

**GEAR RATIO INVESTIGATION OF AUTOMOTIVE
MANUAL TRANSMISSION**

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**A thesis submitted in partial fulfillment of the
requirement for the award of the Diploma
of Mechanical Engineering**

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NOVEMBER 2007

ABSTRACT

Investigation of manual transmission purpose is to train final year student for hands on and automotive investigation experience. In this investigation of manual transmission, two analyses have done. First analysis is about how gear ratio influence vehicle performance curve. Vehicle performances are determined not only by engine performance, but also by transmission gear ratios, differential gear reduction ratio, and tires. Second analysis is about size gear shaft, design of gear shaft is influence by size of vehicle. For example, truck and small car have different of size gear shaft. The second analysis prove why design of gear shaft influence by size of vehicle. Cosmoswork are using in second analysis for test Stress, deformation, strain, displacement in gear shaft at different size. Investigation of manual transmission need to documentation because it will be best reference for student who's involved in fabrication of manual transmission. This report have explain how to using Cosmoswork and calculation for produce vehicle performance curve from gear ratio.

ABSTRAK

Tujuan utama projek mengkaji gearbox manual ialah untuk memberi pelajar pengalaman dalam bekerja dan asas dalam penkajian automotif. Dalam analisis automotif ini, dua analisis telah dijalankan. Analisis pertama ialah tentang bagaimana nisbah gear mempengaruhi graf prestasi kereta. Prestasi kenderaan tidak hanya ditentukan oleh prestasi enjin, tapi juga ditentukan oleh nisbah gear yang berada antara engine dan tayar. Analisis ke dua ialah mengenai saiz gandar gear, rekabentuk gandar gear adalah dipengaruhi oleh saiz kenderaan atau berat kenderaan. Contohnya, truck dan kereta kecil mempunyai saiz gandar gear yang berbeza. Analisis kedua ini membuktikan bagaimana saiz rekabentuk gandar dipengaruhi oleh saiz kenderaan. Cosmoswork digunakan dalam analisis kedua untuk menguji kesan tekanan, perubahan bentuk, ketegangan dan sesaran dalam saiz gandar yang berbeza. Penkajian mengenai gearbox manual ini perlu didokumenkan kerana ia akan menjadi sumber rujukan yang amat baik untuk pelajar yang terbabit dalam pembikinan gear sekaligus mereka yang terlibat secara langsung dalam kajian ini. Repot ini menerangkan sedikit sebanyak mengenai cara menggunakan cosmoswork dan pengiraan untuk membuat graf prestasi kenderaan daripada nisbah gear yang ada.

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CHAPTER 1

INTRODUCTION

1.1 Project Synopsis

1.1.1 General Project Synopsis

The project involves gear ratio investigation of manual transmission. This investigation could be use by the other student to be a reference as future investigation or future work. As the Diploma final year project allocates the duration of 1 semester, this project is need to skill to using equation for produce graph, use software as SolidWorks and cosmoswork.

1.1.2 Specific Project Synopsis

My final year project title is gear ratio investigation of manual transmission. In this project are investigating about manual transmission. Vehicle performances are determined not only by engine performance, but also by transmission gear ratios, differential gear reduction ratio, and tires. This investigation are investigate, how gear ratio influence the vehicle performance curve. Cosmoswork also are using this investigation to test Stress, deformation, strain, displacement at different diameter of shaft. Cosmoswork simulation will shown value of Stress, deformation, strain, displacement at different shaft with diameter 60mm and 35mm.

1.2 Problem Statement

From the manual transmission data as gear ratio, vehicle performance curve is creating. The vehicle performance curve will create from some formula. Gear ratio of third gear has chosen as analysis. The analysis has using cosmoswork software to test Stress, deformation, strain, displacement at different diameter of shaft.

1.3 Objective Project

To investigate gear ratio and test stress, strain, deformation, displacement at different shaft manual transmission.

1.4 Scope of Project

- i. Study of automotive drive train
- ii. Disassemble manual transmission
- iii. Find out ratio of each gear in the original gear sets.
- iv. Determine vehicle performance curve for the original gear ratios.
- v. Analysis strain, stress, deformation and displacement of 3rd gear at Different diameter shaft by using Cosmoswork.

