Demonstration of Three Speed Gear Box

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Aims of the project

The aim of the project is to design, build and test a three speed gear box. The group was given the task to learn and understand how different gearboxes operate. The team members must design the different parts for the 3 – speed gearbox demonstrator and then make a CAD assembly to ensure all the parts fit together and that the gearbox will be able to perform its function smoothly without any problems. In order to exhibit the 3-speed gearbox at the engineering convention in early December, the team needs to make every effort to design, build, and produce it before the project deadline. Considering that there is just 12 weeks to complete this project, planning and preparation will be essential to completing it as well as possible. Designing a gearbox that maximizes power production for the intended application while minimizing mechanical wear and energy loss was a major objective. This required careful engineering, material selection, and making sure the gear ratios were suited for managing both load and speed.

Objectives

- Methodical design approach (each team member's proposal and an explanation of the rationale behind the final design concept)
- Complete SolidWorks design concept, including housing, gears, levers, etc. A design study (FEA) will be included with the design.
- Complete manufacturing of the selected design that is both aesthetically beautiful and functional, including with all necessary documentation (product specifications, drawings, etc.)
- Acquiring more parts that are needed for the construction but cannot be produced by group.
- Final Gearbox Ratio Demonstrator construction and assembly.

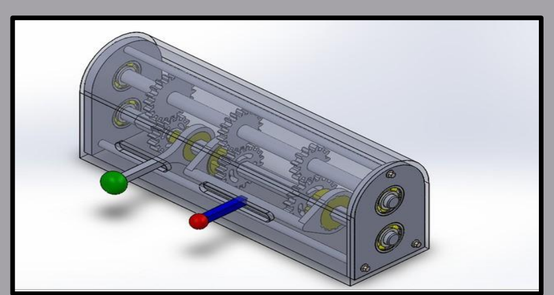


Figure 1: Example design of three speed gear box

Background

In the latter half of the 18th Century, the first gearboxes were designed for use in horse – drawn carriages. By choosing the different gears, drivers could manually change the pace of their carriage with these early gearboxes. These early gearboxes, however, were often extremely laborious to operate and were not very efficient.

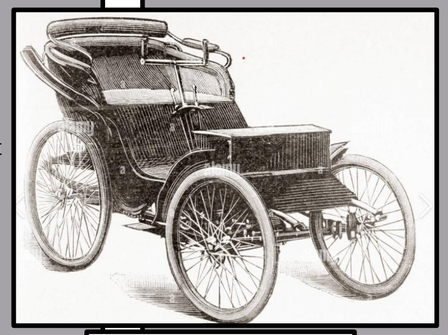


Figure 2: 1890's car

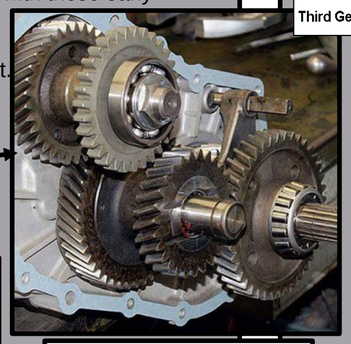


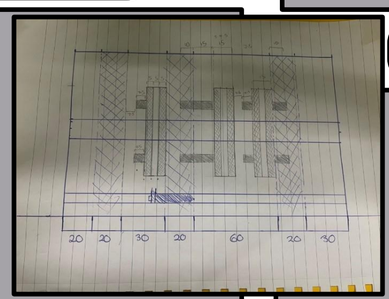
Figure 3: 1900's Gear Box

Three speed automatic gearbox began being replaced by vehicles with overdrive and additional forward speeds in the late 1970's.

The first original manual transmission is said to have been invented by Emile Levassor in 1894. a synchronized manual gearbox was released by Cadillac in 1928 and gear grinding was significantly reduced. Clutches, bands and hydraulic pressure were then applied for changing the gears.

Designing

This section of the project was broken up in to three mains steps. Each member first researched about different styles of gear boxes. They then began to sketch and hypothesise their own designs. The group members then presented their own design to the other members. In order to select a final design the group members used a table to weigh the pros and cons of each concept design.



Sketch 1: Final Design (Concept design 4)

Table 1: Design Study Grading is an example of the table the group members used to determine the best final design. The table shows the design factor, the weight of importance of that factor, and the design factors rating. The rating is between 1-5 1 being the lowest score and 5 being the best score a design factor can have.

GROUP PROJECT DESIGN STUDY							
Scoring system - 1 = lowest / least suitable, 5 = highest / most suitable							
Design Factor	**Weighting**	**1**	**2**	**3**	**4**	**5**	**Total**
Aesthically pleasing	0.5				✓		2
Ease of Manufacture	1.5		✓				3
Ease of Use	1					✓	5
Durability	1				✓		4
					Total for Design No X:		**14**

Table 1: Design Study Grading

Manufacturing

First Gear Output Speed= $\frac{(2000)(20)}{27} = 1481.5\,rpm,\ \mathrm{GR} = 1.35:1$

Second Gear Output Speed= $\frac{(2000)(25)}{22} = 2272.7\ \mathrm{rpm},\ \mathrm{GR} = 0.88:1$

Third Gear Output Speed= $\frac{(2000)(27)}{20} = 2700\,rpm,\ \mathrm{GR} = 0.74:1$

P.C.D (Circular Pitch Diameter) = module x number of teeth

O.D (Outside Diameter) = P.C.D + 2A (Addendum)

Gear Ratio = $\frac{Driven\ Gear}{Driver\ Gear}$

The first parts that the team began with manufacturing was the 6 gears for the project. Two of the gears for the project are 87mm diameter, two of the gears for the project are 66mm diameter, one of the gears for the project are 81mm in diameter and the last gear for the project is 72mm diameter. There is a 10mm gap in between the bearings so 3 spacers are needed to prevent the bearings from touching each other.

For the gear box casing the Cincinnati VMC-500 in "8A401" was used to g-code the various parts.

For the three dog clutches and the shifting forks, a 3d printer was used. Figure 4 shows the assembly of the gear box on solid works. The drawing from this were crucial in helping the group understand the dimensions of each part.

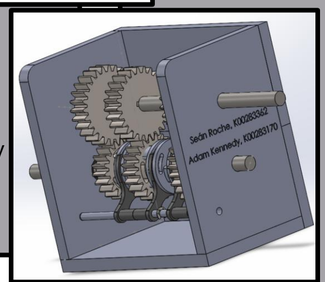


Figure 4: Project's CAD Gear Box

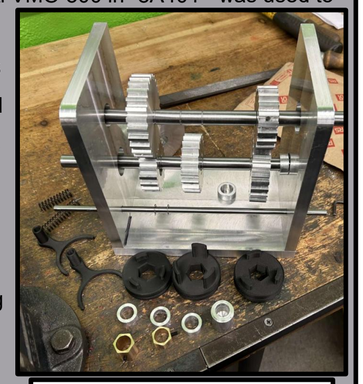


Figure 5: Project and Parts pre assembly

Conclusions

Overall, the project has deepened our grasp of the theoretical and practical facets of developing high-performance mechanical systems while shedding light on the intricacies of gearbox design and production. The project required careful material selection to guarantee strength and longevity, accurate gear ratio calculations, and the incorporation of sophisticated production procedures. We verified through extensive testing that the gearbox provides dependable performance across all three speeds, offering the required torque and speed control.

References

A History of Manual Vehicle Transmissions

How Gear Ratios Work | HowStuffWorks

Constant Mesh Gearbox - Components, Working Principle, Advantages, Disadvantages, Applications - Mechanical Education