PBL REPORT

ON

MECHANICAL TOY DESIGN PROJECT

SE Project Based Learning

Semester IV CBCGS (Rev. 2016)
Mechanical & Automobile Engineering
Pillai College of Engineering, New Panvel
2018-2019

PROBLEM STATEMENT

Objective: To design and fabricate a mechanical toy that converts rotary motion to any other type of motion. This activity provides a platform for students to use their creativity and skills in designing animated mechanical toys. These mechanical toys can be brought to life by cranking (by using a battery to run a crank disc) to move a shaft mounted with a series of machine parts such as cams, gears, linkages, belts and pulleys, ratchets, etc. which are in turn connected to the various parts of the toy to produce the desired movement.

Outcomes: Students will learn

1. Use of CAD/CAM software for modelling and simulation of their design.
2. Basics of machines, transfer of power and energy selection of appropriate mechanisms
3. Basics of fabrication using CNC, laser cutting, 3D printing or any other fabrication technology.
4. Making a product safe to use for children and aesthetically pleasing.

Design Guidelines:

(i). Resources: Students should first visit various websites, such as the http://www.cabaret.co.uk/, http://automata.co.uk/ and http://www.flyingpig.co.uk/ websites before embarking on their own design. They should also visit various Design and Technology websites, such as the http://www.technologystudent.com/ (click "MECHANISMS" and "GEARS AND PULLEYS") to learn how mechanical toy parts can be animated by gears, timing belt and pulley drives, cams, linkage mechanisms, ratchet mechanisms, crank and crank shafts, etc.

(ii). Materials and Dimensions of Construction:

Students are required to build their toy sculpture using materials such as plywood, chipboard, softwood (balsa), wood, ball/cube/dowel, basswood sheet/strip, ice cream stick, plastic, high density foam, kapaline board (lightweight foam board), acrylic etc. They can also use 3D Printer and 2D Laser Cutting Machine from the Project Lab. to create their toy parts.

Students should use Ø10 mm wooden or steel rod as the main cranking shaft and driving shaft(s) of other critical toy parts so as to minimize shaft deflection and power transmission losses which will result in malfunctions of moving parts. The size of toy sculpture should not exceed 40 cm (Length) x 30 cm (Width) x 40 cm (Height).

The input crank shaft should be propelled in to motion by the use of a single 9 V battery. The input crank should be installed on the right-hand side and the direction of cranking should be indicated on the same side. Clockwise direction of cranking is preferred. Parts may be joined together by adhesive (glue), nails, screws or dowels. Pins may be used to create joints. Strings, wires, standard gears, belts and pulleys, etc., can be used to create the movements of the mechanical toy. Compression, extension and torsion springs of appropriate size and stiffness (about 0.5 mm wire diameter) should be connected to cam-followers, cranks and linkages, etc. to create the return or oscillating movements of moving toy parts.

Students should source for the above mentioned materials and standard parts before sizing their mechanical toy sculpture. These materials and standard parts can be purchased from school stationery/hobby shops.

Special care should be taken to ensure that the toy will be safe to use for small children (less than 10 years old). No sharp edges, hanging screws or nails! The design should also be aesthetically pleasing with the outer covering of soft cloth, velvet, fur etc.

(iii). Additional Guidelines:

- Very simple motion transfer mechanism viz. rotation to rotation (e.g., that of a 4 bar crank mechanism of old railway engine wheels) should be avoided. There should be a combination of motion types, from input rotary motion to rectilinear motion, or input rotary (crank disc) to combined rotary and rectilinear motions of connecting parts.
- A mechanism of any level of complexity (4-bar chain, 6-bar, etc.) can be used by the student groups.
- Student groups should be able to calculate the motion characteristics of the final connected link/s of the mechanism (displacement, velocity and acceleration at important points) by hand calculations, and if possible, supplemented by software as simulated data for validation and verification.
- Care has to be taken that no part of the fabricated mechanical toy should be causing harm during its operation, since it is supposed to be used by a child for playing.
- A switch can be installed at a convenient location on the toy structure to start/stop the mechanism as and when required.
- The toy structure also needs to be very light, easily lifted by a child or a toddler.
- Additional emphasis shall be given to the mechanism which can produce as many multiple output motions from a single input rotary motion of the crank disc, also taking care that there should not be too many small parts, keeping in view the end user of the mechanical toy!
- Also, special emphasis shall be given to the mechanism which is unique and original, and where the idea (story) generated through motions/actions of the toy is also very creative, and maybe humorous!!!
- The mechanical toy also should be manufactured to be aesthetically pleasing to the eye.

Judging Criteria:

Design Description 10%
Poster Design (A3 size .ppt template) 10%
Functionality 20%
Model Quality 20%
Originality and Creativity 40%

Deadlines:

Students should submit their expected work through their class-coordinator, to the PBL Committee, in two stages as follows, for judging.

