1.3 Functional Decomposition

After analyzing the project scope and the needs of the customer, the main functions of the design were formed. The main functions were heavily influenced by the key goals of the project because the success of the design is determined by how effective we are at accomplishing these key goals. Using functional decomposition, we were able to analyze a complex system and extract what individual components the system will be fulfilling. The main functions were broken down into subfunctions until there was an understanding of the physics required for a successful system.

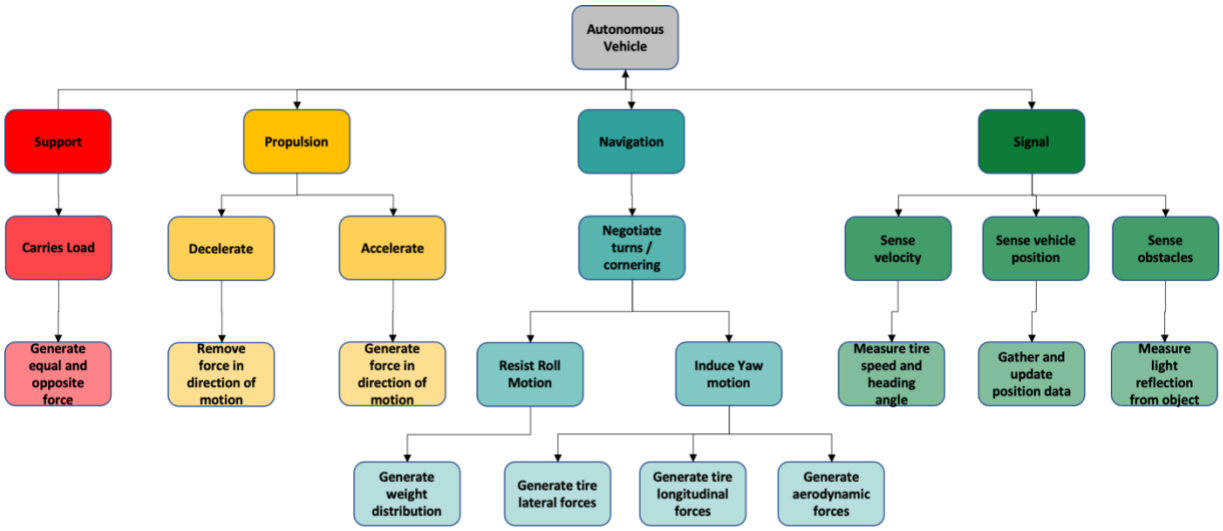

Figure 1 Functional Decomposition Hierarchy Chart

As stated previously, the main functions in the second row of Figure 1 were developed from the key goals of the project. The design is required to work adjacent with team 504 who is designing a system capable of tracking a target. This meant the design must be able to support the system coming from team 504. Specifically, it must be compatible with the tracking software developed by the team and must be able to hold the mechanical load of the

system. To maintain a mechanical load on top of the design, there must be an equal and opposite force to counteract the force being applied by the mechanical load.

The design is also expected to be able to propel itself to successfully keep up with a tracked target and maneuver around a course. This is achieved through removing the force in the direction of motion to create deceleration and generating a force in the direction of motion to create acceleration.

The main function needed to maneuver around a course is navigation where the design must be effective in cornering to prevent collision with obstacles and the extremes of a track. The subsystems to achieve cornering involve resisting the roll motion in the longitudinal axis and inducing yaw motion in the vertical axis of the design. A weight distribution must be generated to counteract the roll motion expected in the design as its negotiation turns. There must also be longitudinal, lateral, and aerodynamic forces generated in the design to induce a yaw motion to negotiate turns. The vehicle must make turns as needed to follow a target or avoid obstacles in the way of its path. The signal main function was determined from the design having to operate autonomously. The design is meant to sense obstacles by measuring the reflection of light from the obstacle. The design must also be able to sense the speed at which it's moving through measuring the rotation of the tires and the heading angle. Finally, the design must be able to sense its position relative to a global frame.

The cross-reference table in Table 2 depicts how the customer needs are related to the main functions of the design. Each "X" indicates whether the need is affected by the main function. More than one "X" shows an overlap of influence that the need will have in the system. The table is meant to serve as an aid in prioritizing the main functions of the design.

Table 2: Functional Decomposition Cross-Reference Table

	Propulsion	Support	Signal	Navigation	Total
Generate force in direction of motion	X				1
Remove force in direction of motion	X				1
Generate Equal & Opposite Force		X			1
Generate Weight Distribution	X	X		X	3
Generate tire lateral forces				X	1
Generate tire longitudinal forces				X	1
Generate aerodynamic forces	X			X	2
Measure light			X		1

Reflection from object					
Measure tire speed and heading angle data			X		1
Measure and update position data			X		1
Total	4	2	3	4	

From the cross-reference table above, the systems that can be considered the most critical are the navigation and propulsion systems. These two systems have the most “X” values and navigation shares the most overlap with other systems. This leaves the signal and support systems which, while having less “X” values, serve to accomplish an integral part of the project. The objective is to minimize inertial losses when accelerating and decelerating, so it would be assumed that the ability to change speeds and the movement through a course or around obstacles is a critical area of focus in the design. Therefore, the propulsion and navigation systems are favored by high priority. However, without any support, the design will lack the necessary weight distribution which will be detrimental to the performance when maintaining velocity while cornering. Signals are a major part of the navigation system because they will identify and interpret data from the environment.

Two of the minor functions listed in Table 2 overlap with multiple systems. The first function is to generate weight distribution, which falls under propulsion, support, and navigation. Maintaining an even weight distribution will help with resisting the roll motion, allowing for better acceleration, and will help determine the placement of the payload. The next function is to generate aerodynamic forces, which will also help with propulsion and navigation. In terms of navigation, aerodynamic forces will allow the vehicle to induce a yaw motion. For propulsion, generating aerodynamic forces can help with either acceleration or deceleration depending on how it is designed. These main functions will allow the team to develop targets and metrics to create a design that successfully fulfills the key goals outlined for the project.