NOTES FOR TEACHER-FACILITATORS

The contents of this file have been summarized in a separate document called the *" In-School FPAC Procedures"*. We strongly recommend that you use this document to schedule the required actions and track your progress through the Challenge process. This *Notes* document provides detailed instructions for most, but not all, of the actions listed. The *"In-School"* scoresheet is used to evaluate the Challenge Event.

Note that all the files required for the National Fluid Power Challenge can be found here.

Print the following:

One Copy for Each Team	
Workshop Lifter Power Point Instructions	*Rotating Platform PowerPoint Instructions*
Judges Rubric	*Challenge Rules*
Building a Cube Instructions	*Process Cube Sides (legal)*
Portfolio Checklist	*Portfolio Template*
Iso-Ortho Views Explained	*Design Process Diagram*

Two Copies for Each Team	
Challenge Scenario	*Challenge Rubric*
Hints for Device Design Construction- Illustrates use of components in the Fluid Power Kits	

One Copy for Each Person	
Pre-Survey for Students- Workshop Day	*Post Survey for Students- Challenge Day*
Teacher Feedback Survey- Challenge Day	

A. PRIOR TO THE WORKSHOP LESSONS

Receive and check the shipment.
Inside the shipping boxes there will be a standard shipment of one Workshop kit, one Challenge kit, one Tools kit and a bottle of wood glue for each team and a layout board and two objects for each school. Also included are paper layout sheets for teams to practice on, one for each Workshop kit.

Separate and store the Challenge Kit for the school Challenge Day.

The materials in the Challenge (Scenario) Kit are nearly identical to those in the Workshop Kit apart from the Lifter Kit and the Rotating Platform Kit each team will make and some extra components (2 pistons, 1 holder and extra tubing).

B. WORKSHOP LESSONS AND DELIVERABLES

All students follow the Workshop lessons including the Design Portfolio work where students explore solutions to the Challenge Scenario. Based on the work each team puts into their portfolio, how well they work together and individually, the mechanisms they explore and build into their prototype and how their device performs under Challenge rules, up to three (3) teams

are selected to forward their work for evaluation in the overall "local" Challenge with other schools.

SEQUENCE OF WORKSHOP LESSONS

1. ***Watch the fluid power careers presentation***

   This PowerPoint will show your students glimpses of many fluid power applications.

   For a 26-minute video by the NFPA that provides more details, go to:

   http://www.tpt.org/Fluid-Power:-A-Force-for-Change/

2. ***Review or introduce the Fluid Power Fundamentals document***

   This document explains Pascal's Law as well as related fluid power concepts such as viscosity, fluid density, inertia and levers. It also provides additional information about where and why fluid power is used in the real world.

3. ***Introductory activity: making a design process cube***

   Note: the steps in the design process are discussed in detail in step 6 below.

   Draw attention to expected standards of safety.

   Demonstrate how to use a saw and miter box safely by cutting two wood strips 4" long. Show how two triangular green cardboard gussets secure the wood at 90 degrees using a SMALL amount of wood glue. The sheet from which gussets are cut can be used as a 90° template. It's best to have this sample cut and glued prior to the lesson.

   Dispensing wood glue and using syringes to connect to dowels. In the kits there are small plastic cups. These are used to hold a small amount of wood glue. Each team of four needs a bottle of wood glue and there are stirring sticks to apply the glue to the wood and cardboard when assembling a device. Emphasize that only a small amount of glue is required to secure the pieces. This is the method for connecting the piston-syringes to the devices is used in the Lifter construction (below).

   As an introduction to cutting ask each pair of students (2 per team) to make a square with external dimensions of 4" using an undrilled piece taken from their long "Workshop Kit" box and using a ruler, pair of scissors, miter box and small saw. Do not tell the students how to do it, let them make mistakes and discover that the thickness of the wood matters.

   There are three ways to make the square: (2 X 4") + (2 X 3¼") or (4 X 3⅝") or (4 X 4" using 45 degree miter cuts), demonstrating that there are different ways of assembling the same thing.

   The two 4" squares can be combined to create a cube with the addition of four 3¼" pieces and then covered with the Process Cube Sides. The sides will identify the six steps of a Design Process. Both *Process Cube Instructions* and the *Process Cube Sides* files are downloadable from the Resources page.

   Demonstrate how to drill a hole in the plunger of a 20 ml syringe using the miter box or vice. This demonstration is for when students explore prototypes and need to attach syringes as actuators.

