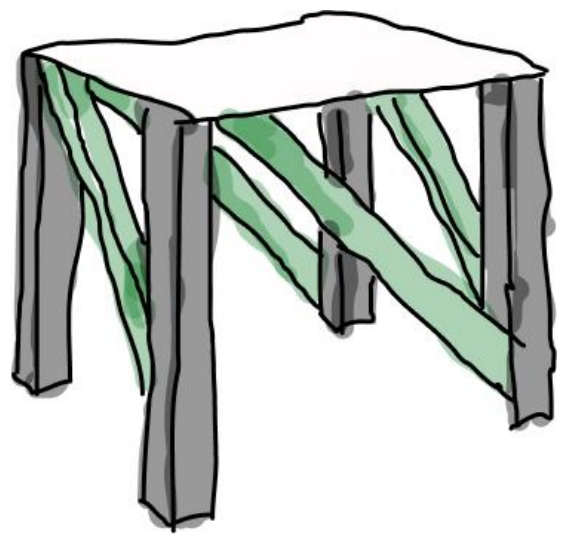


# SHAPES IN CONSTRUCTION



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# SHAPES IN CONSTRUCTION

The use of different shapes commonly used in construction and their characteristics.

Shapes in construction is a very practical project mainly focused on learning by doing. It does not include a lot of theory. The project is easy to follow, also without any pre-knowledge and because of the practical approach it is not very lingual. This makes it a suitable project for heterogeneous groups regarding language and educational background, or for groups that are not so much into theoretical learning. As all exercises will be conducted in teams, Shapes in Construction is a good project to stimulate and train teamwork.

## Skills

- Team work
- Presentation skills
- Talking in public
- Problem solving
- Creativity
- Designing and implementing plans

## Learning goals

- Triangles as a rigid shape
- Rectangles as a deformable shape
- Concept and use of arches
- Concept and use of columns

## Lesson plan

### Class 1: Strength of triangles: the tower

To understand the characteristics of a triangle and its applications, the students will be challenged to build a tower out of straws that can hold a bottle of water.

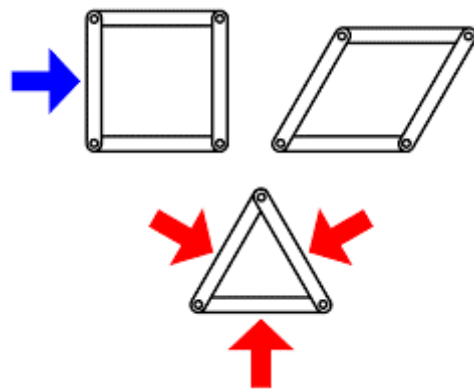
#### What do we need to know?

The strength of a shape is its ability to withstand forces. If a shape does not deform when forces are applied, it is called rigid. A figure that is not rigid will tend to deform when strong enough forces are applied to it. However, in the case of a rigid shape, it will keep its form until the force breaks the sides or opens the edges.

Triangles are a very rigid geometric shape. The reason behind it is that, the length of the sides being fixed, it is impossible to change the shape of the triangle. This only applies until the force is big enough to bend or break the material that the triangle is made of. We can make a weak material, like plastic straws, carry relatively heavy items, like a bottle full of water. However, it will not hold a person. As the strength of the material increases, so will the weight it can hold.

In the case of any other polygon, let's say a rectangle, this is not true. There are infinite different parallelograms that share the same length for its four sides. If we apply a force in one of the edges of a parallelogram, it will be easily deformed.

Therefore, given the same kind of material, a triangle will be able to hold heavier items than any other shape.



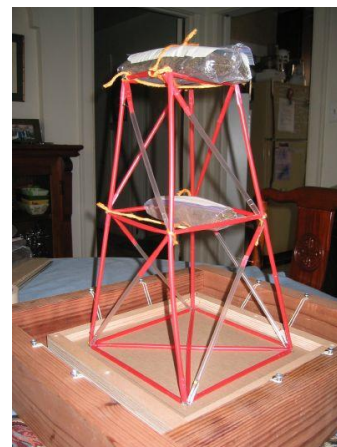
Picture 1 Rigidity of triangles vs rectangles

### What do we need to prepare?

- Plastic straws. At least 15 per team. If they have a flexible edge, it should be cut.
- At least one hot glue gun per team.
- Hot glue
- Two pairs of scissors per team.
- A flat piece of cardboard.
- Several plastic bottles to fill with water, or any other heavy objects.
- A tower made out of plastic straws containing triangles to reinforce it.
- A tower made out of plastic straws without triangles to reinforce it.
- At least one triangle made out of plastic straws.
- At least one rectangle made out of plastic straws.