1.4.1 Project Organization

1.4.2 Chapter 2: literature review. This chapter is generally about the manual transmission. Function or purpose of transmission is providing torque needed to move the vehicle under a velocity of road and load condition. It also about gear ratio and vehicle performance curve,

- 1.4.3 Chapter 3: Methodology.** First works in this chapter is disassembling original manual transmission and get data from manual transmission as gear ratio. Vehicle performance curve will create from gear ratio and using some calculation. It also explain about how using cosmoswork to analysis stress, strain, deformation, displacement at different shaft.
- 1.4.4 Chapter 4: Result and discussion.** Vehicle performance curve from the gear ratio available have been create. Result of cosmoswork simulation will shown at this chapter.
- 1.4.5 Chapter 5:** The aim of this project was to study about gear ratio of manual transmission. It will give more information how gear ratio give performance of the vehicle.

1.5 Project Planning

This project is begin with made a research and research for information via internet, books, supervisor, journal and other relevant academic material that related to my title, this literature review takes about a week. The reviews not stop there. It continues along the way of this project because knowledge is so many to learn.

At the same week I do some schedule management for this project which included schedule management. This is done using Microsoft Office Project using Gantt chart system. This also takes a week to accomplish.

The next week I also had to arrangement several meeting with project's supervisor to be clear about the scope of title, synopsis from previous research and tool requirement which include software (Cosmoswork) or hardware (manual original transmission).

The next week, have been submitting my project title acceptance form and continue detail research in manual transmission. I also make the literature review about Cosmoswork in this week.

The title are well clear at week third, it consist of scope and objective for the project. At this week, the meetings with supervisor only focus about manual transmission and equation to produce of vehicle performance curve from specification gear ratio available. Disassemble original manual transmission also make at this week.

In this week, data from manual transmission have been collect. The data is as gear ratio of each gear, diameter of third gear, count of teeth of gear and final gear ratio. When get all of the data, vehicle performance curve can be cerate from specification of gear ratio. Have three vehicle performance curves can be crate from specification of gear ratio, the graph is trative effort vs. vehicle speed, Power available at wheel vs. vehicle velocity and Engine speed versus road wheel speed.

Next week work is design third gear using solidwork and tests the design using Cosmoswork at different diameter shaft. One schematic have consistence from my supervisor to test deformation, strain, and displacement at different shaft. The fix shaft is 60mm and 35mm of shaft.

Week seventh, this week are time for mid – term presentation. The main objective for that presentation is about to show to the panel how the far the work progress especially for individual project.

Next task is the final report writing and final presentation. This take about one week to accomplished. The report is guided by UMP Thesis writing guided and also the guidance from my supervisor. Due all problems when doing the project the management has agreed to extend the time to submit the report and the presentation. All the task is scheduled to take about fourteen weeks overall to finish.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter is generally about the manual transmission and gear ratio.

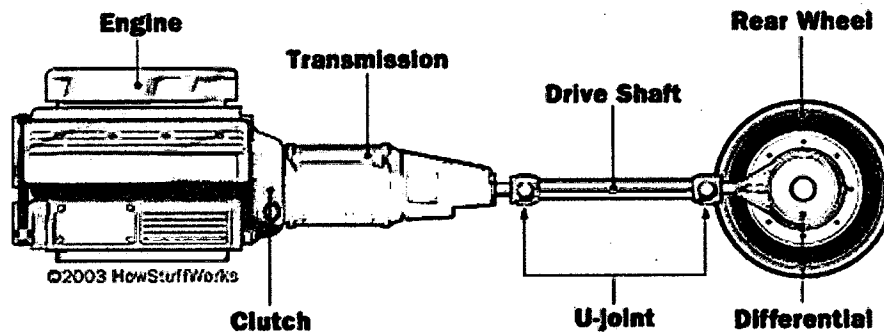


Figure 2.1: drive train systems

The transmission location is among clutch and drive shaft as a figure 2.1. Transmission is a sub system in drive train except clutch and drive shaft. The transmission is connected to the engine through the clutch. The input shaft of the transmission therefore turns at the same rpm as the engine.

