Video Game: Continuous Track Design

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Abstract

Have you ever wondered why tanks use the continuous track design instead of just regular wheels? What are the advantages and disadvantages behind this design? This STEM project is to study continuous track design by playing the hill climb racing video game, and applying Minitab statistics to determine the positive and negative aspects of it. The benefit of this project is to research and explore an interesting topic and have fun playing video games at the same time. While doing the project, we will use the Mountain stage in the game, the stage with the most extreme terrain and assess five various cars; Hotrod, Moon lander, Super off-road, tank and hovercraft. Each vehicle has a different wheel design or continuous track design. We will compare their performances based on the distance they can climb on the mountains. Our hypotheses is we want to determine whether there is any measurement repeatability, so that players could duplicate the similar result to prove the playing patterns are less-human dependent. The other objective is to determine whether continuous track design actually is the better wheel design with several merits to overcome the several challenges of the Mountain stage. This paper will combine STEM (Science, Technology, Engineering and Mathematics) in demonstrating the advantages of using the Continuous Track Design.

Keywords
Minitab, Hill Climb Racing, Continuous Track Design, Statistics

1. Introduction

Continuous track, also called tank tread or caterpillar track, is a system of vehicle propulsion in which a continuous band of treads or track plates is driven by two or more wheels, the large surface area of the tracks distributes the weight of the vehicle, enabling a continuous tracked vehicle to traverse soft ground with less likelihood of becoming stuck due to sinking.

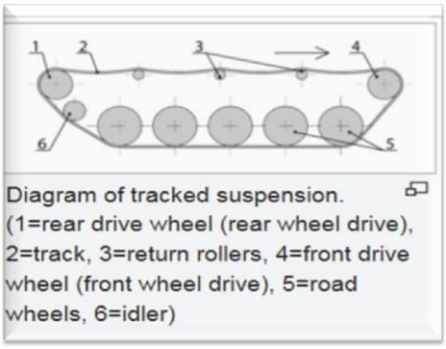

Diagram of tracked suspension. (1=rear drive wheel (rear wheel drive), 2=track, 3=return rollers, 4=front drive wheel (front wheel drive), 5=road wheels, 6=idler)

Figure 1: Diagram of tracked suspension

1.1 Hypothesis

Is there any player dependency and is the continuous track design better than the wheel design?

1.2 Advantages and disadvantages of wheel design

Advantages of wheel design:
Wheel designs have a much lower production cost, and has a higher maneuverability because it is generally lighter than continuous track design.

Disadvantages of wheel design:
With its weight unevenly distributed, it makes it much harder drive over obstacles.

1.3 Advantages and disadvantages of continuous track design

Advantages of continuous track design:
Cars with continuous track design has much higher power efficiency, as it doesn't run out of gas as fast as wheel designed cars. It also has higher traction to the ground because its weight is more evenly distributed, this allow continuous track designed cars to move on tough terrain much easier. Although this design might not be the best choice in the beginning without upgrades, it sure does have a much higher upgrade potential, we will cover that in the results section.

Disadvantages of continuous track design:
Though continuous track design has a lot of advantages, it also has some disadvantages. For example, it has a lower speed than the wheel designed cars and has less maneuverability due to its large size and heavy weight.

2. Project scope and stage selection

2.1 Mountain stage challenges

We chose the mountain stage because it is the most difficult stage in the game as it has many steep climbs and rocky terrain.

Figure 2: The mountain stage

The reason why we chose the mountain stage is because it best helps prove our hypothesis that Continuous track design works better than wheel design in hard terrains.

2.2 Design experimental study

We used measurement mode analysis and failure mode analysis. We selected and compare 5 cars best cars, 2 with wheel design and 3 with continuous track design. The 2 wheel designs are Hot Rod, which is a 2-wheeled car with big tires and Moon Lander, a 3-wheeled spacecraft with a thruster to make it fly.

The 3 continuous track design cars are Tank, which most people are familiar with; it has a large size and heavy weight. Super Off-road, a lighter continuous track designed car that has a spoiler on the back; and Hovercraft, which is technically not a continuous track designed car, but it does has one thing in common with all other continuous track designed cars, heavy weight and large contact area. We want to identify which wheel/track design car has more potential to overcome mountain stage challenges. In the beginning, it seems that the 2 wheel designed cars perform much better due to their fast speed/mobility which leads to more airtime therefore further distance; Whereas the tank and continuous track cars don't do as well due to the fact that they are way too heavy and slow. This concept will be further explained in 2.5.