Picture 2 Tower without triangles on the sides



Picture 3 Tower with reinforces on the sides

### Class session

The approach of this session is very hands-on from the beginning. Our goal is for them to discover how triangles can bring stability to a construction. For that, we will propose a competition among the students where they will have to build a tower with plastic straws.

The first thing to do will be to explain the rules of the challenge to the class:

- They will be divided into groups of up to 4 members.
- Each group will have 13 plastic straws, a hot glue gun and some pairs of scissors.
- They will have 30 minutes to build a tower as strong as possible.
- The towers should be at least 20cm high.

- They can cut the straws. If they decide they should not have cut a straw, they can get a full new one as long as they give back to the teacher all the pieces of the cut straw.
- The group with the tower that can hold the most weight will be the winner.

Once the activity is understood, we can divide the students into groups and let them work independently for 30 minutes.

*When we conducted this class, we noticed that even if the exercise was simple and all the students claimed they had understood the instructions, some of them had actually not. Given that the context we worked in always had the language barrier between them and us as an issue, we had to check during the process whether what each team was doing matched the requirements of the exercise.*

*Furthermore, the language differences among the students themselves made teamwork even more difficult. It was helpful to keep an eye on the teamwork of those groups where not all the students spoke a common language and mediate when necessary to make sure everyone was involved.*

We consider that learning as a consequence of experiencing can be more efficient than gaining it passively from an outside source. If students manage to come up with a tower where triangles prevent it from being deformed, they will have deduced the theory we want them to learn. If their tower has no triangles, they will see how it collapses easily and will learn from their mistakes. In both cases, the students will actively gain knowledge instead of passively absorbing it, which will presumably stick better in their memories.

After the 30 minutes, everyone will have to stop working, regardless of the state of their construction. It will then be time to test the strength of each tower. It can be done using a flat piece of cardboard as support on top of the tower. Different items can be placed on top of the cardboard one by one until the tower collapses.

It could happen that one or more of the groups come up with a design that includes triangles to give stability. In this case, these towers can be used as examples. Otherwise, we should have prepared a strong one.

Using the towers as examples, we can explain why those with triangles are stronger than those made only with rectangles, which tend to change form and collapse very easily. We can now show the flat triangles and rectangles to see clearly how external forces affect their shape. If we have enough material, one triangle and one rectangle could be handed to each group or each student to try.

## **Class 2: Strength of triangles: the bridge**

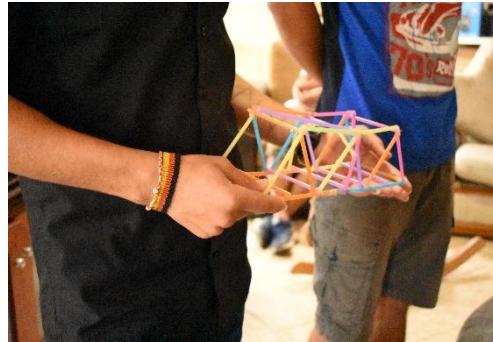
After spotting triangles in several buildings, the students will be challenged to build a bridge out of straws that can hold as much weight as possible.

### **What do we need to know?**

The purpose of this session is to help absorb the information the students got in the previous one. Therefore, no new theoretical knowledge is needed.

## What do we need to prepare?

- Per team, one set of pictures of different buildings where triangles can be spotted. We used the following:
  - Eiffel tower
  - Egyptian pyramids
  - Golden Gate bridge
- A camera or phone per team. They could be allowed to use their own phone if they own one
- Plastic straws. At least 15 per team. If they have a flexible edge, it should be cut.
- At least one hot glue gun per team.
- Hot glue
- Two pairs of scissors per team.
- Heavy objects that can be placed on top of the bridge to test its strength.
- A bridge made out of plastic straws containing triangles to reinforce it.