2.2 Purpose of Transmission

There are three reasons for having a transmission in the automotive power train or drive train [4]. The transmission can:

- Provide torque needed to move the vehicle under a velocity of road and load condition. It does this by changing the gear ratio between the engine crankshaft and vehicle drive wheel.
- Be shifted into reverse so the vehicle can move backward.
- Be shifted into neutral for starting the engine and running it without turning the drive wheels.

There are two basic types of transmission: manual and automatic. Manual transmission is shifted manually, or by hand. Automatic transmission shift automatically, with no help from the driver.

2.3 Transmission System

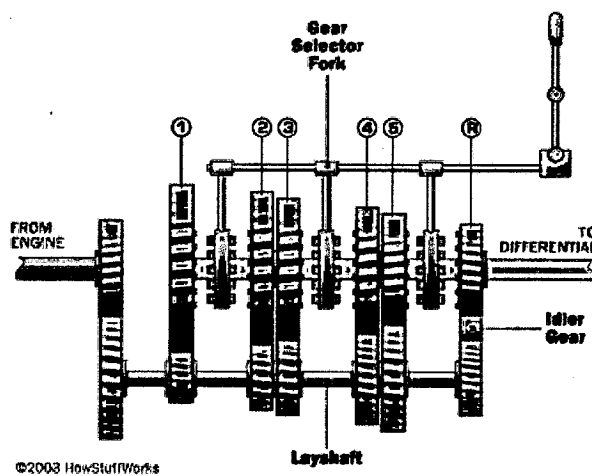


Figure 2.3.1: Transmission system

To understand the basic idea behind a standard transmission, figure 1.2.1 shows a very simple five-speed transmission in neutral. There are three forks controlled by three rods that are engaged by the shift lever. Looking at the shift rods from the top, they look like this in reverse, first and second gear.

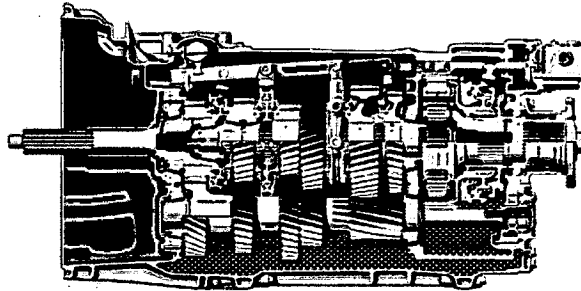


Figure 2.3.2: Manual transmissions

The five-speed manual transmission is fairly standard on cars today. Internally, it looks something like figure 2.3.2.

2.4 Choice of Top Gear Ratio For Maximum Speed

When the engine power available is plotted on the same graph as the power required to a common base of vehicle speed the gear ratio will position the maximum engine power condition relative to the vehicle speed. The low gear or high gear will position the engine maximum power condition at a high vehicle speed and vice versa.

To obtain maximum speed on level road and still air from a given engine the power required curve must intersect the power available curve at its maximum value.

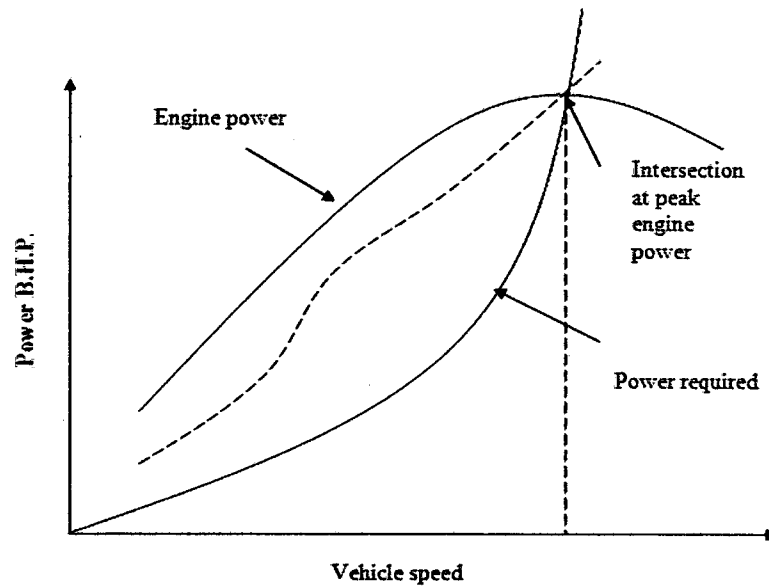


Figure 2.4: Graph gear ratio for maximum speed

This however is rarely chosen, as maximum speed has now become of little importance for cars due to speed limits.