4. ***Build the Lifter and Rotating Platform***

It is advisable to have the two models pre-made to show how the Lifter and the Rotating Platform work.

The pieces in the Lifter and the Rotating Platform Kits are pre-cut and drilled so that the only tools required to make them are a ruler and scissors. Tools, however, will be needed to make all or part of a prototype in steps 5 and beyond. The instructions for building both devices are available on the Resources Page. Please note that although the instructions will display on cellphones, iPads or other tablets are best.

Students should next open the Workshop Kit and pull out the Lifter and Rotating Platform Kits. The box will contain additional materials for use later (wood, dowel and two bags of parts) and some will spill out. Return all materials to the box except for the two kits.

When the students open the Lifter and Rotating Platform kits, they will notice that the axle holders (white) are pre-cut and hole-punched in the Lifter Kit. The two kits demonstrate different ways of connecting pieces that accommodate movement and the building of a housing structure.

Draw attention to the *Lifter* and *Rotating Platform PowerPoint instructions*.

Referring to the downloaded instructions the students will now build the two kits. Either all four students in each team can work on both the Lifter and then the Rotating Platform, or two students can be assigned the Lifter while the other two make the Rotating Platform.

The Lifter comes together after a fair amount of construction. The Rotating Platform is less "glamorous" than the Lifter and easier to make. Once finished the pair can help with the Lifter starting at slide 13.

Both models demonstrate important techniques. The plunger can be used for linear movement directly, but where linear-to-rotary movement is required, the syringe must pivot or turn – hence, the syringe platforms that turn, albeit a small amount, to accommodate the rotation.

5. ***Introduce the Challenge Scenario***

During this phase, the students are introduced to the Challenge Scenario. They will explore possible solutions to the Challenge Scenario and investigate them by designing and making sub-systems that perform specific functions, e.g. a mechanism for picking up the object, a mechanism for achieving the required rotation, etc. Each team of four students will combine the sub-systems to make a prototype device, all the while recording their work in a Design Portfolio following the instructions found in the *Portfolio Checklist* and *Portfolio Template*, both available on the Resources page.

It is recommended that the team of 4 students take on different roles:

Builder – responsible for construction of device

Designer – responsible for research and alternative designs

Illustrator – responsible for graphics including isometric and orthographic drawings

Writer – (also team leader) responsible for portfolio content

In this lesson, you will need to refer to the *Challenge Layout Board*.

The layout design is available for download if you wish to make additional boards.

At this point you should also download and review the *Introducing the Challenge* file with the students.

You will also need the following:

- Two copies of the *Challenge Scenario* and the *Challenge Rubric* for each team. There is a short version (*Challenge Rubric)* and a detailed version (*Judges' Rubric)*. The detailed version can be a teacher resource detailing specifically with how points are awarded.
- One copy for each team of the *Challenge Rules, Portfolio Checklist, Portfolio Template* and *Challenge Layout dimension Iso-Ortho* file.
- The *Portfolio Templat*e is the minimum requirement for the portfolio

Once all this material has been distributed:

a) Read through the *Challenge Scenario* and show the *Layout Board* to the students. Make it clear that all movements of the device MUST be controlled using fluid power. *(This is explained in more detail in Section C.2)*

b) Go over the *Challenge Rules* emphasizing safety requirements.

c) Go through the *Challenge Scenario* paragraph-by-paragraph, accepting questions. Typical questions are "What happens if the object is dropped or falls over outside the boundary of the destination area?" or "Can we clamp our device to the footprint wall?"

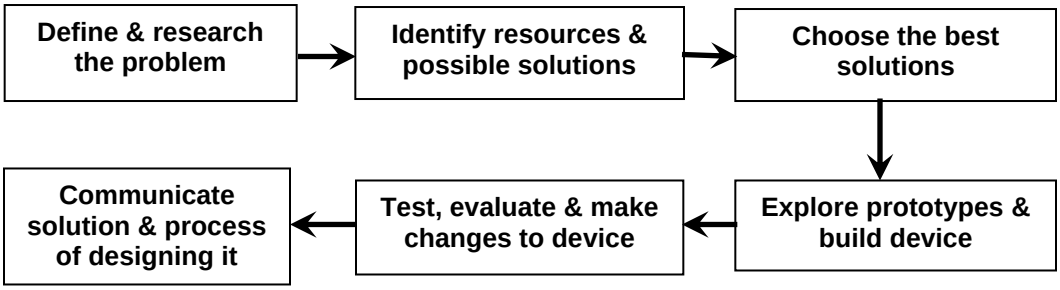
d) Go through the *Challenge Rubric* which will tell the students how their efforts will be graded.

e) Stress the importance of the portfolio and refer to the *Portfolio Checklist* and *Portfolio Template* and the *Challenge Layout dimension Iso-Ortho* file.

f) Emphasize the need to explore different designs! Usually the first idea is **not** the best!

