Required</td>
</tr>
<tr>
<td>Safe for participants and observers</td>
<td>Required</td>
</tr>
<tr>
<td>Written list of all steps in your RG</td>
<td>Required</td>
</tr>
<tr>
<td>Number of steps</td>
<td>Minimum: 10 Maximum: unlimited</td>
</tr>
</tbody>
</table>
| Physical size of RG | Minimum: no minimum size  
Maximum: 6 feet x 6 feet x 6 feet |
| Single run time to complete the task | Minimum: None  
Maximum: 2 minutes |
| Reset time (time required to set your machine up again after a run) | Maximum: 20 minutes |
| Air compressor hoses running to the machine | Maximum 1 hose |
| AC or DC power cords running to the machine | Maximum 1 cord |
| Air compressor hoses and power cords used within the machine boundaries | Unlimited |
| Objects flying beyond machine boundaries | Objects must stay within overall maximum boundary of 6 feet x 6 feet x 6 feet. |
| Corporate logos | Allowed with written permission from the logo owner. |
| Use of live animals | Not allowed |
| Hazardous (toxic, noxious, dangerous) materials, explosives, or flames. | Not allowed |
| Combustion engines | Not allowed (No gasoline or other combustible fluid may be a part of the machine.) |
| Use of profane, indecent, or lewd expressions, offensive symbols or graphics | Not allowed |
Theme and Story
While developing the design for your machine, consider having a theme for your machine. The theme and story should be a fun part of creating your machine, and might even make the design process easier. As a team, decide how you will share your story. Your team will have a chance to tell the audiences and judges about your RG machine story and theme. Videos should not be used as a presentation technique during the contest.

Recordkeeping Materials
One of the most important parts of the Rub Goldberg challenge is reflecting on and recording one’s learning as the team designs the RG machine. Each team should have a notebook (journal) documenting the design and building process. The team should also prepare a presentation that summarizes their work outlined in the journal. The recordkeeping requirements must be completed by the time the RG machine is judged at the county fair. The completed notebook will be judged with the machine.

Team Notebook Specifics
The team notebook or journal should be a record of the team’s ideas, progress, setbacks, and accomplishments throughout the design and building of the RG. The notebook should be accessible to all the team members and everyone should have the opportunity to make entries and record information. The notebook should contain both writings and drawings. If an idea is not used or if something does not work, do not scribble it out or erase the information. Instead, go into detail on why the idea did not work or wasn’t used. The team can write in the notebook throughout their meeting or the team could designate the last 10-15 minutes of the meeting to write in the notebook.

Suggestions of what to record....the location, date, and length of time the team worked on the machine. Record who was present at each of the sessions; document each of the experiments. Explain if the experiment worked or did not work and why.

The purpose of the notebook is to give the team members a way to reflect on what they learned and accomplished each time they met. The notebook also provides documentation to the fair conference judges of the team’s work, including research, successes, setbacks and progress. The following page illustrates the five stages of the design process and outlines some questions that may help the team record their meeting entries.
DESIGN PROCESS STAGES
The design process has five stages:
1. Problem definition
2. Information gathering
3. Idea generation
4. Testing and decision-making
5. Redesign

REFLECTING ON YOUR PROCESS

Problem definition:
- What is one problem that your team ran into today?

Information gathering:
- What did your team know already that helped you think of a solution?
- What more does your team need to know to help you think of a solution?
- How does your team plan to gather the information that you need?

Idea generation and decision-making:
- List the ideas that your team came up with for solving the problem.
- How did your team decide which of these ideas to test?

Testing:
- Did it work? If yes, how? If not, what more did your team do to solve the problem?
- Write down the information/date that your team collects from testing to help you make a decision/solve the problem.

Redesign:
- What did your team do to improve your design/or solve the problem?

SUMMARY PRESENTATION
The purpose of the summary is to assist the team in describing their experience during the conference judging at the fair. The summary can be a one or two page account that highlights the team’s experience, or it can be a poster, photographs, a video or anything else the team could use to describe their experience. The journal helps the team think about the entire process in small steps, the summary highlights the big moments, the fun, and frustrations the team had from the beginning to end.
FREQUENTLY ASKED QUESTIONS

QUESTIONS ABOUT RG

Question: What is a step?

A step in the machine is a transfer of energy from one action to another action: identical transfers of energy in succession should be counted as 1 step.

Example: A sequence of dominos hitting each other counts as 1 step. Counting 100 dominoes as 100 steps is not a different transfer of energy.

Question: Can programmable logic controllers or microcontrollers be used?

Yes, but their use must fit within the definition of a step. Steps that use controllers should be clearly stated in the written step list and include detailed information on how the transfer of energy is accomplished.

Example: A ball falls onto a switch connected to a controller that turns on a motor.

Question: What is meant by human intervention?

Answer: Once the first step in your machine takes place, (a team member can physically start the machine) the machine should function all the way to the end without a person touching it. If the machine fails before it completes the task, it may be necessary to start it again from the point where it failed.

Question: Can I enter a machine that has been previously built and posted online?

Answer: No. All entries must be new machines created and built for entry into this competition.

Question: Does our machine have to fill the whole 6’ x 6’ x 6’ space?

No, your machine can be smaller than the maximum allowed dimensions, it just can’t be larger.

Question: Can you tell me more about the theme and the story?

This year’s task is putting toothpaste on a toothbrush. You could select a theme that ties in with a situation in which you might be using a toothbrush/toothpaste. Once you think of your theme, the story will begin to take shape.

Question: What sources can we use for research?