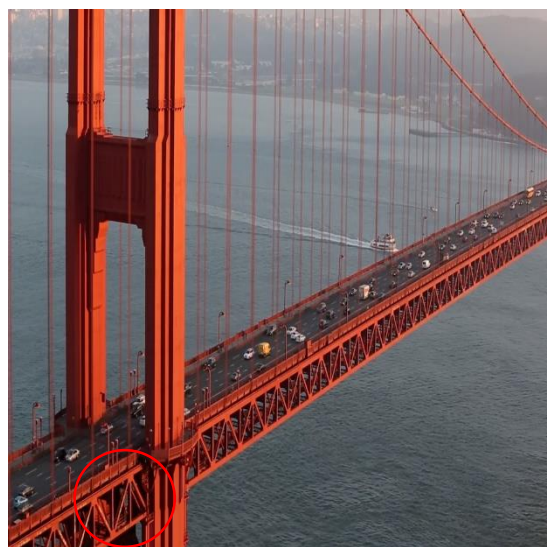
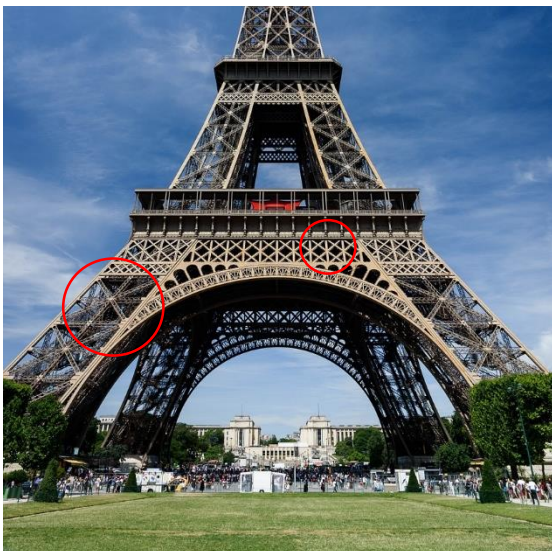
*Picture 4 Bridge built by our students, reinforced with triangles*

## Class session

This class is an organic continuation of the previous one. In session one they tried to come up with ways to make a structure strong. They, now, have some extra information. They should be able to use their new knowledge to build a strong structure.

Our intention, apart from guiding them getting new knowledge, is to make them aware of their own learning. By applying what they learnt in the previous class and being able to come up with a rigid construction, better than the tower they built the day before, they will realize that they are able to improve, boosting their self-esteem.

To begin with, we will quickly remember what we did in the previous class. Our approach for this review is to ask the class to tell what they remember, and then guide their answers until we reach the main points that we want them to learn. In this case, we want them to remember that adding triangles in a structure will make it more rigid and able to hold more weight.



*Picture 5 Eiffel Tower and Golden Gate bridge. On the circles, triangles can be spotted*



The class will then be divided in teams. The teams from the previous class can be kept so they see their own development as a team. However, this decision should be taken by the teacher according to their feeling of the class and the results of the previous class.

Each team will get a set of pictures to find triangles in real structures. With this activity we expect them to visualize where and how architects place triangles. Even constructions that do not clearly present triangles usually have this shape hidden in different parts of its structure. It is a good idea that at least one of the chosen structures is a bridge, so they can later use it as a reference for their construction.

*When we conducted this class, our first intention was that every member of each team work together on each picture. However, they split the papers and each one looked for triangles in one of the pictures. It is actually a sensible way of splitting work, but if our goal is for them to work together, it might be a possibility to only provide one picture per team and then ask each group to present their results to the rest.*

After they have spotted triangles in real buildings around the world, we will ask them to find them in their own environment. Each team will get a camera and they will go around the building, for ten minutes, looking for triangles that provide strength. They can be found not only in buildings, but also in furniture, in day-to-day objects... It is important that the triangles they find have an effect on the structure. They should not only be decorative.