Stage 1 (9 March 2019, Saturday, 2.00 – 4.00 p.m.)**:**

- Rough sketches (hand-made/computer assisted - 2D/3D) of possible mechanisms to obtain the desired motion/s of parts (at least 2-3 are expected).
- 3D modeling and Animation using any CAD software, of the selected best mechanism from the 2-3 design alternatives.
- A poster (on A3 size paper) using well defined template (consisting of PCE logo, and suitable headers and footers, apart from the main content of the toy mechanism).
- A report consisting of printouts of the rough sketches and the A3 sized poster shall be submitted to the judges during Stage-I evaluation, and soft copy of the model and animation shall be mailed to the PBL coordinator by this date.

Stage 2 (8 April 2019, Monday, 2.00 – 5.00 p.m.):

- A well documented **report** consisting of detailed design description, andthe working model of the mechanical toy shall be submitted to the judges by this final evaluation date.

Courtesy: https://www.sp.edu.sg/engineering-cluster/mae/news/Toy-Design-Competition-2018

STAGE-1 ASSESSMENT OF SE PBL

MECHANICAL TOY DESIGN PROJECT

Semester IV CBCGS (Rev. 2016)
Department of Mechanical and Automobile Engineering, PCE Panvel.
2018-2019

Class: SE Mech & Auto **Venue:** P401 **Date:** 9 March 2019 **Timing:** 2.00 p.m. – 4.00 p.m.

GROUP NO._____

ROLL NO.	NAME OF STUDENT	SIGN.
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

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1. **Action Scene** Planned:_____
   _____
2. Is the action scene idea **original** (not adapted or copied from any source, **indigenous**) (Y/N): _____
3. Materials to be used:_____
4. Mechanical elements used for animating toy parts (e.g., gears, timing belt and pulley drives, cams, linkage mechanisms, ratchet mechanisms, crank and crank shafts, wires, springs, pins/nails/screws etc.): _____
   _____
   _____
5. Method/s to be used for manufacturing toy parts: (3D printing, 2D Laser cutting machine, Lathe Machining etc.):_____
   _____
6. Whether **Rough Sketches of the possible mechanisms** to obtain desired motion/s of parts created? (Y/N)_____. If Yes (Y), whether hand-made or computer assisted?_____
7. Whether **kinematic analysis** of links done (estimation of displacement, velocity, acceleration) (Y/N): _____
8. Whether 3D modeling and **Animation** using any CAD software done, to simulate motion/s? (Y/N)_____. If Yes (Y), CAD software used: _____
9. Whether A3 sized poster of the PBL work prepared? _____
10. Whether **Report** (consisting of rough sketches of mechanisms, preliminary calculations, etc.) prepared and submitted? (Y/N): _____
11. Judges' **Rating** of the Stage-1 Performance (min. **1** to max. **5**):_____

Judges' Signatures: _____ _____ _____ _____

FINAL STAGE ASSESSMENT OF SE PBL

MECHANICAL TOY DESIGN PROJECT

Semester IV CBCGS (Rev. 2016)
Department of Mechanical and Automobile Engineering, PCE Panvel.
2018-2019

Class: SE Mech & Auto **Venue:** Workshop **Date:** 8 April 2019 **Timing:** 2.00 p.m. – 5.00 p.m.

GROUP NO._____

ROLL NO.	NAME OF STUDENT	SIGN.
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