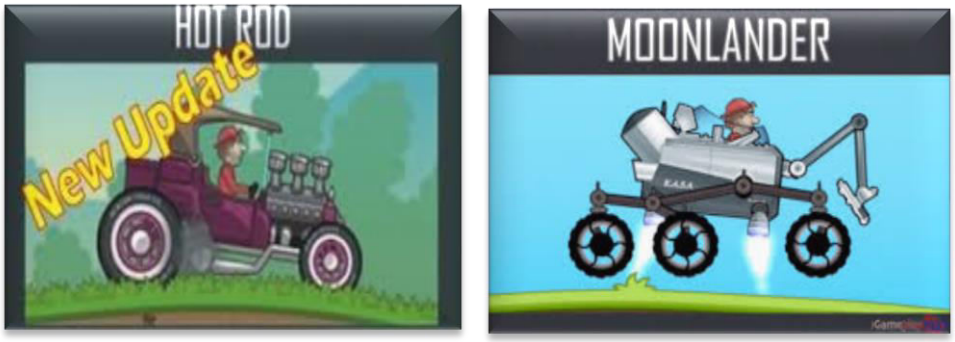

Figure 3: The wheel design cars

Figure 4: The Continous Track Design cars

2.3 Measurement system analysis 1 (Repeatability)

Repeatability: run the same car on the same Mountain Stage for 10 Times: ensure player is well trained and who can repeat the same measurement. Results: the distribution IQR= 168, Standard deviation= 120 due to two failure modes observed. Repeatability is acceptable.

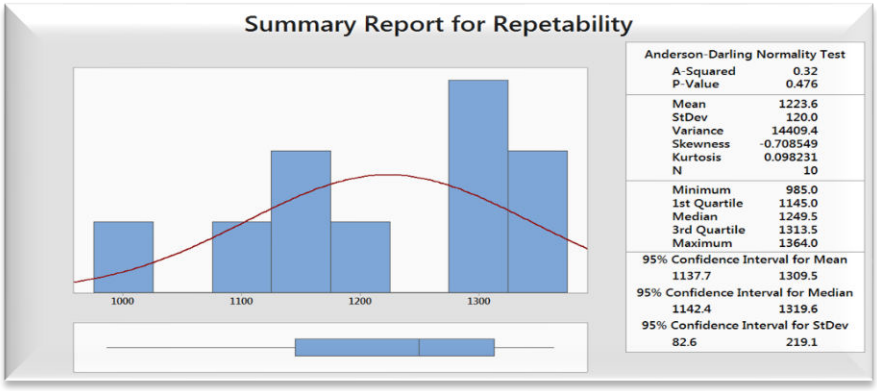

Figure 5: Bar Chart for repeatability

2.4 Measurement system analysis 2 (Reproducibility)

Train three Players and check whether three players can reproduce the similar score distribution.

- Three Players (Player C, Player J, and Player M) demonstrated similar score pattern (no reproducibility concern)

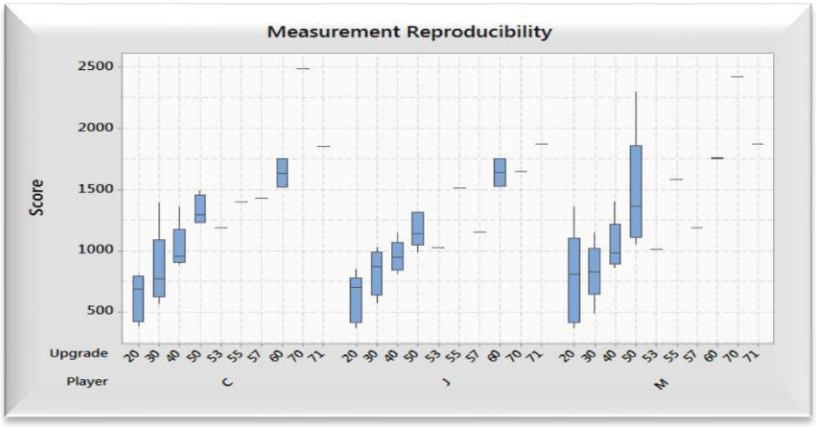

Figure 6: Chart for reproducibility

2.5 Scatterplot for car upgrade

Two Cars with Continuous Track Design (Track, Super Off-road) showed higher upgrade potential on the Mountain Stage. As mentioned previously in 2.2, wheel designed cars perform much better at the earlier stages of upgrades, but the problem with that is they don't have as much upgrade potential. As more upgrades are added, wheel designed cars mostly only increase speed and stability, and stability doesn't really play much of a role in the mountain stage due to the extreme terrain, also these cars are all very light, so the car will flip and bounce around no matter what. The continuous track designed cars, however, has a much higher upgrade potential, because when upgrading it not only increase its speed, its traction also increases, which makes it much easier for the cars to stick to the terrain and steadily climb over extreme hills rather than fly around and die like wheel designed cars. "The traction is greater if you use tracks instead wheels, but for the best results this depends on the terrain."[1] At mountain stage, the heavier the car and the more traction it has, the better.