*Picture 6 Two chairs where triangles can be spotted. In the first one, they reinforce the structure. In the second one they are just decorative*

Once these activities are done our students should have a better idea and understanding of how to use triangles. It will be time for the challenge. Every team will get their material and will be asked to build a bridge that can hold as much weight as possible. The distance the bridge will need to cover will be specified at the beginning, and it should be longer than the length of one single straw.

During the time they are building, we will have a look at the pictures the students took. If we detect something interesting, such as a triangle that is just decorative, we can briefly comment on it at the end of the class.

*From our experience, even if the concept of triangles have been repeated for two days, there might be students that do not find it easy to make the mental connection between the theory they have learnt and the exercise they are asked to do. For them each activity is a different block, independent from everything else.*

If we detect that a team is not reinforcing their structure, there are different approaches we could take. The approach is up to the teacher, who should have an overview on the possible reactions of their students. For example, if a team is usually teased by the rest for being the least capable, it could be a good idea to give them a hint if they are not using triangles. Otherwise

they might get more and more demotivated. On the other hand, for a team that does not take well outside input and tends to be overconfident, letting them work and discover their mistake when comparing the results with the other teams could have a positive impact.

Finally, when every team is done with their construction, every bridge will be tested by adding weight on it until it breaks. The one that holds the most will be the winner. After the competition, in case no bridge had the same structure as ours, we will show the bridge we had prepared and point out at the triangles we added to make it strong.

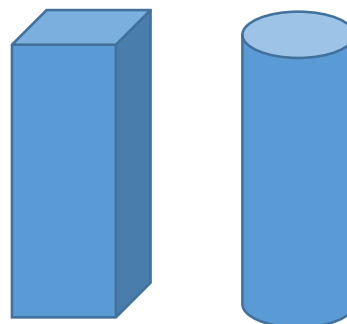
If time allows, and if there is something to comment, before dismissing the class we can make some notes about the triangles that the students found around the building.

### **Class 3: Cylinders and columns**

The students will be challenged to hold their weight using metal cans and toilet rolls to discover the strength of cylindrical columns.

#### **What do we need to know?**

A cylinder is a very strong geometrical shape that is often used in construction as a column to support heavy weights. As the top and the bottom of a cylinder are circles, the cylinder does not have any corners. This means that all points on the perimeter of a cylinder are equal. As all points are equal, when you put a weight on top of a cylinder all parts of the cylinder will carry an equal part of this weight. The ability of cylinders to divide weight equally over the whole shape results in it being a very strong shape, as all parts of the structure attribute to its strength.



*Picture 7 Squared and cylindric columns*

In a column with corners, such as a triangular or a quadric column, the corners will be the strongest part of the structure. The main weight will be carried just by the corners, whereas the walls in between contribute much less to the strength of the column. The strength of a column gets bigger by increasing the amount of corners. As a cylindrical shape can be seen as possessing an endless amount of corners, it is the strongest shape for a column.

#### **What do we need to prepare?**

- a minimum of eight soda cans per group, rather ten to have some spares.
- Paper
- Tape
- A weight of around 50kg, can also be a person
- Five heavy books per team

#### **Class session**

We start the class with a short review of the previous class. Subsequently we introduce the shape we will talk about today, cylinders and columns. We will not explain the theory yet as we think it will be understood better after the exercises.

The students will be divided into groups. Each group will be asked to go around the building and photograph as many columns and cylinders as they can find. After 10 minutes the group comes



back together and we discuss the photos they took. We will take out some of the columns they found, and ask what they think their function is.

The next challenge will be for the teams to organize their cans in a way that the cans will hold a person using as few cans as possible. The group that uses the fewest cans but stands, wins. The teams first of all have to decide how many cans they will use, and then think about how to best arrange them. In order to keep the competition fair, the same person will be used as a weight for all the groups. It is advisable to use a light person, or instead of a person you can choose any other item with a weight around 50 kg. Make sure the students know the weight of the person/object before they decide the amount of cans.

After 10 minutes, all groups should have finished with their plan, and the testing can begin. We first put a piece of thin wood -or anything else that can function as a base- on top of the cans. In order to properly test the strength of the structures, the person/object will have to be placed in the middle of the base, to spread the weight evenly. This means that if a person is used as a weight, this person will have to be barefoot and keep his/her feet flat. He/she will then have to be lifted and carefully put down on top of the cans. If the weight is unequally divided over the feet, part of the cans will have to carry more weight and will collapse easily.

