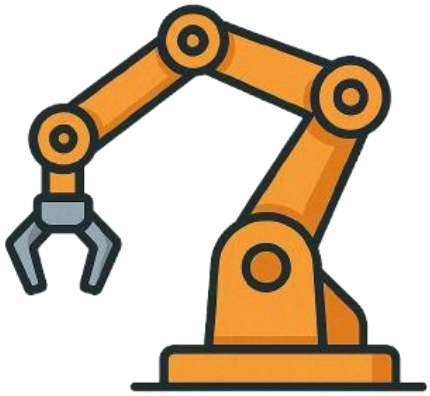
JUNK DRAWER RACES
/
COURSES DE TIROIRS DE BRIC-À-BRAC

Grade 7-8 / 7e-8e année



Hydraulic/Pneumatic Machine Challenge

Défi de grue hydraulique/pneumatique

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If you require assistance or have any questions about the contest, and for important dates, please consult the website at www.skillsontario.com/junk-drawer-races, or you may contact the Competition Coordinator at cvollum@skillsontario.com.

TABLE DES MATIÈRES

Si vous avez besoin d'aide, si vous avez des questions au sujet du défi, ou si vous souhaitez connaître les dates importantes, veuillez consulter notre page Web à www.skillsontario.com/courses-de-tiroirs-de-bric-a-brac ou communiquer par courriel avec la coordonnatrice de ce programme à cvollum@skillsontario.com

1. CURRICULUM CONNECTIONS

Competition	Grades	Ontario Curriculum Connections
Hydraulic and/or Pneumatic Crane Challenge	7-8	Ontario Elementary Science & Technology Curriculum *Below is a suggested list of curriculum connections for this Junk Drawer Race challenge. Teachers are encouraged to select the expectations that best align with the strand being explored and the appropriate grade level (Grade 7 and/or 8).* **GRADE 7 CONNECTIONS** **A. STEM Skills and Connections** ● **A1.3**: Use an engineering design process and associated skills to design, build, and test devices, models, structures, and/or systems. ● **A3.1**: Describe practical applications of science and technology concepts in various occupations, including skilled trades. **D. Structures & Mechanisms – Form, Function, & Design of Structures** ● **D1.1**: Evaluate environmental, social, and economic factors that should be considered when designing and building structures to meet specific needs. ● **D2.3**: Identify the magnitude, direction, point of application, and plane of application of the forces applied to a structure. ● **D2.5**: Describe factors that can cause a structure to fail. **E. Earth and Space Systems – Heat in the Environment** ● **E2.1:** Use particle theory to explain how heat affects the motion of particles in a solid, a liquid, and a gas. ● **E2.3**: Use particle theory to explain the effects of heat on volume in solids, liquids, and gases, including during changes of states of matter.
		GRADE 8 CONNECTIONS **A. STEM Skills and Connections** ● **A1.3**: Use an engineering design process and associated skills to design, build, and test devices, models, structures, and/or systems. ● **A3.1**: Describe practical applications of science and technology concepts in various occupations, including skilled trades. **C. Matter and Energy – Fluids** ● **C2.4**: Explain the difference between liquids and gases in terms of their compressibility and how their compressibility affects their technological applications. ● **C2.6**: Explain in qualitative terms the relationship between pressure, volume, and temperature when a liquid or a gas is compressed or heated. ● **C2.7**: Describe how forces are transferred in all directions in fluids, including using Pascal's Law to quantify the transfer of forces in fluids. ● **C2.9**: Describe the differences between pneumatic and hydraulic systems. **D. Structures and Mechanisms – Systems in Action** ● **D2.2**: Describe the purpose, inputs, and outputs of various systems. ● **D2.3**: Identify the various processes and components of a system that allow it to perform its function efficiently and safely. ● **D2.5**: Demonstrate an understanding of the relationships between work, force, and displacement in simple systems. ● **D2.6**: Explain the relationship between input and output forces and determine the mechanical advantage of various mechanical systems, including simple machines.

2. CONTEST OVERVIEW

Welcome to your new role as Junior Engineers with the Skills Ontario Mining & Construction Division. A low-rise support facility is under construction on a remote mining site. Your team has been assigned a critical task: to design and operate a hydraulic and/or pneumatic machine capable of lifting a fully loaded shipping container (simulated by a 20 g object) up three levels of a construction tower.