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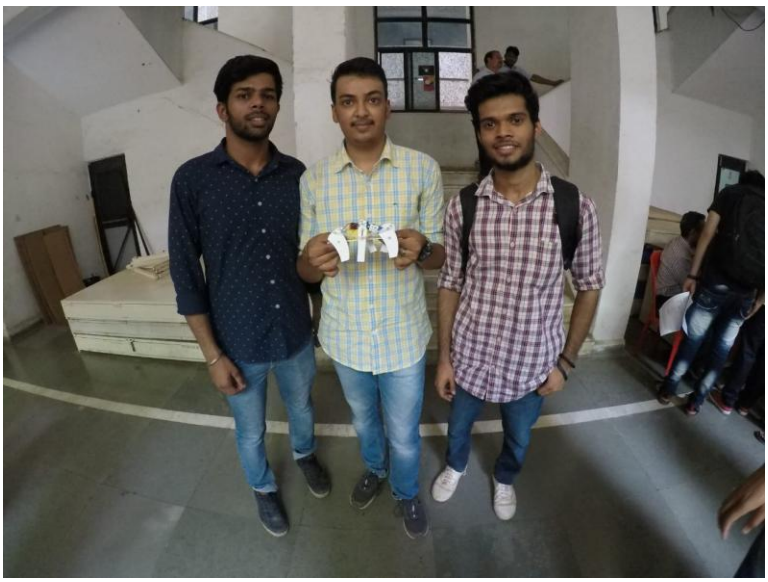
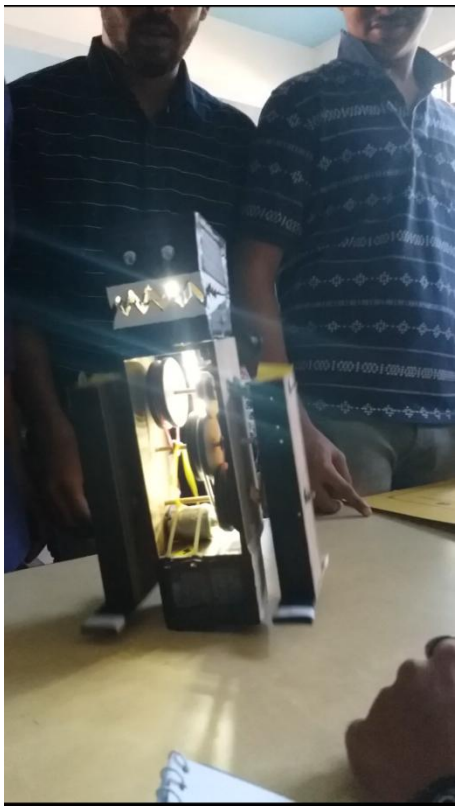
1. PBL Marks for **Stage-1 Assessment** (out of 5):_____(**Note:** Enter 0 for Absent)
2. **Action Scene**: _____
   _____
3. Materials used:_____
4. Mechanical elements used for animating toy parts (e.g., gears, timing belt and pulley drives, cams, linkage mechanisms, ratchet mechanisms, crank and crank shafts, wires, springs, pins/nails/screws etc.): _____
   _____
5. Method/s used for manufacturing toy parts: (3D printing, 2D Laser cutting machine, Lathe Machining etc.):_____
   _____
6. Whether **kinematic analysis** of links done (estimation of displacement, velocity, acceleration) (Y/N): _____
7. Whether **Report** prepared and submitted? (Y/N). Rate from min. **1** to max. **5)**: _____
8. Whether the Mechanical Toy is FUNCTIONAL? Rate from min. **1** to max. **5)**: _____
9. Build Quality & Aesthetics of Mechanical Toy (min. **1** to max. **5)**:_____
10. Rating for Originality and Creativity (min. **1** to max. **5)**: _____
11. Judges' **Rating** of the Final Stage Performance (min. **1** to max. **5)**:_____
12. **Overall Rating (Average of Sr.Nos.1 and 11)** (min. **1** to max. **5)**:_____

Judges' Signatures: _____ _____ _____ _____

Sample photographs taken during the PBL Assessments:





Observations:

1. Not many student groups turned up for the Stage-I assessment on 9 March 2019 even though the project topic was floated to the students during the first week of the semester course, and orientation on the same was conducted shortly after. It was found that only 7/18 groups in SE Mech-A, 4/20 groups in SE Mech-B, and 8/17 groups in SE Auto actually reported for the assessment.
2. It was also found that almost all groups who were present for the Stage-I assessment, had not done sufficient homework related to the topic. The project ideas and the underlying mechanisms were either adapted or copied from various sources from the internet without any original or unique ideas of their own, which was a strong requirement from the student groups. As such, devising of alternate mechanisms, and the selection of best mechanism from the various alternatives for achieving the required motions of the links of mechanism, was clearly missing.

3. Also, almost no effort was seen by the student groups performing preliminary calculations related to kinematic analysis. The good thing observed was that many who reported could create a CAD model in SolidWORKS software and some could animate it, with the dimensions of their model all assumed.
4. Some student groups submitted a poster and a report based on their work done. But, the quality seemed to be very poor and non-professional.
5. All the above observations related to Stage-I PBL work, clearly point to a lack of professional/technical approach to handling a project by the student groups.
6. 13/18 groups from SE Mech A, 14/20 groups from SE Mech B, and 15/17 groups from SE Auto, attended the Stage-II (final) assessment, conducted on 8 April 2019. Here, it was again found that a sufficient number of student groups still remained absent, indicating that no proper work had been done by them at all related to PBL.
7. Very few student groups' works were found to be truly commendable, and the results were hardly satisfactory overall. Many toy projects didn't seem to be working at all, while many were not constructed with the use of proper materials, most of the work was done using cardboards, with the exception of a few using plastic, metal etc. for some links. As such, most projects lacked the basic rigidity and strength required while handling and using the toys.
8. Very few student groups made use of the facilities available in the institute (project lab.) viz. 2D Laser Cutting, 3D Printing, lathe machine etc.
9. Also, as indicated earlier, very few student groups could actually perform some kinematic analysis of the links (either manual/analytical, or computer simulated).
10. From the above observations, it is concluded that, the quality of the PBL work has to be enhanced way better to an acceptable level. The PBL objectives had not been properly percolated as reflected in the students' outcomes. It is advised for the project coordinators and subject experts (related to PBL topic) to construct a sample PBL project, with all necessary criteria required from a student, and explain them the methodology in a detailed manner, in the orientation programme during the start of the semester course. This shall instill confidence and interest in the students' minds, and they shall be better prepared to handle real life projects in future.
