Teacher information

PATHFINDERS
design and technology

While your Class Pack has many pieces, we have designed it so that there will be enough material to make about 15 or so machines, with a variety of styles. To make this economical for you we have assumed that not everyone will make the same kind of machine, otherwise we would have to include hundreds of sticks (if everyone made scissor lifts for example), or large numbers of syringes (if students used 6 syringes per machine). For this reason, and since it is nice to have a variety of machines for other students to look at, we encourage you to support a wide diversity of thought and designs with a variety of challenges. We also encourage you to have students work collaboratively in groups, to enhance inventive designs.

This Manual has six sections:
First Booklet (this one)
1. Information about ways in which students can be challenged
2. Activities leading up to the day,
3. The building day

Second Booklet
4. Background Information about Hydraulics. Ideas and drawings of common hydraulics machines and ways they can be adapted for the parts you have.
5. The parts and how they can be put together.
6. An internet links page that has links to educational web sites with more information

1. Challenging Students

To create diversity, in a class situation you might want to *assign* a group's objectives:

- Build a machine that flings (and/or catches) an object.
- Design and build a machine that makes an object move sideways, vertically or horizontally.
- Design and build a machine that can lift and turn an object(s), or one that will push an object.
- Design a machine that can turn a horizontal movement into a vertical movement

To add to the challenge, other actions may be added:

- The machine has to double in height
- A marble placed on the machine must not roll off
- An object must be grasped

Or add a type of movement - or class of lever:

- The action must keep a platform level
- The actions must include a first, second (and/or) third class lever

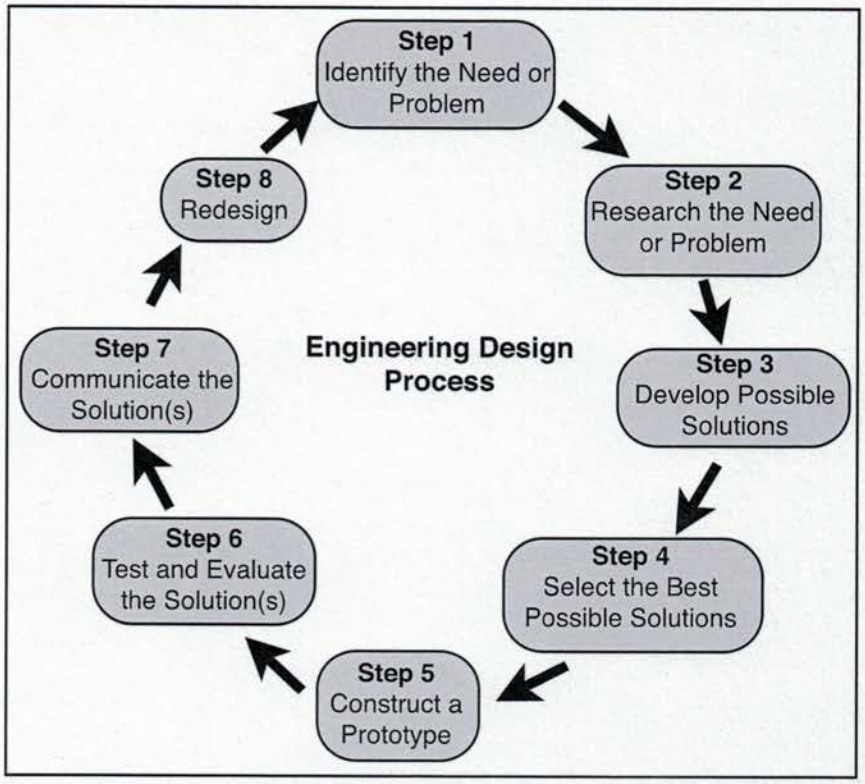
Or add a community action and service component:
- Create a machine that will make moving something easier
- Design a machine that will help disabled people have more mobility

Conversely, leaving the options wide open also allow for a variety of designs. Based on the number of students, certain limitations to the number of syringes, bases, or sticks might be imposed.

We find students often have more task commitment when they are making their own designs, but if they haven't done a lot of inventing, then some direction is a good idea, especially if you have a curriculum objective in mind.

You can also use the **Engineering Design Process** in the delivery of this class pack.

It is defined in Wikipedia as: ... the process of servicing a system, component or process to meet desired needs. It is a decision-making process in which the basic sciences, mathematics, and engineering sciences are applied to convert resources optimally to meet a stated objective.
Among the fundamental elements of the design process are the establishment of objectives and criteria, synthesis, analysis, construction, testing, and evaluation.