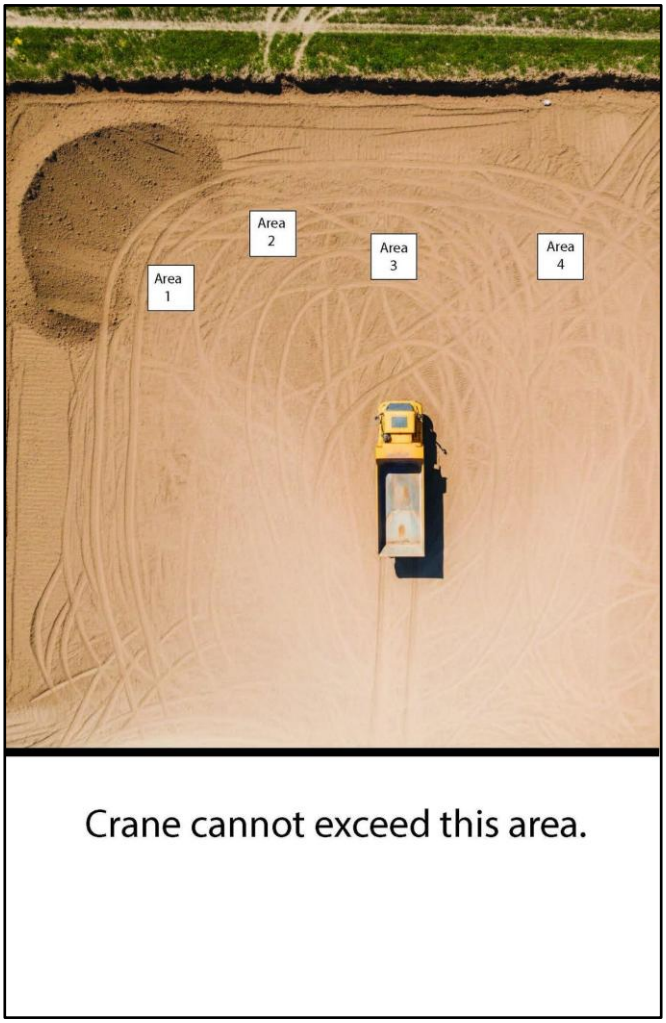
Each time a building level is completed, the container must be hoisted to the next floor to deliver tools, materials, and supplies. The construction platform — made of snap cubes — represents the growing height of the building. The platforms will be constructed as per the image below:

The shipping container will be created as per the image below:

Your team must design, build, and operate a hydraulic (or pneumatic) machine that can:

- Securely hold a 20 g container. (assume a snap cube weighs 3 grams)
- Lift the container up, simulating vertical movement.
- Move side to side (horizontal travel).
- Move in and out (reach extension or boom control)
- Raise the container to each of four levels, one at a time — each level built from snap cube platforms.
- Place the container securely on top of each new level, demonstrating both precision and control.

Coin	Toonie	Loonie	Quarter	Dime	Nickel
Weight (G)	7	7	5	2	4



PDF of Map (Print on 11 x 17 paper)

Important Points:

1. All judging is final. Individual final scores will not be shared with teams.

2. Students are encouraged to work in a team where every student has a different responsibility.

RESOURCES

- How to make a hydraulic crane out of cardboard experiment
- CARDBOARD Robotic Hydraulic Arm
- How to make a remote control Hydraulic Crane from Cardboard
- Young Engineers: Easy Hydraulic or Pneumatic Machine - Engineering Projects for Kids
- Science North - Hydraulics & Pneumatics

3. SUBMISSION REQUIREMENTS

Below you will find the description and judging requirements for each section of the Hydraulic/Pneumatic Crane Challenge. This includes the following three sections:

A. The Design Document

Teams will find the design document posted to our website (https://www.skillsontario.com/junk-drawer-races), under "Design Document". Students will fill out the document and submit it with their final submission.

B. The Process and Reflection

Teams must complete the reflection section of the design document. Use the prompts and space provided in the design document to guide your responses. Your reflection should explicitly connect the steps of your design process to the outcome of your crane. Describe how initial ideas were tested and adapted, and make clear how decisions throughout the process shaped the final result.