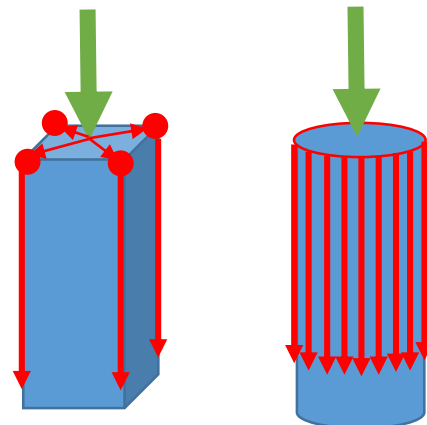


Picture 8 Student standing on 2 cans

After we finish the testing of the structures, we will explain why columns are often used in structures and what makes them strong. We will also elaborate on the weak points of columns.



Picture 9 Cylindrical column holding 7 books



Picture 10 Comparison on how the weight is distributed in a square and in a cylindrical column

If there is some time left, we can do one last exercise. Now the students know why cylindrical columns are strong, we will compare them to quadratic columns. In order to do so, we will give them papers and tape. Using that, they will have to make cylindrical and quadratic columns. To see which one is stronger, they will put books on top of the columns until they collapse. We ask

them to observe what happens and analyse the difference between the cylindrical and quadric column.

Lastly, we will discuss the observations they did and ask for a possible explanation. We will then explain the difference in strength between a cylindrical and quadric column using a simple drawing.

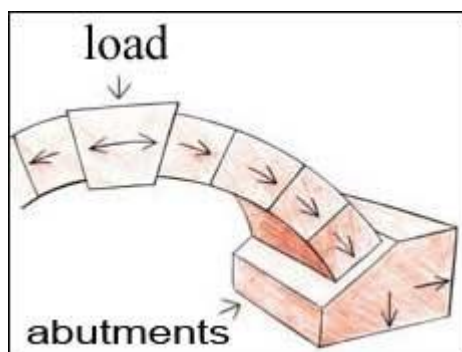
If there is still some time left, you can give the students extra challenges regarding the placement of the columns. They could, for example, make a structure using 6 cans that will collapse under the weight of the same person that was used in the first challenge. This will make them understand the importance of the placement of the columns and the spread of the weight.

## Class 4: Arches

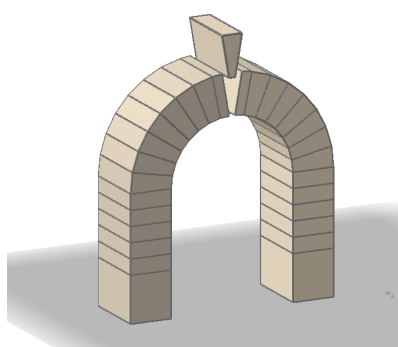
The students will try to build an arch by applying the theoretical knowledge they will gain on this shape.

### What do we need to know?

The arch is a semi-circular, very strong shape. It is often used in constructions, probably the most famous ones being bridges. The components of the arch bridge are the arch shaped bridge itself, and two abutments, one on each side of the arch. When weight presses down on the arch, the force is transferred along the arch and divided into two components. One component of the force pushes vertically into the ground, the other component pushes horizontally against the abutments. The arch owes its strength to its shape, as the semi-circular shape ensures that the force is being transferred down the arch, instead of being centralised in one point as would happen with a quadratic structure.



*Picture 11 Load split into vertical and horizontal components when reaching the abutment*



*Picture 12 Roman arch*

The Romans used the arch shape a lot in their constructions. Their arches were built up out of separate stones, with in the middle the key stone. The key stone would be the last stone to put into the structure, and locks all the other stones into their positions. This gives the arch the ability to hold weight.

Apart from its strength, the arch is also a useful shape because it can create a lot of space. In bridges it can create enough space for boats to sail through and still be strong enough to carry weight. In buildings it can create high ceilings and very spacious rooms without the ceiling collapsing.