There are a number of educational engineering websites with information about this process of design. An internet search with **Engineering Design Process** will give you many ideas!
We like the one below, there is a great video outlining the design process that would be good for your students to see!

http://www.teachersdomain.org/resource/phy03.sci.engin.design.desprocess/

They use a more plain-language version of the process:

Identify the Challenge
Brainstorm
Design a solution
Test Ideas
Evaluate
Build it

Whatever the challenge, or manner in which the student building projects are presented, we have found that telling the groups that they are responsible for a written evaluation helps keep students focused on the design process and to monitor the victories and defeats as the project unfolds.

We feel it is also a good idea to allow students to bring personal items to add to the machines and encourage them to use imagination and creativity in building, This personal touch can make their machines really fun! While we have supplied solid bases for use, there is no reason why students can't use different building items (we really like cardboard!). This freedom can result in some pretty cool inventions.

Finally, while students like to have an outcome that works, and fulfills the task, they must remember that the **process** is just as important a learning experience as the **product** at the end.

The following pages has a sample of how a typical challenge-to-reflection might progress. Photocopiable sheets are at the end of this booklet

Here is a sample of a teacher-directed task. It can be useful to keep students on track.

This challenge card could lead to an outline such as the one below.

Hydraulic machines!

Group members: _____

Your task is to design and build a machine that can take an object, lower it at least 5 cm while keeping it horizontal, and then move it from the platform.

Describe a place where this type of activity is needed (or already used). Include pictures or drawings.

Before you begin building you must have a drawing of your machine that makes sense to you to work from. Show it to your teacher for review before you gather the parts you need, and use it in the building process. Remember, your design must be clear from the drawing! Show at least two views in your drawing. Include dimensions of major pieces.

This outline (right) might lead to a drawing that looks like the one on the next page.

You can make your own or use the template at the end.

Hydraulic machines!

Group members: *Austin, Haylen*

Our machine will: *take a wheeled vehicle, roll it onto a ramp, lower it down and roll it off.*
We plan to use a third class lever with a parallel linkage.

We think it will be useful for: *moving people in wheelchairs from one level to another. It could also be used to lift cars in parking garages.*

Before you begin building you must have a drawing of your machine that makes sense to you to work from. Show it to your teacher for review before you gather the parts you need, and use it in the building process. Remember, your design must be clear from the drawing! Show at least two views in your drawing.