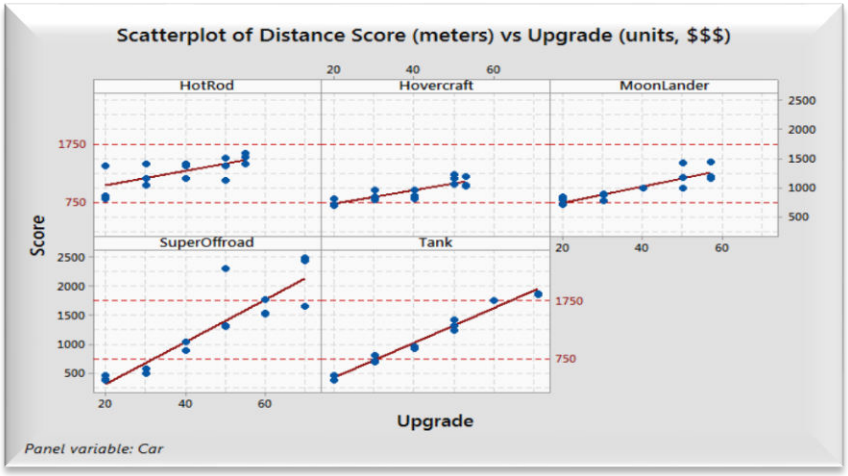

Figure 7: Scatterplot for car upgrade

3. Building Regression Model

A regression model was constructed to show the relationship between performances after upgrades.

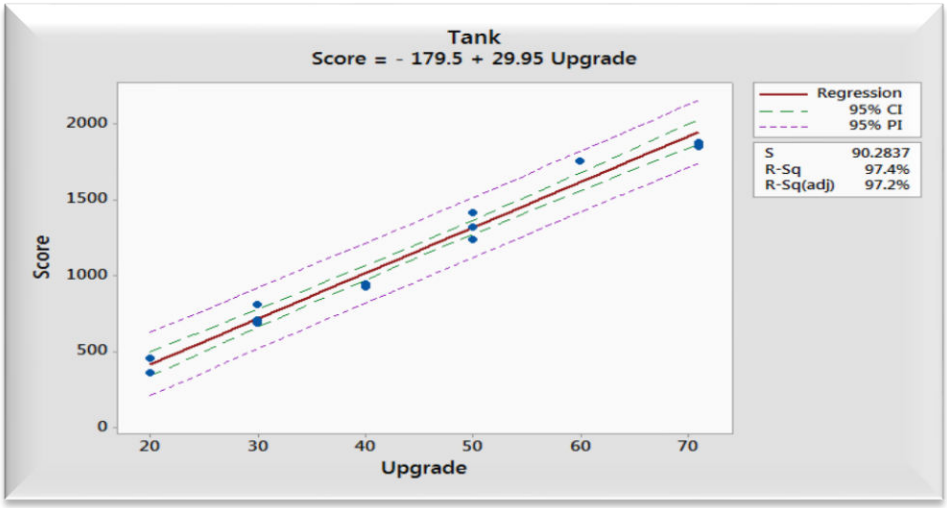

Figure 8: Sample regression model for tank

Tank Regression Model has shown Slope= 29.95 (Highly Upgrading Potential) and R-Square= 97.4% (Highly Accurate Model).

3.1 Compare regression models for results

After all, the Continuous Track Design has shown a higher potential than Wheel Design to run over the modulated peaks. Heavier Continuous Track Tank has a better prediction (97.4%), though Lighter Super Off-Road has a better Potential Slope. Even with Bigger Tire Size, Hot Rod still could not survive on the highly modulated Mountain Stage.

	Design	Slope	R-Square
Tank	Continous Track	29.95	97.4%
Super Offroad	Continuous Track	36.70	82.2%
Hovercraft	Partially Continuous Track	11.46	74.5%
Hot Rod	4-Wheel Design	12.13	46.2%
Moon Lander	6-Wheel Design	14.04	75.7%

Figure 9: Regression model results

3.2 Why the super off-road is the best choice

It's very fast, which means it is easier for the super off-road to reach a longer distance. As it has continuous track, it is much easier for the super off-road to climb steep hills and jump over bumps without flipping over or crashing. With its lighter weight and spoiler to balance, it stays on the ground easier and balances well.

4. Conclusions

4.1 Conclusions

We conducted Measurement System Analysis: passed both repeatability and reproducibility and designed a successful experiment to study the Car Upgrade Potential among five different cars.
We also demonstrated the Advantages of Continuous Track Design over the Wheel Design on the Mountain Stage.

Citation:

1: “Wheels vs Continuous Tracks: Advantages and Disadvantages.” *Into Robotics*, www.intorobotics.com/wheels-vs-continuous-tracks-advantages-disadvantages/.