Amanda Byrne

Assignment 5

MEGR Components: Highest fidelity solid models and refinement of solid model equations

Problem Statement

The purpose of my design is to help utilize the limited space in my small kitchen, the design must fit into all of my design parameters which include: easy to use by myself and all my roommates, compact, durable, relatively inexpensive, and easy to assemble and/or disassemble. The design chosen in past assignments is a shelf with horizontal translation, now I must consider and decide on a design that best achieves the parts movement. In order to determine the most fitting design, I must analyze the modules created in Assignment 4 and choose the “best” module based on my design parameters stated above. After deciding which module to proceed with, I then must consider what critical components it must feature.

Assumptions About the Problem

For this assignment, I will be analyzing the smaller details of my design. These smaller details will be the critical components that will allow my design to function properly. Since these critical components account for the functionality of my design I must procure and resolve any possible problems that may come up. Some problems that may come up during this aspect of the project are: Finding a way to keep the shelf from sliding completely out, finding a suitable material and safety factor to keep the shelf from experiencing any type of shear or bending, and finally designing a system that will provide minimal friction.

Pugh/Decision Matrix

In Assignment 4, it was decided that the shelf would operate with a horizontal translation and three different concepts where created to achieve this movement. These concepts where:

1) <u>Dove tails</u>- Shelf fits into dove tail slots and slides in and out
2) <u>Wheel bearings on shelf</u>- Shelf has rollers that slide in and out of a slot built into the structure.
3) <u>Wheel bearings and track combination</u>- Shelf and structure have tracks that interlock and rollers that slide.

To determine which concept will be the best fit to achieve the required translation I will use the Pugh decision matrix. The decision matrix allows me to place emphasis on evaluation criteria and rate each individual concept on how they would perform. The concept with the greatest overall rating will be chosen for the final design. My evaluation criteria are ease of use, durability, easy assembly/disassembly, and inexpensive.

Evaluation Criteria Analysis

Ease of Use: The shelf must be easy to operate and reliable for my roommates and myself. Designs that result in a greater amount of friction or have higher chances of breaking will receive lower ratings.

Durability: The shelf must be able to withstand common wear and weight placed on it. Shear and bending will have differing effects on each shelf depending on the forces acting upon it.

Easy Assembly/Disassembly: The shelf must be able to be taken apart and put together easily. Less parts will result in a higher rating.

Inexpensive: The parts that make up the shelf and any modifications made into the structure will account for additional cost. Therefore, simpler designs will result in a cheaper cost of production.

Relative Weights	Evaluation Criteria	Alternatives					
		Dove Tail		Wheel bearings on shelf		Wheel bearings and track combination	
		Rating	Score	Rating	Score	Rating	Score
30%	Ease of Use	3	0.90	3	0.90	4	1.2
30%	Durability	5	1.5	2	0.60	4	1.2
20%	Easy Assembly/Disassembly	3	0.60	5	1.00	5	1.00
20%	Inexpensive	2	0.40	5	1.00	5	1.00
100%			3.4		3.5		4.4

Based on the decision matrix and the scores indicated in the above chart, the final design will obtain its horizontal translation though a wheel bearing and track combination.

Solutions

Critical Component Analysis

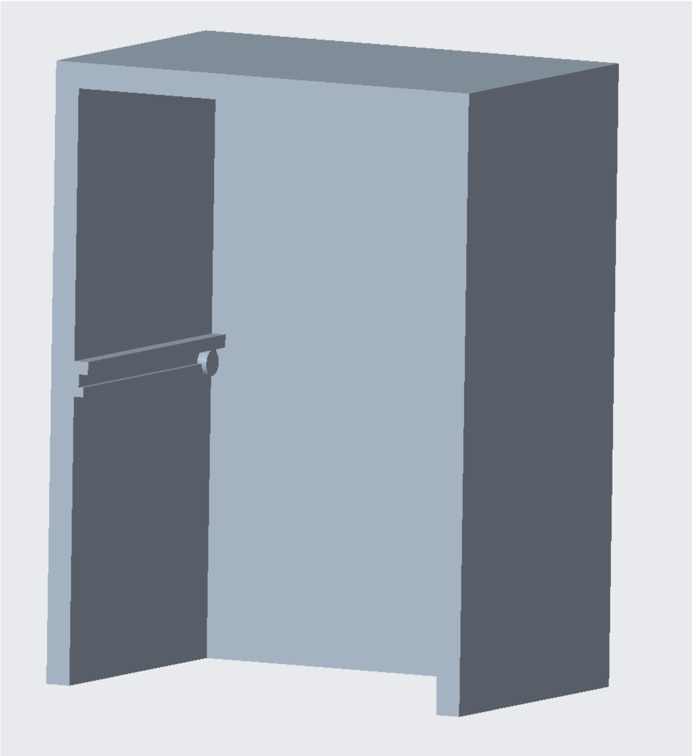
The critical components of my design will allow for the proper functioning of the design. The main function of the design is the horizontal translation, therefore the components that make up the movement of the design are critical. The shelf will use a wheel bearing and track combination to achieve the horizontal translation, and in order to keep the shelf from sliding out of place there must also be a braking system.