2.5 Under-Gearing (Gear Ratio Large or Low Geared)

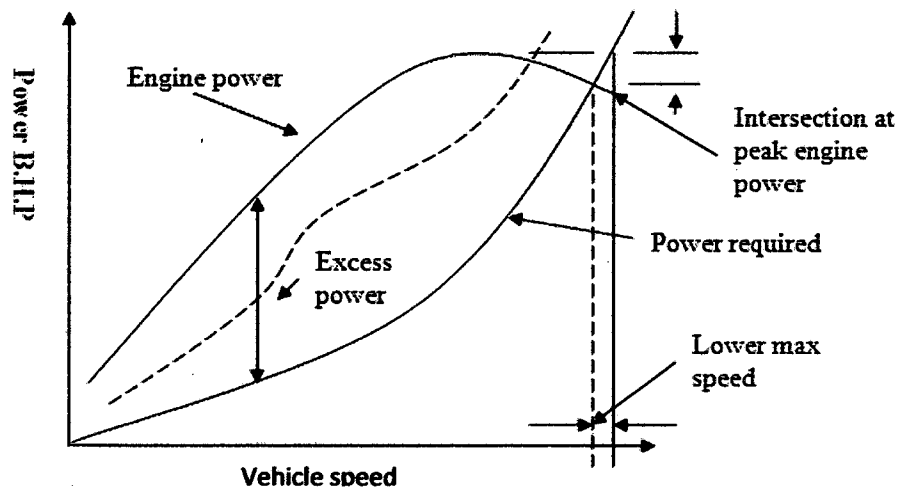


Figure 2.5.: Under gearing

Under gearing is the case where the power required curve intersects the power available curve at a speed above engine maximum power.

For the small to medium car V_{\max} can be limited to 75 mph – 85 mph (120km/h – 137 km/h) i.e. 10 % in excess of maximum legal speed.

The advantages of under gearing are to increase the excess power available at low speed. This excess power is used for acceleration and acceleration is becoming more and more important as traffic density increases. Better hill climbing performance is also obtained by this type of gearing.

Note: excess power is the power available over the power required for steady uniform speed on level road.

2.6 Over Gearing (Gear Ratio Small or High Geared)

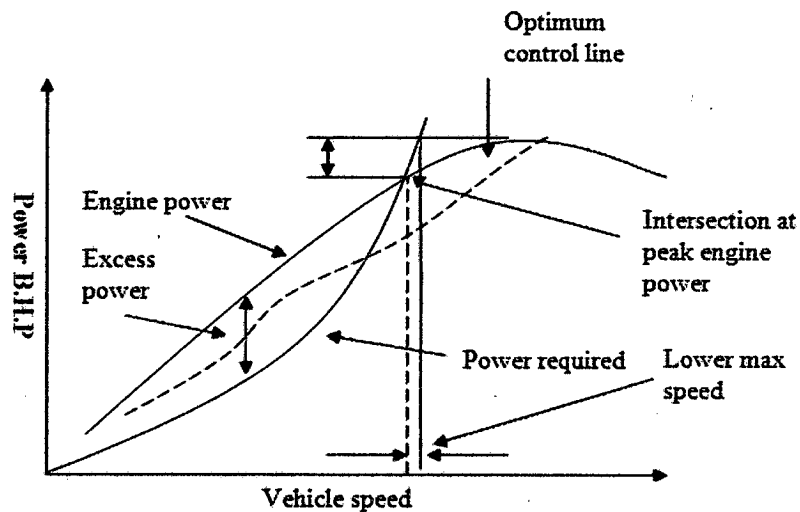


Figure 2.6: Over gearing

Overgearing is the case where the intersection of the power required and power developed curve intersect at a speed below engine maximum power.

The advantages of gearing of overgearing are bring the power required curve close to the optimum control line, i.e. improve fuel consumption.

The disadvantages is that the power available fro acceleration and hill climbing is very much reduced.