Reflection should also include honest consideration of stumbling blocks. These may include challenges with teamwork and communication, difficulties in achieving precision or stability, or engineering improvements that required re-thinking. Identify how your team responded to these challenges and what you learned from them. This section should highlight not only what worked, but also how your problem-solving, collaboration, and persistence contributed to your finished project.

C. The Photos

Teams will take a minimum of three photos of their final project and submit them with their final submission.
The photos must clearly show the following:

- Top view
- Side view - Right and Left
- Front and back views

D. The Video

The crane will need to be recorded without edits to move the shipping container from one platform to another. Evaluation will be based on efficiency and timing, following the criteria from above.

The video must capture the entire load test of the Crane and the timer that shows the time it takes for the crane to complete the load test.

4. EXAMPLES OF MATERIALS

Paper Products

- Printer paper
- Wrapping paper
- Newspaper
- Tissue Paper
- Paper Towel
- Cardboard (either corrugated or non-corrugated)
- Stiff cardstock
- Foam Board

Other Materials

- Bamboo/wood Skewer Sticks
- Toothpicks
- Popsicle sticks
- Syringes of various size *
- Vinyl tubing for syringes*
- Water and colours for fluids
- Standard masses or coins for counterweights
- Thin wire or craft thread for hook and hoist rope
- Pulleys
- Paper Clips
- Straws
- Elastics

*Kidder Canada: Syringes
Kidder Canada: Vinyl Tubing
Spectrum Canada: Syringes

Adhesives & Connectors

Students may use ANY type of adhesive for their crane. *Recommended Adhesive/Connector products:*

- Adhesive tapes (e.g. 3M scotch, 3M masking, painter, duct)
- Glues (e.g. Super, white, carpenter's, hot glue)
- Zip Ties

Materials Not Permitted

- Any other form of metal
- Any pre-manufactured crane components (e.g., hoist)

We encourage students to be creative with materials. Therefore, if you have an idea for materials you would like to use that aren't listed above, please contact cvollum@skillsontario.com.

5. SCORING

Category	Maximum Points
A. Design Documentation ● All fields complete, names listed, sketch/diagram clear and labelled, materials listed, safety questions answered	10 points
B. Photo Submission ● Clear top, side, front, and back views; photo shows full build and mechanisms	10 points
C. Engineering Performance Crane demonstrates the ability to: ● Securely lift and hold the load ● Perform controlled vertical lift (to four levels) ● Complete horizontal side-to-side motion ● Extend and retract reach (in/out movement) ● Place the container precisely at each level	4 points 16 points (4 per level) 4 points 4 points 2 points
D. The Video Load Test Demonstrates the complete task sequence as described in the challenge. Crane must complete the following (20g minimum load): ● Vertical motion to 4 levels (1 pt per successful lift, total of 4) ● Horizontal motion is clearly visible and functional ● Reach extension (in/out) performed effectively ● Placement precision: load is placed cleanly and stably on each level	4 points 5 points 5 points 6 points
E. Design Evolution ● *Process to product link (6 pts):* Uses the prompts and space in the Design Document to show how early ideas, tests, and decisions led to the final crane. Makes explicit references to the relevant fields or pages of the Design Document. ● *Evidence of iteration and impact (8 pts):* Clearly explains design changes and supports them with evidence from sketches, tests, photos, or timing data. Describes the impact of changes on accuracy, stability, and function. ● *Stumbling blocks and responses (4 pts):* Identifies key challenges met along the way (for example, precision, stability, reach, material limits) and explains how the team addressed them and what was learned.	20 points

F. Team Collaboration ● *Roles and shared ownership (3 pts):* Team roles are defined, followed, and documented in the Design Document and reflection. Shows equitable contribution and effective handoffs. ● *Decision making tied to outcomes (3 pts):* Describes how team communication, feedback, and testing informed decisions that shaped the final result. Explicitly connects collaboration moments to specific changes recorded in the Design Document. ● *Team stumbling blocks and growth (3 pts):* Names real teamwork challenges (for example, time management, communication, conflict, division of labour) and explains strategies used to resolve them and what would be improved next time. ● *Clarity and professionalism (1 pt):* Reflection is concise, uses the provided prompts and space, and presents a unified group voice.	10 points

TOTAL **/100**

SUBMISSION PACKAGE

Submission packages should contain:

- The Design Document (including photos)
- One Video

HOW TO SUBMIT

To submit your project, go to www.skillsontario.com/junk-drawer-races click the button called "Submit Your Project".