### What do we need to prepare?

- 10 similar sized rocks per team. The rocks can be different shapes
- A PowerPoint presentation showing pictures of arches in famous structures all over the world (the one we used is available together with this document)

- A piece of paper
- A plastic cup
- 4 egg trays, each with at least a dozen eggs

## Class session

After having reviewed the information of the last class, we introduce the shape we will be talking about in this class, the arch. We show the students a presentation with photos of arches in famous structures all over the world. It can be a nice idea to include some photos of structures from the countries that your students are from.

We ask the students where else they have seen arches, and what they think the advantages of arches are. If needed we can help the discussion by first analysing what they are used for and why this shape is useful in that setting, think of bridges where boats can sail through because the arch provides enough space for that.

After the short brainstorm, we will explain the strength of the arch using a paper, two rocks and a plastic cup. We first put the paper on top of the two boxes, and ask the students what will happen if we put the plastic cup on top. We put it on top and the “bridge” will collapse. Now we place the paper in a semi-circle between the two boxes, and ask the students again what will happen if we put the plastic cup on top of the paper. This time the bridge will stand. We explain why the paper can hold the cup this time, and what makes an arch such a strong shape.

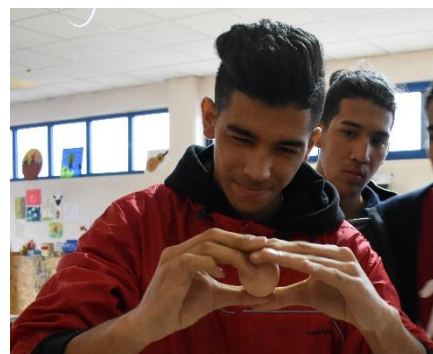


Picture 13 Paper arch holding a purse

Now it is time for some action, the group will be divided into teams and the teams will have to make an arch out of rocks. The most important thing in this exercise is to see whether they understood what an arch is, and the role of the keystone.



Picture 14 Roman arch built by the students



Picture 15 Students trying out the resistance of an egg

*Both of the times we carried out this class, the students made two towers of rocks and then joined them with a middle rock on top, that functioned as a bridge. This is not an arch, and it is important to make the students aware of that. If the central rock can be removed without the building collapsing, then it was not a Roman arch.*

As a final fun activity, we will stand on eggs. The shape of an egg is a dome, that can be seen as an infinite amount of arches, and is therefore very strong if weight is equally distributed. We will put a wooden sheet on top of a tray of eggs, and another one on top of another tray. We will now see whether these eggs can support our weight. In this challenge it is important to lift the person on top of the eggs spreading his or her weight equally. When the weight is spread equally, the eggs will be able to bear the weight thanks to their shape, even though the material they are made from is very fragile.

## **Class 5: Building a stool: design process**

Using the knowledge they have gained, the students will design a stool stable enough to hold their weight.

### **What do we need to know?**

There is no new theory to be taught in this class.

### **What do we need to prepare?**

- Papers and pencils
- Several pairs of scissors per team
- Cardboard
- At least one hot glue gun per team
- Hot glue
- Measuring tape

### **Class session**

We will start the session briefly reviewing the main points that we learnt about arches in the previous lesson. Then we will directly introduce the students to the task that will cover the next two sessions: building a stool that holds their weight.

This first class will be focused on designing the piece of furniture, so for the next day they will all be ready to enter the wood workshop. Each team will get papers and pencils to draw their ideas. Once they decide together on a design to build they will need to build a scale model of their stool.

For the model they will have cardboard and hot glue. After building their sample stool they can re-evaluate the design and add or remove any parts. We will walk around the teams checking that their designs can work and that they are reinforced with triangles. In the case that they are not, we will give them hints to guide them in the right direction. It is also important to take into account the limitations of our working space. The students might decide to build cylindrical legs for their stools, but if we don't have the right wood or tools to produce them, we should inform our students so they choose a different approach.

Finally, they will have to draw every single different piece that they will need to produce in the workshop to build their stool. For each piece they will have to decide on a measurement as well. To get an idea they can use the measuring tape to measure the chairs in the room.