FRDPARRC Tables

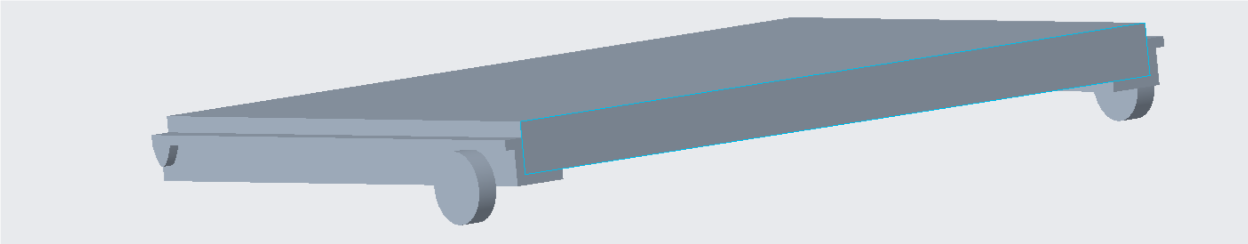
Critical Components

FR	DP	A	A	R	C
Brakes (stoppers)	Bend at the end of the tracks	Velocity V = position/time Acceleration A = V/t	https://www.Physicsclassroom.com/class/1dkin/Lesson-6/Kinematic-Equations	May skip wheel and keep sliding out	Will have to have a tight tolerance so the bend catches the front wheel.
Track and wheel bearings	Have a track on both the shelf and the structure and wheel bearing the keep the shelf balanced	Friction $F_f = \mu N$ Constant linear acceleration A = F/m Torque T = Fr	https://www.Physicsforums.com/threads/forces-on-wheel.410185/	Jamming, off balance	Will have to strategically place wheels to keep balance, and keep tight tolerances to avoid jamming

Parametric Model



Structure of shelf shown with track and wheel



The shelf shown with the other half of the track, wheel, and braker.

Stress Analysis

Material Selection

The shelf will be made from wood for aesthetic purposes, there are many different types of wood, but most can be broken down into a few categories. Below are the three types of wood I am considering, going from most expensive to least expensive in descending order.

- Hardwood: Very strong and durable, an example of hard wood is Cherry.
- Plywood: A manufactured wood, strong and easy to cut. Must use furniture grade plywood for my design.
- Softwood: Can be cut and worked with easily, although softwood can split very easily. An example of softwood is Pine.

Based on strength and overall price, I will use plywood to build the shelf.

Stress Analysis

The shelf will be a single span, meaning there are only two supports on either side. For the single span structural use panel, the bending (M) of the shelf can be derived from the formula $M = \frac{wL}{96}$, where *w* is the uniform load and *L* is the length of the shelf. Shear (V) can be found from the equation $V = \frac{wL}{24}$.

Safety Factor

The factor of safety used for lumber is typically 1.3, for additional support on the shelf I will round up to 1.5.

Lessons Learned

- Material decisions require dimensional analysis and a proper understanding to how said materials will react in a certain environment.
- The further we move towards the final design, the more problems and necessary requirements must be addressed

Comments to Advisee

Jake Weber

- Have frdpaarc tables for each of your critical components, not just one with all of them
- Include a stress analysis portion into your page

Cameron Klovstand

- Include some detailing next to your decision matrix, i.e. why you chose what you did
- Include some equations

Gantt Chart

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Activity	Resource	Status
Assignment 1: Create Portfolio		
Create landing page	1/12-1/17	100%
Create about me page	1/14-1/17	100%
Create files for each assignment	1/14-1/17	100%
Assignment 2: Strategy		
Problem Statement/Assumption	2/1-2/2	100%
Pugh/Decision Matrix	2/2-2/4	100%
Multiple Solutions/FRDPARRC	2/4-2/5	100%
Gantt Chart	2/4-2/6	100%
Lessons Learned/Advisee comme...	2/6-2/7	100%
Assignment 3: Conceptual Design		
Problem Statement/Assumption	2/15-2/16	100%
Pugh/Decision Matrix	2/17-2/18	100%
Multiple Solutions/FRDPARRC	2/18-2/20	100%
Gantt Chart	2/20-2/21	100%
Lessons Learned/Advisee comme...	2/20-2/21	100%
Assignment 4: Modulus Phase		
Problem Statement/Assumption	2/25-2/28	100%
Decision Matrix	2/28-3/5	100%
Multiple Solutions/FRDPARRC	3/5-3/7	100%
3D Models	3/8-3/15	100%
Gantt Chart	3/8-3/15	100%
Lessons Learned/Advisee comme...	3/16-3/21	100%
Assignment 5: Components		
Problem Statement/Assusumption	3/25-3/30	100%
Decision Matrix	3/25-3/30	100%
Multiple Solutions/FRDPARRC	3/30-4/2	100%
Stress Analysis	4/2-4/4	100%
3D Models	4/4-4/5	100%
Gantt Chart	4/6-4/7	100%
Lessons Learned/Advisee comme...	4/9-4/10	100%
Assignment 6: Drawings		
Problem Statement/Assusumption	4/15-4/21	0%
Decision Matrix	4/21=4/25	0%
3D Models	4/21-4/25	0%
Assembly block	4/25-4/29	0%
Bill of Materials	4/25-5/2	0%
Gantt Chart	5/2-5/3	0%
Lessons Learned/Advisee comme...	5/3-5/5	0%