Computer Aids for Design - ME30043/MI50167
Assignment - Pusher Mechanism

Introduction

These notes are for the nssignment for the unit. This is the full assighment if you an undergradunte; There is an additional part given separately is you are an MSc student.
The assignment is concerned with the design of a "pusher mechanism". The aim is to take you through some of the typical design stages. These begin with an initial concept where the initial "stick geometry" for the mechanisin is obtained. The design is made more detailed by using a CAD system (Solid Edge) to generate the parts as 3D models and then to assemble and move these. Some analysis work is undertaken and some preparation for manufacture using rapid prototyping (RP) techniques.

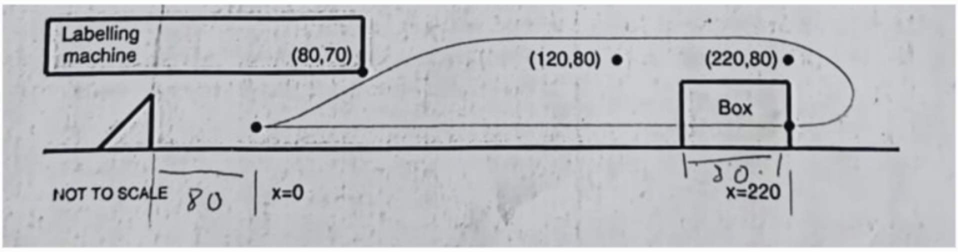
Typically CAD systems are good at modelling geometry and moving this into forms suitable for manufacture. They are less good at supporting the conceptual phases of design and at handling (non-standard) analysis. For the assignment these parts can be undertaken using the constraint modelling software created at Bath. There is however no need to use this if you do not wish to and if you can find suitable alternative procedures.

The following sections firstly describe the underlying mechanism application. This is followed by section describing the assignment as a whole and then its individual parts. Finally the requirements for the assessment are given.

Mechanism

It is desired to obtain a pushing mechanism for moving a box into a labelling machine and then returning over the next waiting box. A horizontal pushing stroke is needed along the line y = 0 between x = 220 and x = 0 (dimensions here and elsewhere are in centimetres).
During the return, the pushing head should not enter the region where both x<80 and y > 70; and it should pass above the points (120, 80) and (220, 80). The figure shows an initial attempt at a schematic design.

The box is 80cm long (in the direction of travel), 60cm high, and 60cm wide (normal to the plane of the diagram).



Overview of assignment.

There are many ways in which this motion can be achieved, For the purpores of this asignment, a four bar mechanism is to he used.

The assignment is to design a mechanism to perform the above task. Part of this activity is to model the part of the mechanism and simulate its motion to verify that is likely to work correctly. Some analysis of the motion is to be performed. This is to find the kinetic energy of the mechanism as it goes through a cycle. In particular the maximum KE should be determined. A graph of the KE against time (or against crank angle) should be produced with at least 36 points. Assume that the mechanism takes 5 seconds to perform one cycle and that the link are made of steel with density 7800kg/m^3.

In addition, the design should be done in such a way that a working model (suitably scaled) could be produced using rapid prototyping (RP) techniques. Such a model would again be used to check that design operates properly. The mechanism links are the main parts that would be checked in this way. A base board (to be made of wood) needs to be designed into which supports for the fixed pivots are to be placed. The supports are to be made using RP techniques. There should be a specification for the position of (circular) holes drilled in the base board into which lugs on the pivot supports need to be designed to fit.

It is hoped that it will be possible to select one or two of the designs from the group for production using RP. This will be done as a demonstration in one of the sessions after Christmas.

Rapid prototyping considerations

The cost model used for RP work is based upon the depth of the "RP build" containing all the parts to be made. For this reason, costs can be reduced by making the parts as flat objects with minimal thickness. These then need to be packed reasonably closely on a plane region of size 140mm x 220mm. Moving parts should be designed with a clearance between holes and shafts of (approximately) 0.25mm (this is to allow for inaccuracies in theRP process).

Stages in the assignment

There are a number of stages to the assignment. Some are relatively straightforward, others require some thought and time to complete successfully. You are strongly advised not to leave everything to the last minute.

The stages are as follows.

• Establish the basic geometry for a planar mechanism to achieve the given path. There are several ways in which this can be done. The constraint modeller incorporaters a "mechanism selector" and this can certainly be used. In reporting on the basic geometry, the following data should be supplied:

- position of the two fixed pivot positions
- lengths of the three moving links and of the fourth base link
- the position of the couple offset point relative to the coupler

• Using Solid Edge, design and model the links of the mechanism (and any other parts that you consider appropriate). The parts should be in 3D. To minimise the eventual cost of RP and/or to maximise the use of the available build area, you may wish to construct the links out of sub-parts.

• Assemble the links in Solid Edge to ensure that they fit together. Simulate the motion of the mechanism using the Simply Motion option within Solid Edge.

• Create a means for evaluating the KE of the mechanism as it cycles. This can be done using the constraint modeller but other appropriate methods are acceptable. One approach using the constraint modeller is firstly to adapt a macro for a four bar chain to represent and simulate the motion of the particular mechanism. Then the macro is enhanced to find velocities and kinetic energies of the links.

• In Solid Edge, save each component as a separate part file. In addition, lay out the various parts using Solid Edge on a plane to obtain a configuration suitable for RP production. The maximum height (RP build depth) should be identified.

All design work is iterative and there is need to go back to previous stages to make improvements. As the time for the assignment is fixed, it is allowable to proceed with and submit a sub-optimal design provided that the deficiencies are discussed and means for improvement indicated. However, it is expected that the basic mechanism obtained will cycle appropriately and will follow the correct form of path.

Hand-ins and assessment

You should work individually for this assignment. The assessment is based on a report and a demonstration. The assessment counts 50% towards the overall assessment of the unit. The other 50% is from the examination. The percentage break-down below are the assignment only:

Demonstration (10%):

The simulation of the motion of your mechanism using Simply Motion needs to be demonstrated. You may be asked few brief questions about the motion you have produced. This demonstration will be during one of the two computer sessions on Thursday 16 December 2004. A time table will be produced. There will be no tutorial help on this day.

Report (90%):

The report should be submitted by Thursday 16 December 2004 via the departmental office.
It should (at least) contain clearly marked sections giving the following information.

• A sketch giving the dimensions and location of your mechanism. [5%]

• A short description of the method used to obtain your mechanism and any design work undertaken that is not covered elsewhere in the report. [10%]

• A diagram (produced from Solid Edge) of the assembled 3D mechanism (a shaded image or a wire-frame image or orthographic views). [5%]

• A detailed discussion of the method used to find the KE of the mechanism and of the relevant underlying theory (such that someone else could easily understand and reproduce what you have done for another mechanism). This should include: a listing of any constraint modeller macro used, a listing of any programming language code used; an indication of the calculation performed by ant spread sheet used; etc. The graph of KE and a statement of its maximum value should also be given here. [50%]

• A diagram (produced from Solid Edge) of the layout of the parts proposed for RP production. A short discussion of the advantages of the layout (or any problems with it) should be given, and the build depth stated. [10%]

• A discussion of the suitability (or otherwise) of your mechanismn and an indication (if appropriate) of how you would proceed differently if tackling the same type of design problem again. (10%)

There is no need to bind the report. Simply stapling the sheets together at the top left corner is sufficient.

GM
October 2004