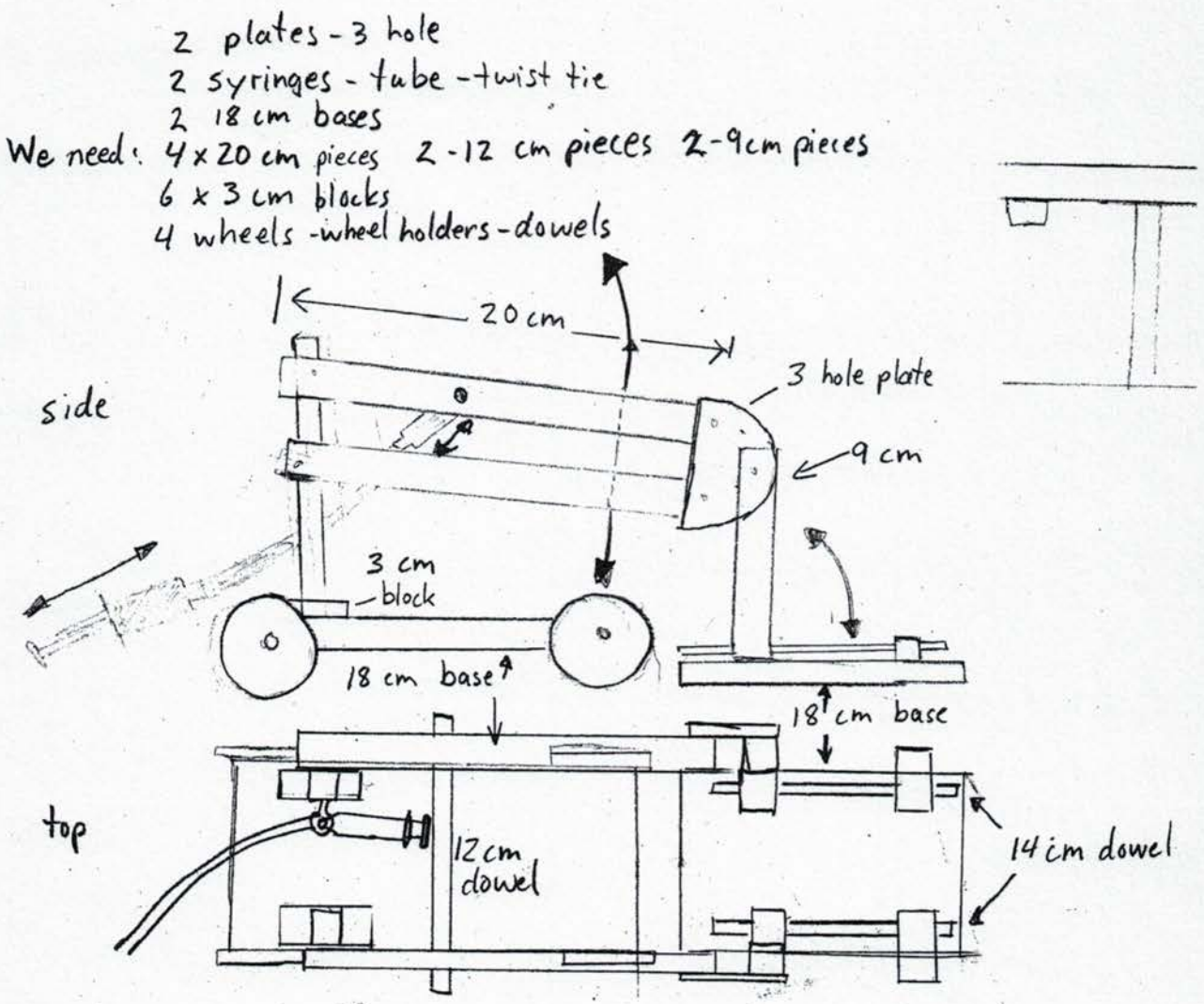
It is a good idea for the students to include a reflection at the end to identify thought processes, problems, and ways they solved them, both for the teacher, and the student. This usually follows the building and testing of the machine.

Sample

Hydraulics Design Sheet

Name: Austin Haylen Challenge: Lift a platform up and down horizontally

Draw a diagram of the mechanism or machine you are going to make. **Show a side and top view, and an end view if needed**. If you can draw in 3-D then all the better! You must give dimensions of the pieces that you are going to use. Since the pieces are already cut this shouldn't be too hard. Do a rough draft in the corner or back if needed, and then a good diagram with a ruler. Make your drawing **big**!
The drawing must be clear before you can go on to the next stage! A list of parts on the side can be helpful.



Hydraulics Machines – Builders reflection page

Sample

Mechanism you created: Horizontal Platform lift Name: Austin partners: Haylen

The Lifternator 2000

While your machine is done and may work, this reflection is critical to your learning about what you just did. You solved a lot of problems and now you can tell about it!

Making observations about what did and didn't work is a critical element in many scientists and engineers development of machines and tools. Things go right, (and wrong!) and if we write them down we can do the same thing again next time (if it worked) and **not** do the same thing next time (if it didn't work). For example you might make the reflection that the mechanism was very wobbly, or it kept falling over to the side. You may also reflect that your partners didn't help much, or that you were happy with the way the machine does a certain movement, these are all helpful for the teacher (and you), to understand the overall process.

Write down as many observations as you can and share them with your class.

What materials would you use to make a real life machine? Can you get some pictures and add them to this page?

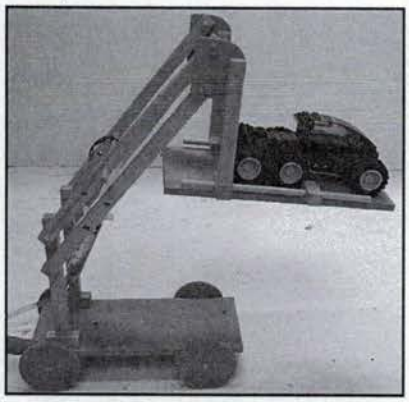
Use the back if you need to!