Example of overgearing is 5th gear in 5 speed gearbox. When cars are fitted with five speed gearboxes the maximum speed on level road is virtually the same for both 4th and 5th gear. In some cases the maximum speed in 5th gear is less than that in 4th gear.

CHAPTER 3

METHODOLOGY

3.1 Project Flow Diagram

From the figure 3.0, the project starts with literature review and made research about the project title. This is consisting review of the concept about gear ratio. These tasks have been done through research on the internet, books and others sources.

After gathering all the relevant information, the project undergoes dissemble of manual transmission. Dimension at original manual transmission as count of teeth, and diameter of gear set have collect. Each of the gear set data will collect for next work.

Vehicle performance curve can be creating from the data of manual transmission as gear ratio. There is three vehicle performance curve can be sketch using excel, the graph is vehicle tractive effort versus vehicle speed, Graph Power available at wheel versus vehicle velocity and Graph engine speed versus road wheel speed. Vehicle performance curve shown performance of the vehicle, while using the gear ratio.

Cosmoswork have use to test Stress, deformation, strain, displacement at gear shaft while shaft work at 0.5 minute from 1 minute. Two analyses have been done using different shaft, first shaft is 60mm and second shaft is 35mm. the both shaft shown different result for different diameter shaft.

After all these progresses were complete, the report writing and the final presentation will come. So must be ready for final presentation and submission of the final report. For more detail about progress work at every week, refer appendix A (Gantt chart of project).

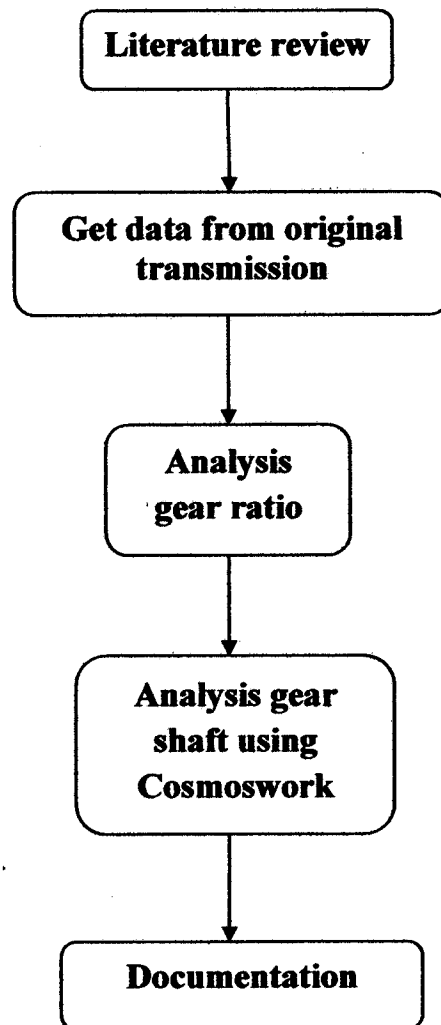


Figure 3.1: Project flow chart

Figure 3.1 above shown the flow diagram which start with literature review and finish with final presentation.

3.2 Dissemble of Manual Transmission

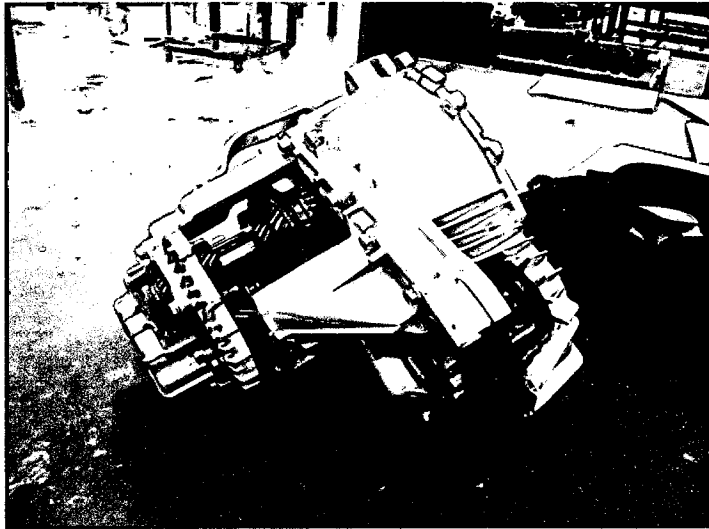


Figure 3.2.1: Original manual transmissions

Firstly open all nut at the transmission and pull up the top case of manual transmission. Second task, open the gear selected fork, and lastly pull up all of the gear set