*The first time we implemented this session, once the students had a sketch and some measurements we moved directly to the workshop. The results were not as good as expected, so for the next time we decided to focus only on designing for this first time, and make them build a scale model of their idea. This approach worked much better. This session was rather short,*



*but the construction process afterwards was reduced by a half, since the students had a very clear idea of what they had to do.*

## **Class 6: Building a stool: construction process**

Once the students have a proper plan, they will produce their stool using professional tools

### **What do we need to know?**

There is no new theory to be taught in this class.

### **What do we need to prepare?**

- Enough wood to produce all the stools. The type or size will depend on the students' designs
- Measuring tape
- Wood tools. Screwdrivers, hammers, saws, drillers, sandpaper...
- Consumables. Screws, nails...
- Safety material. Glasses, gloves...
- A suitable working space
- An expert in wood work. It could be the teacher themselves, but in the case that they are not experts on the field it would be advisable to have an external expert supervising the work.

### **Class session**

At the beginning of the class the students will be introduced into the safety rules of working in a wood workshop. If needed, the correct way of using each tool should also be explained. Once everybody is ready to enter the workshop each team can take their work from the last session: the scale model of their stool and the sketches with the measurements of each piece to produce.

We will distribute the wood and the tools, so the students can begin measuring and cutting. Then, together with the external expert, we can walk around checking in with each team and making sure that things go smoothly until all the stools are produced.

As the process goes, if we detect that a design is lacking stability or we spot any designing flaw, we will ask the students to check where the problem might be and try to adapt the product to



*Picture 16 Students working on their stools together with our wood expert*



*Picture 17 Two students with their stool/coffee table*

solve the issue. We will test each stool when they are finished, in case they need to readjust it. As a team finishes their product in a satisfactory way, they can leave the class.

*Entering the wood workshop with our students helped us learn many things. The first time it was very challenging, but the second one, after we rearranged our approach using what we had learnt, everything went smoothly. While in the first attempt each team needed more than 2 hours to finish, the second time, when everyone had a clear idea of each individual piece they needed, in 40 minutes all the stools were produced. This shows how important the designing session is.*

*Some students, especially girls, were reluctant to use some of the tools. They would prefer others to do that work because they didn't expect themselves to be able to do it properly. By pushing them to at least try, they all realized that their capacities go beyond their expectations. We think that it is important to make everyone try to do everything. If after trying they still don't feel confident is OK, but at least they will overtake barriers like shame or lack of self-confidence. It is important for this to create an environment of respect where failing on an attempt will not become a reason for a joke. Otherwise, we might end up producing the opposite result in our students: fear to fail, shyness, and, therefore, less willingness to try new things or push their limits.*

## Evaluation

To test the knowledge that our students have got during the cycle we will organize a treasure hunt. It will consist of four challenges, each of them in a different location. Once every team is finished, all the groups will have to solve a task together.

To find the tasks they will have to solve a riddle that will tell them where to go. The location of the challenges and the complexity of the riddles depend on the setting of the course. They can be in different rooms of a building, in different areas of a playground...

When we organized the treasure hunt, we placed each challenge in a different building of Habibi.Works. Library, Dome, volleyball field and main building. One of the riddles was:

*"Two cylinders going up,  
a net, full of squares, in the middle  
two teams pass a ball above them  
can you solve the riddle?"*

### The challenges:

1. Using two blocks of wood, hold a plastic cup using a piece of paper. Then, indicate how the weight of the cup is distributed.

Needs:

- Two blocks of wood or any other heavy material
- A piece of paper
- A paper or plastic cup

In this challenge the students will use their knowledge about arches. They will need to build a paper bridge like the one we built in class (see picture 13). Then, they will have to point how the force travels along the paper and eventually pushes the pieces of wood horizontally.



2. Take a picture of three triangles, two columns and one arch that bring strength to a structure.

Needs:

- A camera

This challenge will help the students remember the three different structures that we studied. It is important to have a look around the area where the exam will happen beforehand, to make sure that there are structures of which they could take pictures of. If, for example, we didn't find any columns but many arches, we could adjust the requirements and ask for five arches and no columns. The design is up to the setting.

We think that this task is a good starting point for any team that might struggle remembering everything they learnt. In our experience, when solving the task about arches, those teams that had faced this task before found the solution more easily.

