DESIGN OF A "THING" THAT TURNS ITSELF OFF !

Design Project

ME 202: Foundations of Mechanical Systems

Fall 2005 – Drs. Angstadt, Jalili & Blouin

Problem Statement:
An inventor has proposed designing and building a mechanism inside a box that, once turned on, would send a "finger" out of the box, turn itself off, and return back into the box. Your engineering team has been requested to design, analyze, fabricate, and demonstrate a prototype powered linkage mechanism which performs this task. The demonstration will consist of opening the box lid, sending the finger out, switching off the toggle switch and returning completely inside the box with door closing automatically. Note that the external switch (to be turned off) and an internal limit switch (which shuts down the mechanism at the end of its cycle) are in parallel, so that the latter keeps the motor running until the finger has been withdrawn into the box.

While some of the dimensions of the mechanism and its package will be specified for you, you will have some flexibility in determining other dimensions. Specifically, your ability to "optimize" (e.g., minimize or maximize) dimensions *A*, *B* & *C* (see Page 3) will directly determine a portion of your project grade.

Although a variety of designs are possible, your mechanism should reflect some of the concepts learned in ME 202 which may include linkages, cams, gears, and belt/chain drive systems. Two important considerations are the engineering design process and the kinematic analysis of the mechanisms operation from the input (i.e., crank) to the output (i.e., finger). Please note that prototype fabrication using materials such as "legos" and "erector" parts will not be allowed. The materials of construction should be durable and aesthetically pleasing. Unacceptable materials include particle board, cardboard, duct tape and the like. Hardwood plywoods (e.g., birch or maple) are acceptable for the housings. Contact your instructor if you are unsure if a construction material will be acceptable or not. The final report must fully describe all aspects of the design project. A ten minute "Powerpoint" presentation and demonstration will be required during the final week of class.

Design Team Tasks:
Review the design project information and (i) methodically apply the engineering design process to formulate the "best" solution, (ii) fully analyze the mechanism's motion (i.e., draw a kinematic diagram for the mechanism and find the number of DOF using Gruebler's equation and intuition, perform required analysis such as position and velocity to design the linkage dimensions such that the desired task is satisfied), (iii) using software packages, animate the design and show its

working conditions, (iv) develop a parts list and procure the components, (v) fabricate the prototype and test, (vi) demonstrate the design feasibility to class, and (vii) provide written progress/design report with in-class oral presentation. Again, all teams are strongly encouraged to apply the engineering design process to guide their efforts and use mechanisms studied in class with their accompanying mathematical relationships.

Design Project Procedures:

You shall form a team of five students to work on the design project. One written report on your group's progress will be due on **Friday October 14, 2005** with the focus listed below in the schedule. The progress report should be thorough and professionally completed.

A final comprehensive report is due on **Monday December 5, 2005**. The "hand crafted" prototypes will be demonstrated to the class on December 7 and 9 with an accompanying presentation by all team members.

Grading Process:

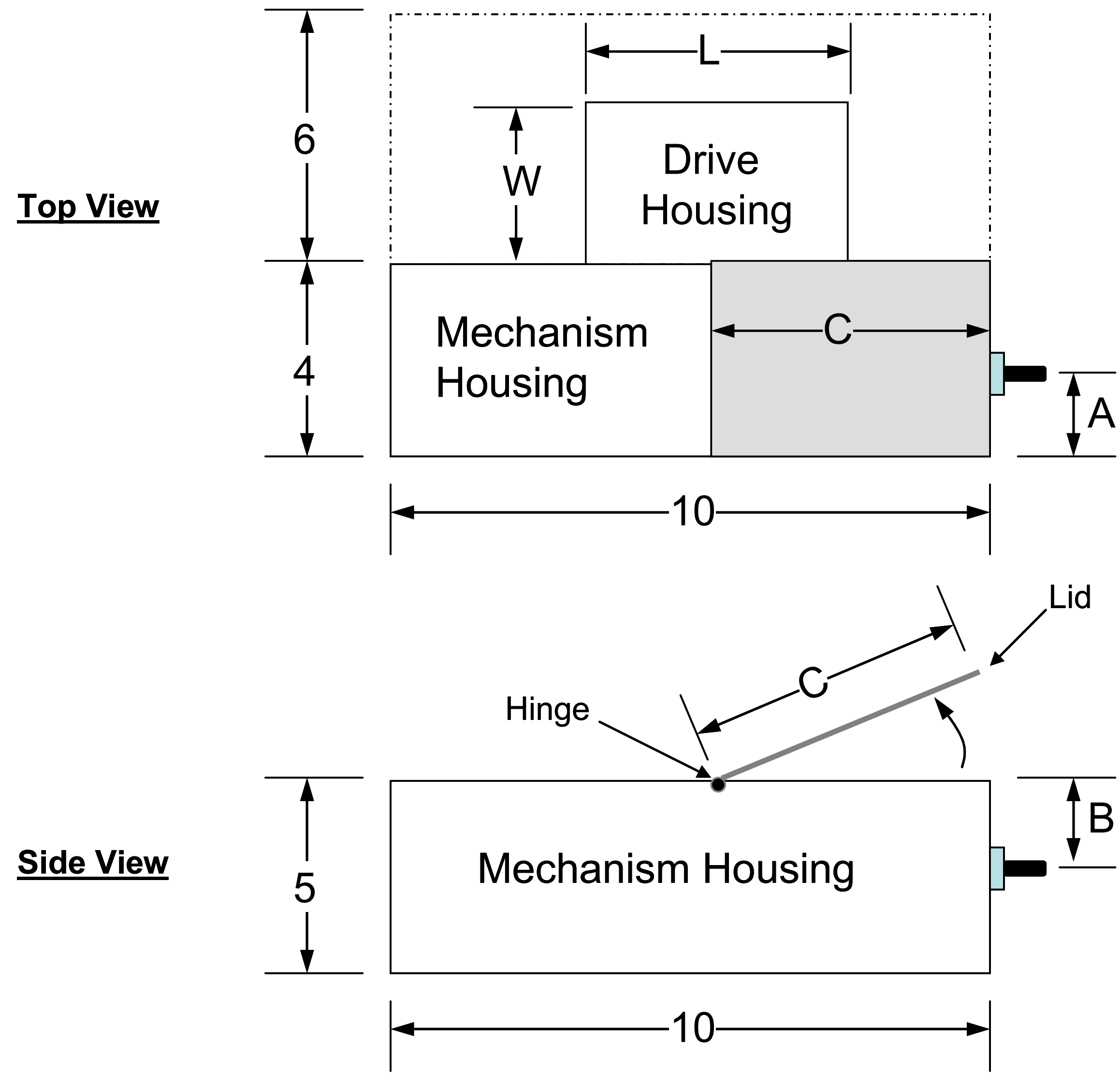
Progress Report = 20%
Design Report = 50%
- Clear application of engineering design process (10%)
- Proposed mechanism design relationship to course topics (10%)
- Kinematic analysis (20%)
- Creativity of design (10%)

Prototype Fabrication = 15%
Demonstration = 10%
Oral Presentation = 5%
Total =100%

Schedule of Design Team Deliverables:

No.	Date	Activity
1	September 12	Design Team Organized; Membership Reported to Instructor
2	October 14	Progress Report: (a) Problem recognition and statement of objectives (b) Identification of criteria/constraints (c) Technology review and list of alternative solutions (d) Kinematic analysis of mechanism (e) Fabrication update
3	December 5	Final Report (due at beginning of class)
4	December 7 & 9	Demonstration of Prototypes with Accompanying Oral Presentation

Geometric Dimensions & Constraints for Project Device (all dims in inches)



Constraints

A – Group's Choice

B ≥ 0.5" (Larger is better)

C ≥ 1" (smaller is better)

L ≤ 10"
W ≤ 6" } Minimize footprint area (WL)

Rectangular Drive Housing must fit within 6" x 10" footprint defined by dashed line & must not extend above or below mechanism housing.

Dimensions shown are interior dimensions—wall thickness should not exceed 0.75".

Miscellaneous Notes:

1. Your team may wish to use an "objectives tree" in the design process; the problem definition may then follow based on the insight gathered from this exercise.
2. Make sure to prepare a comprehensive list of requirements and constraints, as well as a set of evaluation criteria to consider the alternative solutions that your team proposes.
3. A single rotating shaft will be the sole input from the motor used to drive your mechanism. The motor power source could be a battery, 110 VAC or some other (safe) energy source.
4. The general geometry, dimensions and constraints on the geometry of the mechanism packaging can be found in the attached drawing.
5. The location of the toggle switch (determined by dimensions *A* & *B*) is up to your team. It is presumed that dimension *A* will have little impact on the difficulty of the proposed task but that increasing dimension *B* will increase the difficulty of the task.
6. The hinged door should cover the full 4" width of the mechanism housing. The door must extend all the way to the end of the mechanism housing where the toggle switch is located. However, the length of the door (dimension *C*) can be determined by your team (it is presumed that a smaller door will make the task more difficult).
7. The footprint size of the drive mechanism housing ($L \times W$) should be minimized. The housing must be physically attached to the mechanism housing but can be placed anywhere within the footprint designated by the dashed line.
8. Only a single drive shaft and necessary wiring can pass between the drive housing and the mechanism housing. No part of the "mechanism" can be located in the drive housing and vice versa.
9. Your mechanism housing should include one transparent side so that operation of the internal mechanism components can be observed throughout the cycle. In addition, it is desirable to have all components of the drive system (e.g., gears, belts, chains) readily visible.
10. Your team may select the appropriate materials; however the total cost is capped at **$75** per team.
11. All team members are expected to equally contribute in the design project; please notify the instructor if difficulties arise with the member contributions.