Problem 1. A detailed version of a toggle press was described and was available on the Statics SolidWorks tutorial web pages. You are to create a simpler version of the toggle press mechanism using the standard parts provided with Solidworks. Several parts of this mechanism are already available and assembled in Assembly.SLDASM at http://www.me.cmu.edu/academics/courses/NSF_Edu_Proj/Statics_Solidworks/homework/togglepressbase.zip. You only need to modify two additional parts, then move those into the Assembly.SLDASM file, along with one pin, and mate everything together. All skills for doing this were described in the tutorials which you were to read as part of previous problem sets #1 and #2..

20"

Upper arm

10"

10"

Moving base
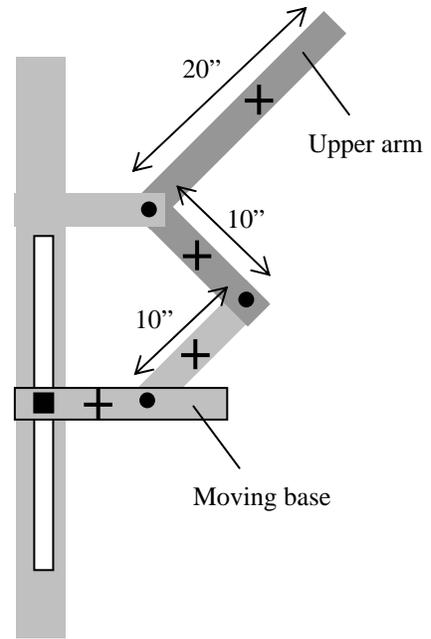
Print out (black and white) an isometric view of the completed mechanism from which the parts can be readily seen. An undergraduate assistant Evan Small will be available in the BH 140C computer cluster on Sunday 9/21 and Monday 9/22 from 8-10 PM to answer questions and offer help.

Questions to Answer:

(i) If the moving base moves up by 15" from its lowest position, determine the extreme orientations of the upper arm relative to the horizontal.

(ii) For the above range of travel, determine the greatest horizontal and vertical positions of the far end of the upper arm relative to the upper pin to which it is attached.

Say the moving base is to move down a small amount from the position show. You are to indicate the displacements of the 4 points designated with a dashed cross. Indicate the displacement approximately by drawing an arrow in the direction of movement at the center of each cross, for example, as follows: The length of each arrow (the magnitude of the motion) is not important, only its approximate direction.

We are also interested in the absolute rotation of the part to which each cross is attached (clockwise, counter-clockwise or not at all). On each of the 4 points (dashed crosses), these possible rotations should be designated with one of the following:

Thus, in total, each designated point should have an arrow indicating displacement and, possibly, a rotation. Do all this drawing on the diagram shown on this page.

<u>Problem 2.</u> Consider the door opener configuration of problem 4/142 in the textbook Meriam and Kraige. You are NOT to solve the problem as stated in the book.

Instead, you will construct a model of this mechanism in SolidWorks and use it to determine the angle through which the motor must turn the crank to cause the door to open by 90º. The CAD model will have a door, a crank (AB), a connecting rod (BC), and 4 pins.

There is no need to create new parts; use the standard parts available on the web site. Notice that you can manipulate the part "adjustable plate.sldprt" to create the door (which needs to have two holes at selected points – the third hole doesn't matter). Size all the parts, create the assembly, and print it out in the configuration depicted in the book. Then, move the mechanism so the door is in the 90º open position and print it out in that configuration. From this configuration, within SolidWorks (not the printout) you can determine the positions of points and from that determine the angle of crank (the link driven by the motor).

On several occasions, you will need to move a part to a particular point, or to see where that part is. This is described in the tutorials at (http://www.me.cmu.edu/academics/courses/NSF_Edu_Proj/Statics_Solidworks/SOLVE. htm). You may find it easiest to do this positioning with the pins. Note that you can also fix a part (in addition to the original part which started the assembly). To do this look at http://www.me.cmu.edu/academics/courses/NSF_Edu_Proj/Statics_Solidworks/PLANA RJOINTS.htm.

An undergraduate TA, Evan Small will be available at the Baker Cluster 150C on Monday, October 13th at 8:30 – 10:00 PM to answer questions.

Problem 3. Construct a two link robot, actuated by 2 cylinders. The arms are 20" long, with holes located as shown.   Construct a two dimensional model of this robot with Solidworks. It will consist of two links, two pistons and a set of pins. Move the model around in SolidWorks so that the position of the end effector is at (x,y) = (10,25), relative to the base pin. Determine the angles that the members make with the positive x-axis (measured counter-clockwise) and the lengths of the cylinders. You might want to put a pin at the end effect in order to locate that point conveniently. (Don't worry that the ram overlaps the case in this orientation; the piston as originally dimensioned is too long for this assembly.) **SolidWorks hints to make this assembly**: Put the base pin in first which will fix it at the origin. When you add the piston assembly (two of them), make sure you right click on the assembly in the feature tree and hit 'dissolve Sub-assembly' before you begin mating it. (Otherwise the ram and case will not be able to move with respect to each other. Dissolving the sub-assembly retains the matings between the ram and case.) After dissolving you can mate links, pins, ram and case properly.