You may already know some of the information you use to build your RG before you start the design process. However, you probably won’t know everything. You can use the library, your teachers, the Internet, your family or 4-H volunteers. It might be a good idea to talk to an engineer if you know one.
QUESTIONS ABOUT THIS YEAR’S CHALLENGE

Question: Does the size of the toothbrush or toothpaste tube matter?

Yes, the toothbrush should be a standard adult size toothbrush (~19cm), and the toothpaste should be the 6.0 OZ size.

Question: Is there a certain amount of toothpaste that needs to be squeezed onto the toothbrush?

No, as long as the toothpaste can be seen by the naked eye the amount does not matter.

QUESTIONS ABOUT RG TEAMS

Question: Can a team be made up of youth from different school grades?

Yes. A team can be made up of more than one grade, as long as all members are between third and twelfth grades.

Question: If our team qualifies to attend the state fair, but not all of our members are able to attend the state fair, is it still OK for some of us to show our machine?

Yes, you can show your RG even if you are missing a team member. However, make sure that you have enough team members to transport, assemble, demonstrate, and disassemble the machine.

Question: If we qualify to show at the state fair, can we make changes to our machine, records and presentation between the time we show at our county fair and we show at the state fair?

Yes. The engineering design process encourages us to learn from experience and redesign to improve the RG.

EXHIBITING YOUR MACHINE AT COUNTY AND STATE FAIRS

Be sure to read the information in the registration section about registering to compete at your county fair or at the state fair.

TRANSPORTING AND STORING YOUR MACHINE

County Fair
Space differs from one county fair to the next. Teams must contact their county Extension staff regarding their plans to exhibit their machine at the county fair. The staff will be able to give you guidelines on whether or not you will be able to drive right up to the exhibit space at your county fair to unload your machine or whether or not it can be stored at the fairgrounds before or after the fair takes place.

State Fair
Teams attending the state fair should plan on bringing their machine to the fair on the day of their conference judging, and taking the machine back to their home county after judging. Some exceptions may be made for teams traveling a long distance. Any such arrangements must be made ahead of time with the North Dakota 4-H state fair staff.
Private vehicles may not drive onto the fairgrounds during the state fair, so you won’t be able to drive up to the 4-H building to drop off your machine.

North Dakota 4-H will make an effort to arrange with the North Dakota State Fair to allow us to provide a truck to transport machines onto and off of the fairgrounds (early in the morning and late in the evening), but North Dakota 4-H must comply with the North Dakota State Fair policies and can’t guarantee transportation assistance. If North Dakota 4-H is allowed to provide assistance, information will be communicated to teams shortly before the state fair opens.

FAIR JUDGING

All entries will be judges using the conference judging process, where a team meets with the judges at the fair and talks with them about their machine, including developing the design, building it, solving problems, identifying lessons and their applications and working as a team. Final ribbon placement will be based 50% on the team members’ knowledge of that process and 50% on the machine itself.

Ribbon placements will be purple, blue, red or white.

WHAT THE RIBBON COLORS MEAN

- Purple. The exhibit meets all standards. The exhibit meets all standards. The exhibitor has shown complete understanding of what, how, and why the exhibit was done, and has a thorough knowledge of the subject. The exhibit and workmanship are extraordinary and need no improvement.
- Blue. The exhibit meets most standards. The exhibitor can explain what, how, and why the exhibit was done and has a good knowledge of the subject. The exhibit is well organized and well done.
- Red. The exhibit meets some standards. The exhibitor can somewhat explain what, how, and why the exhibit was done and has a fair knowledge of the subject. Some improvements may be needed on the exhibit.
- White. The exhibit meets few standards and lacks the quality of other exhibits. The exhibitor cannot adequately explain the what, how and why of the exhibit. Possibly they have overlooked a safety flaw. Improvement is needed in either the exhibit, the knowledge of the subject, or both.

JUDGING PROCESS

- The team will participate in a public presentation and conference-judging-style experience.
- Teams will share their journals during conference judging and review the process for the design and construction of their RG.
- Team members will share with the judge their individual contributions of the construction of the machine.
- The team will demonstrate its machine for the judge and the public.
- Teams that complete the judging process will be awarded a purple, blue, red or white ribbon at county and state fairs.
Rube Goldberg Judging Form

Date __________________                         Grade range of team members___________________

County___________________                    Team Name________________________

Number of team members at judging______________________________

<table>
<thead>
<tr>
<th></th>
<th>Very Good</th>
<th>Some Improvement Needed</th>
<th>Much Improvement Needed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purple</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blue</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Red</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td></td>
<td></td>
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</table>

Theme or story about the machine

Sequences of steps are clear and described; energy transfer is described; simple machines are identified

Degree of machine complexity

Degree of innovation, creative use of everyday items in new ways

Degree of human intervention

Machine run time:
- Up to 2 minutes - very good
- 2-3 minutes - some improvement needed
- Over 3 minutes - much improvement needed

Worked as a team, role of each team member is identified and described

Discovered ways problems were solved and described using examples; demonstrates perseverance

Identified “lessons” learned and how they apply beyond RG
<table>
<thead>
<tr>
<th>Identified “lessons” learned and how they apply beyond RG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conducted research (sought information and knowledge)</td>
</tr>
<tr>
<td>Elements of the design process stages are evident</td>
</tr>
<tr>
<td>Provided a record or journal that documents the process of building the RG</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Machine Specifications</th>
<th>Specifications met</th>
<th>Specifications not met</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Steps (≥10)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Task completed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Objects leaving the machine</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Machine does not exceed size requirement</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Machine meets rule and safety requirements</td>
<td></td>
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