Targets

The functional decomposition is a breakdown of functions in a hierarchical format that includes all of the functions the project should include, based on the needs of the customer. The following targets and metrics were created to be quantifiable goals for each of the functions to reach.

Movement System Targets and Metrics

In relation to the Movement system, the limitation of the body roll of the F1/10th vehicle is targeted to remain below 5 degrees of rotational angle. This ensures preventative measures from rolling over the vehicle. Given the load applied on the vehicle when in motion, the ground clearance targeted at 1.6cm preventing scraping or damage to undercarriage and other components from excessive vibration. When making a turn, the vehicle will necessitate the ability to move freely or have sufficient clearance to achieve a maximum wheel turn of 30 degrees.

Structure System Targets and Metrics

Falling under the Structure system is the “Withstands Forces from Crashes” function. The decided target would be 150N. This was calculated with the assumed mass of the vehicle multiplied by the maximum acceleration of the vehicle. The number was calculated at 112N. However, it was decided that the target would be 150N with a safety factor of 1.34. Another function listed is “Supports Weight of Components”. The decided target would be 12N. This was calculated with the mass of the vehicle along with the mass of the components, cables, and connectors.

Utilization System Targets and Metrics

Frequent utilization of ports implies a targeted lack of port obstruction within 5 cm distance for cable access. Components like Lidar also need unobstructed views in all directions, within a 360-degree field of vision.

Protection System Targets and Metrics

In the realm of the protection system, the designated metrics align with predefined targets to ensure the vehicle's safety and performance. For collision protection, the chassis must withstand a force of 150 N, determined through calculations involving a constant top velocity of 70 mph and a vehicle weight of 3.6 kg. In addressing rollover protection, the specified target is a Static Stability Factor (SSF) of 20. To enhance user safety, strict targets are set: limiting energy dissipation to 70 Amperes (A) and maintaining a sharpness level of 0 meters on the vehicle. These targets and metrics are pivotal in guiding the vehicle design process, emphasizing safety considerations for collision, rollover incidents, and user protection.

Targets and Metrics Derived Outside of Functions

There were several targets and metrics that did not fall under a function category because they needed to be defined before other targets and metrics could be. This category mainly contains the vehicle dimensions. Mass is one of the most important metrics used to define other metrics such as the forces during turning, in a crash, and the body roll in a turn. Metrics from the prefabricated subframe were defined by taking measurements from the subframe. The mass of the subframe was 1.44kg, wheelbase was 26cm, total length was 42.5cm, front and rear track width were both 7cm, total width was 20cm, ground clearance with no load was 1.6cm, steering angle was ±30deg, and the reported top speed from the manufacturer was 31.3m/s.

Method of Validation

Validating the newly made targets ensures accuracy for future accomplishments within the project. The methods that will be utilized in validating the targets are as follows: Utilizing 3D software such as CREO Parametric can help with looking for displacement on fixed components on the chassis, port clearance, and clears ground. To ensure there will be no errors within the targets, using formulas and clear calculations will help with validation. With validation, errors can be reduced which will lead to less issues with future testing. Without it, it can create multiple problems that can hold back the team as well as the sponsor. Finally, validation can also help with choosing the correct concept in the future. Methods such as using the House of Quality for concept selection can drastically change which concept will be used for the project which solely depends on the target values/engineering characteristics.

Derivation of Targets and Metrics

The targets and metrics were derived from the functions in the functional decomposition. For every system, several functions have a metric assigned to them by determining what unit of measure would show best how well the function will be accomplished. These metrics were then assigned a target value that the team believes will characterize good performance in the final design. Many of these targets are found by a direct measurement from the vehicle subframe, or a calculation based on those measurements.

Certain targets are solid targets,which are more critical. Some solid targets are those directly measured from the vehicle subframe. The targets that are derived from these data are also of a higher importance as they will determine the handling characteristics of the vehicle. One such example is the static stability factor, which is assigned a target of 20. This is the ratio of forces in the vertical direction such as downforce and weight to forces in the horizontal direction such as lateral force and centripetal force felt while going around a corner. The downforce and weight of the vehicle should cause a moment about the outside tires 20 times greater than the centripetal force in order to ensure the car does not roll, and the inner tires maintain sufficient traction.

Other targets are soft targets, such as utilizing free space, concealing secondary components, and containing cables to name a few. These were added to be able to have a quantity attached to these functions, but are not as important to the performance of the car.

Discussion of Measurement

Measurements were taken from the prefabricated subframe using a tape measure for longer lengths, and calipers where possible. Angle measures such as body roll and steering were measured using a protractor and a reference line. For body roll, a protractor was attached along the center of rotation of the subframe and measured against a vertical reference to determine how many degrees the vehicle rolled over when the body came into contact with the ground.

Summary and Catalog

Table 1. Targets and Metrics of Critical Functions

System	Critical Functions	Target	Metric
Movement	Limits Body-Roll	±5 [deg]	Rotation Angle
	Clears Maximum Turn Radius	±30 [deg]	Steering Angle
Structure	Limits Height	18 [cm]	Height
	Supports Weight of Components	12[N]	Weight
	Withstands Forces from Crashes	150 [N]	Force
	Dampens Component Vibrations	Ns/m	Damping Coefficient
	Handles Rough Treatment	360 [deg]	Rotation Angle
Utilization	Allows for Easily Accessible Input/Output Ports	5 [cm]	Port Clearance
Protection	Protects Against Collisions	150 [N]	Force
	Protects Against Roll-Over	20 [N*m/N*m]	Static Stability Factor
Non-Function Targets	Vehicle Dimensions	26 [cm]	Wheelbase
		20 [cm]	Total Width
		31.3 [m/s]	Maximum Speed
		1.44 [kg]	Subframe Mass
		3.6 [kg]	Vehicle Mass
		±30 [deg]	Steering Angle

Table 1 consists of the critical functions of the project, and their respective targets and metrics. It was important to declare these initial targets in order to better determine the direction of the design process. With these targets and quantifiable metrics in mind, the team is better suited to satisfy the needs of the customer and successfully carry out the functions of the project. The critical functions discussed for these targets and metrics were determined to be the most imperative targets to be achieved to create a well-engineered chassis for the F1TENTH vehicle. Defining a target for weight and crash protection are some of the most important design goals to take into consideration when designing any type of vehicle. Knowing the customer needs, the functions of the project, and now the targets the design needs to achieve, provides a necessary foundation for the design of the project.