You will be brought to a website where you must fill out all required information and upload your projects. It is recommended that teams put all parts of their projects into one folder. In order to tell which files belong to which team, please title your folder the name of your team. The folder must be converted to a zip file in order to be submitted.

If you have any questions or need any help submitting, please contact cvollum@skillsontario.com.

SKILLS ONTARIO & SKILLED TRADES

Skills Ontario's Mission Statement is to champion and stimulate the development of world-class technological and employability skills in Ontario youth
Apprenticeship Programs are the main pathway into the skilled trades. According to OYAP, an apprenticeship program is an education pathway that combines on-the-job training, work experience, and technical training that leads to certification in over 150 trades.

While in high school, students can participate in OYAP! OYAP is a school-to-work program that opens the door for students to explore and work in apprenticeship occupations starting in Grade 11 or 12 through the Cooperative Education Program.

6. SOME OF THE CAREERS THAT ARE CONNECTED TO THIS CHALLENGE

In Grades 7 and 8, students are starting to think about their future career. This is a good time to introduce them to some of the pathways they might explore that connect to the skills that they are using to complete this challenge. These pathways include a variety of skilled trades; organization and leadership; and communication and outreach.

There are over 140 registered skilled trades in Ontario Below are just a few of those careers, as well as some technology careers, that are connected to this challenge. To learn more about the skilled trade careers listed below and more, visit https://www.skilledtradesontario.ca/about-trades/trades-information/

You can learn more about skilled trades pathways, certification, grants and more at Skilled trades | ontario.ca and Skilled Trades Ontario

Skilled Trades

Hydraulic/Pneumatic Mechanic	General responsibilities: Hydraulic/Pneumatic Mechanics install, maintain, repair and rebuild hydraulic and pneumatic systems and their components in industrial and mobile equipment. • Reads and verifies design drawings to ensure hydraulic circuits conform to specifications. • Develops sketches and writes technical reports for system modifications and repairs.
Steamfitter	General responsibilities: Steamfitters lay out, assemble, install, maintain and repair piping systems that carry water, steam, fluids, gases and chemicals under high pressure. • Installs and maintains high-pressure piping for steam, process and industrial systems. • Calibrates and services instrumentation control systems for fluid flow and pressure.
Industrial Mechanic (Millwright)	General responsibilities: Industrial Mechanic Millwrights work on mechanical equipment and machinery—including hydraulic and pneumatic systems—in manufacturing and processing plants. • Installs, aligns and services pumps, hydraulic cylinders and control valves.

	• Performs preventive and predictive maintenance on fluid-power drives and conveyors.
Agricultural Equipment Technician	General responsibilities: Agricultural Equipment Technicians service and repair farm machinery—tractors, combines and implements—that use hydraulic power for lifting, steering and attachment control. • Maintains hydraulic cylinders and manifolds on tillage, planting and harvesting equipment. • Calibrates electronically controlled hydraulic valves for precise implement functions.
Marine Engine Technician	General responsibilities: Marine Engine Technicians inspect and repair marine propulsion and onboard systems, including hydraulic steering and trim controls. • Services hydraulic steering gears and power-assisted trim tabs. • Diagnoses and overhauls hydraulic drive units for inboard and outboard propulsion.

Organization and Leadership

Project Coordinator	General responsibilities: Oversees project timelines, coordinates multidisciplinary teams, and presents progress reports to sponsors and stakeholders.
Community Engagement Officer	General responsibilities: Builds relationships with local communities, organizes consultations, and presents project impacts to ensure social acceptance.

Communication and Outreach

Science Communicator/Journalist	General responsibilities: Writes articles, produces videos, or hosts podcasts that explain engineering and scientific innovations in clear, compelling language.
Marketing Communications Coordinator	General responsibilities: Develops campaigns, promotional materials, and pitch decks that translate technical concepts into engaging stories for clients and the general public.