3. Modify a tower made with plastic straws to make it stronger

Needs:

- For each team, a tower like the one in the picture
- For each team, at least one plastic straw. The amount will depend on the approach to the challenge
- A hot glue gun
- Hot glue
- Scissors
- A heavy object to test the tower

We will repeat the activity from the first session now that they have the knowledge to make a good construction. To make it more difficult, we will give them only one straw, so they cannot add a full diagonal on each side of the tower. Instead, they can cut it and reinforce the edges making small triangles.



*Picture 18 Two students reinforcing the corners of their tower*

Depending on our students, if we think that the approach of providing one only straw could be too difficult, we can provide as many as we consider. We can also tailor the challenge to the capacities of each team, making it more difficult for the groups that usually get better results.

4. Using four papers and tape, create a structure that can hold ten books

Needs:

- Four papers per team
- Tape

- A flat surface to place on top of the papers. For example, a piece of plywood or thick cardboard
- Ten books

The students will repeat the experience from class three, showing that they remember what they learn. Depending on the students, the challenge could be adjusted to make it more difficult by, for instance, asking them to do another structure, with the same material, but that cannot hold the books.

#### 5. The group challenge

Every time a team solves a challenge, they will get a piece of the scale model of a stool. It could be done with cardboard, plywood, or any material that is available for the teachers. Once every team has finished the four tasks, all the students will gather together to join the pieces and build the stool.

### Implementation

To begin with we will make the groups and explain the concept of the exam. Then, each team will get their first riddle. Each team will start on a different challenge, so we make sure that they are split around the place, not all working on the same task at the same time.

The order of the challenges will be fixed and circular. This means, if a team starts in challenge 2, then they will move to challenges 3, 4 and finally 1. Starting in challenge 4, the following ones will be 1, 2 and 3. If we had more than 4 teams, then we would need to design extra challenges.

The whole treasure hunt will be a time trial. Students will have 45 minutes to solve the riddles, pass the challenges and put together the stool in order to pass the exam and go on the trip. The time, if needed, should be adjusted in terms of the difficulty of the challenges and the riddles and even the distance between each station. From the moment the groups get their first riddle, the timer will start counting down.

The implementation of the exam will require several teachers. We can take two different approaches:

- One teacher follows each team, and they present each challenge and riddle.
- One teacher is waiting on each station, controlling the challenge and giving the next riddle.

If we have less groups than tasks, the first approach will be easier since less people will be needed.

From our experience, in our specific context, it is a good idea to have a teacher accompanying each team, making sure that they fully understand the riddles and that they work as a team on every station. The main advantages of this approach, in our opinion, are the following:

- Sometimes the teams might wrongly solve a riddle and end up in the wrong station. If no one is guiding them, this will end up in them missing or repeating some tasks.
- A teacher overseeing all the challenges will detect if any student is taking over the whole thinking process in all the tasks. In this case, they can try to push others to give their input.
- If the teams are language-based, having a teacher that has some knowledge of the common language will make the whole process easier and more clear for the students.

## Showcase

For this showcase, the students will present, in groups, the stools they built. Each team will explain how they made them stable and strong and what shapes they used on them. Once a team has finished explaining their work, the rest of the students will be asked to propose ways to improve it in any way. It can be, for example, reducing material that isn't really needed, making it more stable by adding new pieces or changing the size of a piece.

## External resources:

- Website with a similar project:  
[https://www.teachengineering.org/activities/view/cub\\_intro\\_lesson01\\_activity1](https://www.teachengineering.org/activities/view/cub_intro_lesson01_activity1)
- Website with a comparison between rounded and square columns  
<https://civiljungle.com/types-of-rcc-columns/>
- YouTube video with the paper column experiment  
[https://www.youtube.com/watch?v=9Bhl8HkmCzo&ab\\_channel=Toppr](https://www.youtube.com/watch?v=9Bhl8HkmCzo&ab_channel=Toppr)
- YouTube video explaining the egg experiment  
[https://www.youtube.com/watch?v=Xckhg7Ns8so&ab\\_channel=SpanglerScienceTV](https://www.youtube.com/watch?v=Xckhg7Ns8so&ab_channel=SpanglerScienceTV)