Say that the end effector exerts a force on another body (not shown) of 400**i** +600 **j** lb. Presuming the pins are all ideally frictionless, use Statics to determine the forces in each of the cylinders (indicating they are in tension or compression), and the force at the base pin and at the pin joining the two arms.

http://www.me.cmu.edu/academics/courses/NSF_Edu_Proj/Statics_Solidworks/SOLVE will have helpful information. In addition, the SolidWorks TA, Evan Small, will be available at the Baker Cluster 150C on Sunday, October 26, and Monday, October 27 from 8:00 – 10:00 PM to answer questions.
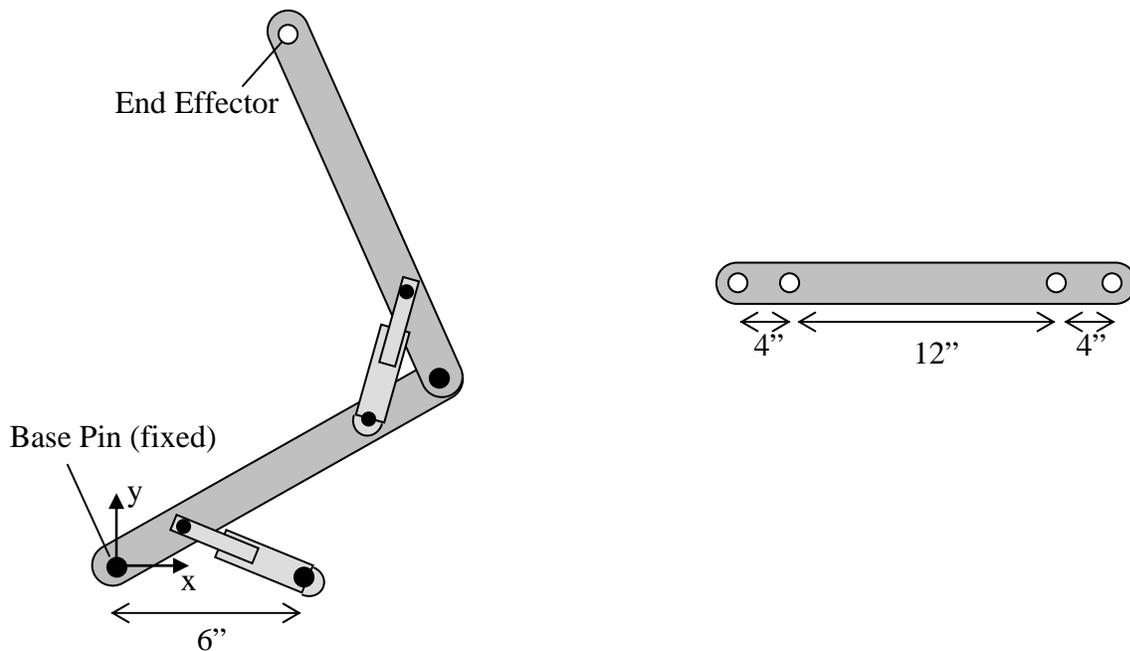
Problem 4. Consider the double high scissors lift appearing in
http://www.westbendequipment.com/brochure_lifttables.asp, (see MODEL STXXS
DOUBLE HIGH SCISSORS LIFT). A CAD model of such a device has been made and
can be downloaded from the SolidWorks tutorials web site
http://www.me.cmu.edu/academics/courses/NSF_Edu_Proj/Statics_Solidworks/scissorlift
.zip. (This model is for you to view the functioning of the device.) In this model, the
links have the following geometry. Notice that two of the links have protrusions to which
the hydraulic cylinders are attached.

7.22"   For attaching hydraulic cylinder

25"   25"
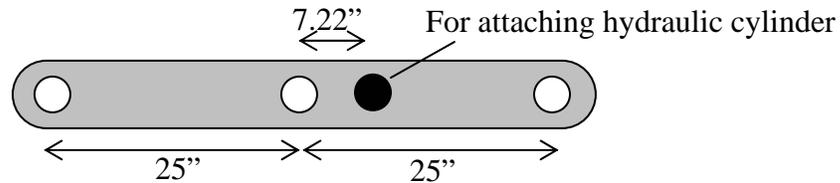
Say the vertical distance from the top of the table (or rather the centers of the uppermost
pins) to the centers of the lowest pins is to vary from 20" to 80".

(i) Determine the longest and shortest length of the hydraulic cylinders. (Answers: 27.90"
and 18.57")

(ii) Neglecting the mass of the table itself, determine the forces in the cylinders if a
weight of 5000 lb is to be carried by the table in its center, when the uppermost pins are
located 40" above the lowest pins. Show free body diagrams. (Answer: force in each
cylinder is 17,985 lb. You have to be very clever in choose free body diagrams.)