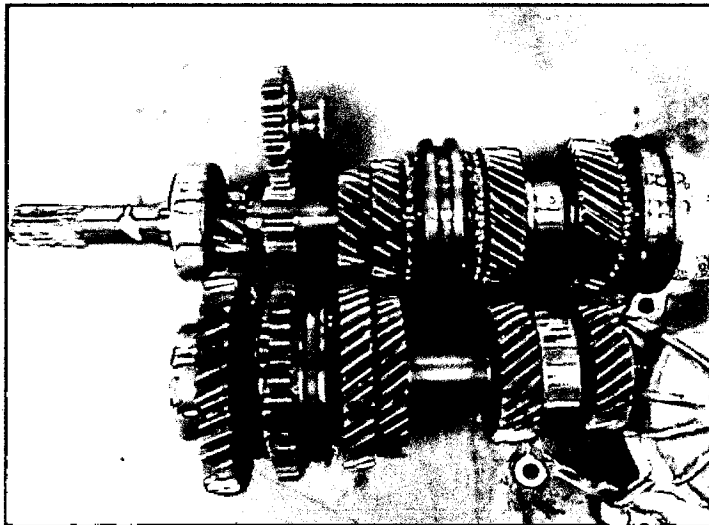


Figure 3.2.2: Manual transmission gear set

This is gear set of manual transmission contain of 1st gear, 2nd gear, 3rd gear, 4th gear and 5th gear. This gear set not contain final gear set.

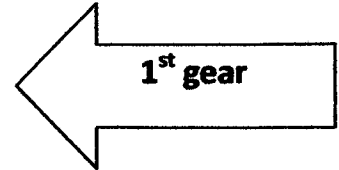
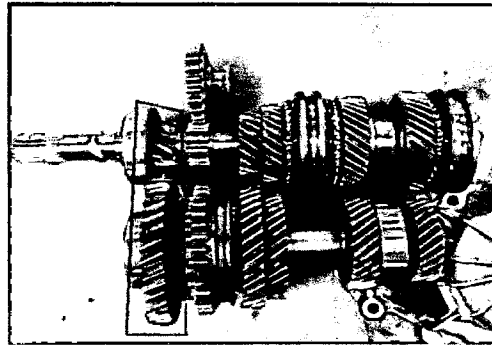


Figure 3.2.3: First gear set

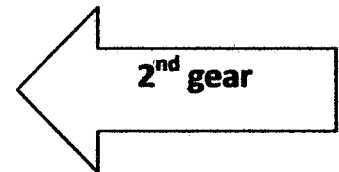
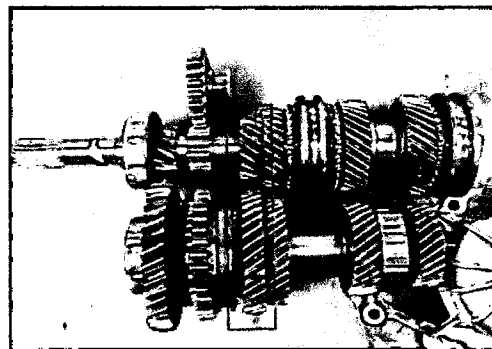


Figure 3.2.4: Second gear set

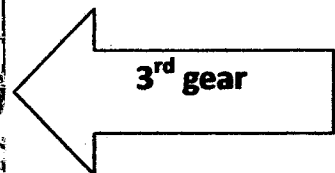
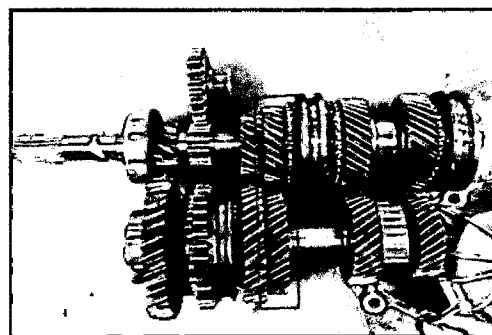


Figure 3.2.5: Third gear set