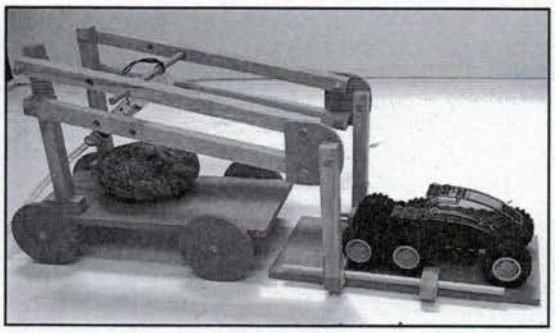
The machine worked well but we had some problems keeping the platform level, and moving it in and out, so we moved the syringe more to the middle so it didn't tilt, and made it so the platform could slide in and out on the dowels. By accident we glued the wheels on too early and had problems with the lifter rolling around while we where making it. I like the way it lowers below the table level, the way they work on those wheel-trans buses. It lifts up very high, which might freak out someone in a wheelchair. The Lifternator 2000 would be great in a parking garage where they move cars to different levels. We found it tipped over a lot, so we added a rock to stop this (see pictures). In a real machine the base would be heavier. It could also be used to lift workers up to do jobs near the ceiling.

It would be fun to have a syringe move the platform in and out too. It should hold my hamster, but we will have to add a railing around the outside

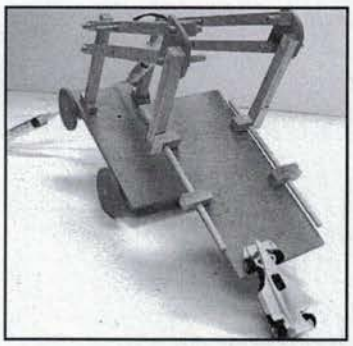
Maybe we can add to this!

Add pictures here:





It lifted well with a rock (or finger) holding it down.



Without a rock, the Lifternator tilted over.

2. Activities leading up to the day

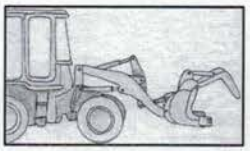
Typical class presentation of the Hydraulics Class Pack

There are a number of ways this material can be presented, based on the type of unit you are doing. Generally speaking this pack is best used with a unit about **Levers and Simple Machines**, or **Fluids** and **Hydraulics**, but can also be used for an **Engineering Design** class.
Here are some ideas we have found are useful in preparing a class for using the pack:

- Spend time gathering images of hydraulics machines from the internet or magazines and books.
- Collect, print, and display them!
- Discuss and display the three different types of levers around the classroom, identify which levers are used in the different machines (an excavator uses both first and third class levers).
- **Copy the design page and the reflections page,** or make up your own.
- Decide in what way you are going to challenge the students and prepare cards with a design challenge, or leave it open ended.
- You can enlarge the **tips** (from the Hydraulics Machines booklet) and mount them on the walls for reference. Free for copying!

Make a Bulletin Board Display!

Display machine pictures with the headings below - add pictures beneath

Machines with a first class lever	**Machines with a second class lever**	**Machines with a third class lever**	**Machines with a variety of types of levers**
 *Excavators have a variety of levers, so this could go in the last column. Few machines actually have **only** a first class lever.*	 *(Dump trucks use both second and third class levers)*	 	   

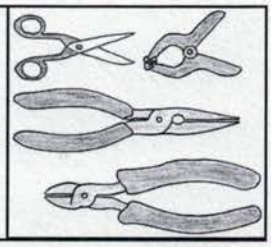
Add more pictures!

- Make the mini machine that comes in the pack. Doing it together will help students understand the process of assembling a machine, since there is an order to it.

Take as much (or little) time as necessary for the students to understand how many places hydraulics machines are used, and their huge variety. The more time spent on this, the more ideas they will likely come up with.
Download the drawings of hydraulic machines from the Pathfinders web site, or photocopy and enlarge the drawings in the Building Hydraulics Machines booklet. They are free for you to use as you wish!

If your focus is on a certain aspect of hydraulics, like machines to improve the mobility of the disabled, machines that help build things, or even machines that can throw, have them research this type of machine in the preparation stages.

Scissors and glue for each group, and a couple of pairs of needle nose pliers, snippers and small clamps for the class are very handy. Big paper clamps can also be used!



3. <u>On the day of the class -</u> lay out the pieces in a easy to access manner along a table.

- **Describe the activity:** They will be designing and making their own machines. They will also be doing a reflection sheet at the end. You can describe how they are to be evaluated at this time if desired.

This is where you tie the activity to your unit of study, and you describe the types of challenges or problems they will be asked to solve (see below).

Give a time frame for the activity: Depending on the grade level, it will take from 1/2 to 1 hour to make a good drawing of a simple machine. They should use rulers.