6. Make students aware of the importance of the Design Process and the Design Portfolio that they will use to document it

The following chart explains the Design Process. It includes the text from the *Design Process Cube Sides*.



7. ***Explore the materials and tools available for building the Challenge Scenario device***

   The students must understand that they will be limited to using the materials that are in the Workshop kit. They also need to see the tools already available at the school and in the Tool kit purchased from Mechanical Kits.

8. ***The students build a prototype and produce a Design Portfolio***

   We suggest that, at a minimum, **all** students in the team(s) design, build and test an arm with a gripping mechanism.

9. ***Hold an "In-School Challenge" using the Challenge kit, under Challenge rules.***

   Team(s) complete the Challenge by making the device they have designed as a prototype using the Challenge Kit and operating it under Challenge rules.

   Apart from the curriculum benefits of engaging students in this STEM activity, the aim of this phase is to identify up to three (3) team(s) of students who will represent their school and submit their portfolio and a video of their working device.

10. Evaluate student's work using all parts of the Judges' Rubric and record scores on the "In-school" Scoresheet.

C. THE SCHOOLCHALLENGE DAY:

C.1 PREPARING FOR THE CHALLENGE DAY:

As a rule of thumb, a team will take up to three weeks to:

- Refine an existing design or design a completely new device
- Build, test and fine-tune a prototype of the modified or new device
- Produce a portfolio that documents their design process
- Build their solution to the Challenge Scenario under "Challenge Day" rules.

To duplicate the rules of a Challenge Day in school it will be necessary to reserve at least half a day for a team to build their device and operate it. A 3 to 3½ hour period is needed to build the device usually, including breaks, and then an additional 15 minutes to organize and operate it.

Finally, the device will be operated for a two-minute period and the "moving object" score determined.

A video clearly showing the movement of the device and the placement of the objects must be recorded of this two-minute demonstration.

C.2 CHALLENGE DAY ACTIVITIES AND RULES

At the start of the Challenge Day the Challenge Kit is handed to the team. It contains the materials that the team will use to build their device. Only these materials will be used, and the team must build their device (again) from scratch using their portfolio to guide them.

When a team demonstrates its device, there are specific rules about the use of hands that apply:

- ***SAFETY IS OUR NUMBER #1 CONCERN***
- Except for tools, all materials that you can use for the construction of your device are provided. ***Do not use any others!***
- ***All movements*** of the device **MUST** be controlled ***using fluid power.***
- If a team manufactures ***a device that only works when it is stabilized by hand(s)*** then ***only 50% of the 'moving object' score will count.***
- ***If a team breaks the device*** during the allocated 2 minutes, then the team can repair it during the 2 minutes but ***subsequent 'moving object' scores will only count 50%***. *(Sometimes, in the excitement of the Challenge a team member will pull too much on a plunger and lose its operation. Hence the proviso that a quick repair may be untaken.)*
- ***If the device is touched by hand IN ANY OTHER WAY, then the 'moving object' score will be zero for the pick and place cycle during which the touching occurs.***

The *Judges' Rubric* is used by teachers to evaluate the team's performance and scores are recorded on the *"In-school" Scoresheet.*

Each member of the team writes the answer of a specific question as indicated in brackets below.

The interview questions on the rubric are:

1. What alternative designs did you look at before selecting the design you are building today? (*Designer*)
2. Why did you select this design to use for the Challenge scenario? (*Illustrator*)
3. What other materials might have been useful? (*Builder*)
4. How did you decide who on your team would be responsible for which parts of the project? (*Writer*)

C.3 WHAT TO SEND TO THE HOST (Up to three (3) teams):

- The team portfolio (this can be entirely electronic or scans of hand-written and/or hand-drawn material; the latter will not be penalized)
- A two-minute recording of the operation of their device under Challenge Day rules; and
- the *In-School Scoresheet* as completed by the teacher(s).

HAVE A GREAT CHALLENGE!