- On a blackboard, **do a sample design sheet for a simple machine** you might make. Show all of the parts you want to see. - top and side view, dimensions, and so on. You can also copy the sample page.

Key Point: If they have to describe the drawing orally then they have to add to it. The drawing should be the blueprint from which they work. The drawing must make sense, if they want the machine to have any chance of working. Insist on a good drawing! Make suggestions where they might add some cardboard to make the machine look real, once it is finished, but that doesn't have to be in the initial drawing. It doesn't have to be to scale (especially in the younger grades), but they should be encouraged to measure parts and put those measurements in. Remind students that as they progress things might change and that is OK, but they should have a drawing to work from initially.

Once the students are getting close to finishing their drawings, review the way the parts go together. (see building tips! - the parts and how they can be put together - section 3)

Let them go at it! It usually takes a number of hours to make something from start to finish, depending on their skills and complexity of the machine. It would be good to discuss the engineering design process as it relates to their progress and either photocopy ours, or make you own and mount it on the wall for reference.

It is ideal to gather the students as groups progress and demonstrate to the class how to:

<u>First gathering</u>

1. **cut the large tubes for stoppers**, - simple scissor demo - each little stopper should be .5 cm
2. **cut a dowel**, - score around the dowel with scissors or snippers, bend and snap (cut too long, just in case)
3. **Make a strong base**, use the 2.7 cm pieces with a peg up the middle
4. **Attach a parallel linkage plate**, - see tips
5. **Test the range of motion of a lever** - help students figure out where to attach a syringe.

<u>Then, after progress has been made (a few hours), meet again and show how to:</u>

6. **fill a syringe with water**, - critical that they get as much air out as possible!!
7. **Attach a syringe to a machine** - make sure the slave syringe plunger is all the way in - **all syringes on a machine are attached before the master syringe is filled and connected**
8. **How to connect a filled syringe to a machine - see tips**
9. **Testing the machine, or a linkage,** and cleaning up the loose parts so it isn't sloppy

<u>Finally, gather the groups and discuss:</u>

10. **Adding to the machine**, cardboard, wheels, color, and for some - they can start on the reflections sheet.

We find if you gather the students, do two or three points at a time as the projects progress, it makes for a quick check-up on how the students are doing, (you can answer and ask questions), and helps remind them of proper methods before they make too many mistakes. However, mistakes are part of the process!

Enjoy, and take pictures as you go!

Finally:

- As the students finish, encourage them to add to the machine to make it more realistic, and to name it.
- After the reflections are done, have a walk-around, where the groups can show their machines to the class, or each other. Display them in the school lobby!
- If using the **engineering design process**, have students reflect on their project as it relates to the EDP outline.

Hydraulics Machines Design Sheet

Name: _____ Challenge: _____

_____ _____

Draw a diagram of the mechanism or machine you are going to make. **Show a side and top view, and an end view if needed**. If you can draw in 3-D then all the better! You must give dimensions of the pieces that you are going to use. Since the pieces are already cut this shouldn't be too hard . Do a rough draft in the corner or back if needed, and then a good diagram with a ruler. Make your drawing big!

The drawing must be clear before you can go onto the next stage! A list of parts on the side can be helpful. Don't be surprised if this is just your first drawing, and remember to keep all drafts and drawings - they are a record of your progress!

Hydraulics Machines - Builders reflection page

Mechanism you created:_____ Name: _____
partners:_____

_____

While your machine is done and may work, this reflection is an important part of your project. You solved a lot of problems and now you can tell about it!

Making observations about what did and didn't work is a critical element in many scientists and engineers development of machines and tools. Things go right, (and wrong!) and if we write them down we can do the same thing again next time (if it worked) and **not** do the same thing next time (if it didn't work). It is likely you have gone through all of the steps in the engineering design process and this is your chance to comment on issues that occurred during the different steps.

Does your machine work? Does it fulfill the objectives of your challenge?

Write down as many observations as you can and share them with your teacher and class.

What materials would you use to make a real life machine? Add some pictures of your machine to this page.

Use your imagination and ingenuity! - and use the back if you need to!

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

Add pictures here:

Hydraulic machines!

Group members:_____

Our machine will:_____

_____

We think it will be useful for: _____

_____

Before you begin building you must have a drawing of your machine that makes sense to you to work from. Show it to your teacher for review before you gather the parts you need, and use it in the building process. Remember, your design must be clear from the drawing! Show at least two views in your drawing.

Engineering Design Process