Functional Decomposition

Team 510

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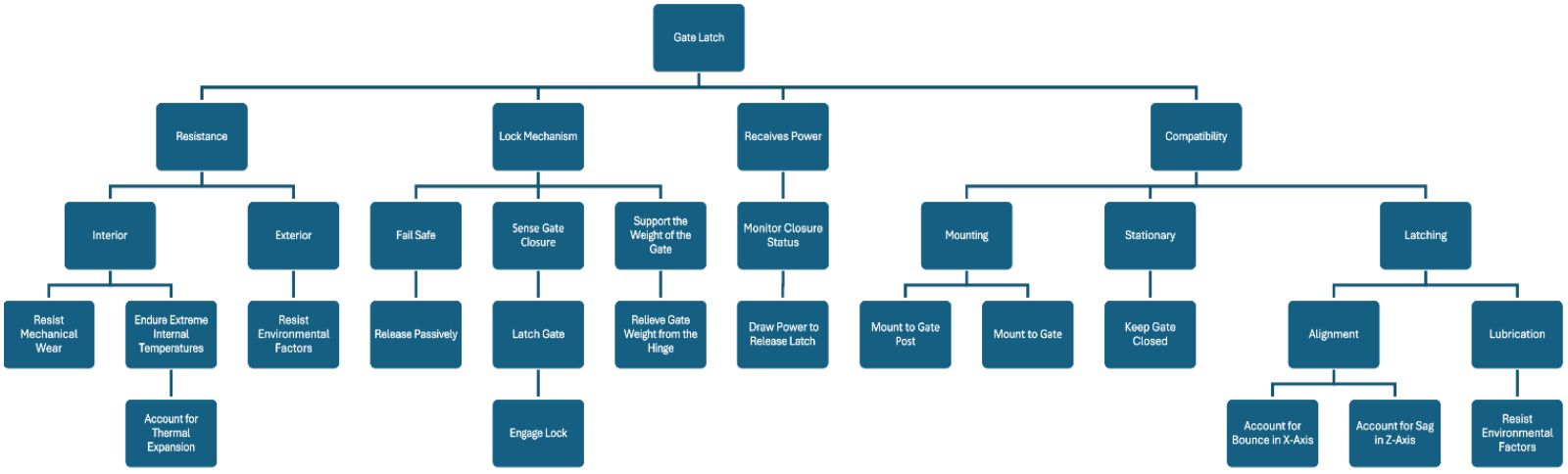
Introduction

The Ghost Controls lock system needs to be analyzed and divided into basic systems. This is done to uncover functions within each system that are necessary components and utilized to lay out the goals of the project. These functions are broken down into a complex process that outlines the small tasks and their outcomes. This process is presented as a functional decomposition.

Function Generation

The functions shown in Figure 1 are placed under their respective systems. The function delineations were based on discussions with the customer and assumptions based on the scope of the project. The manner in which the components interact was established upon the analysis of current systems in place and future design details. Major functions of the system were identified and placed at the top of the chart. Cascading down from the major functions are minor functions meant to produce a functional and reliable gate lock system.

Figure 1: Hierarchy Chart



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Hierarchy Chart Reasoning

The hierarchy chart demonstrates four systems to represent the main functions of the design: Resistance, Lock Mechanism, Power, and Compatibility. These systems were further divided into minor functions, with the objective being to design a solution that ensures reliable engagement, enhanced durability, and ease of installation within an innovative gate latch mechanism that effectively addresses current issues with misalignment and improper latching.

Resistance

The resistance system is divided into two subsystems: interior and exterior. Internal components must be resilient against mechanical wear and extreme internal temperatures to account for thermal expansion. Exterior elements must be able to withstand outside environmental factors, such as wind, significant precipitation, and extreme external temperatures.

Lock Mechanism

The lock mechanism system is divided into three subsystems: fail-safe, gate sensing, and gate weight support. A fail-safe ensures that the gate can be released passively in the event of a power failure. Sensing the gate’s closure ensures that when the gate is latched, the lock is engaged. The weight of the gate must also be supported to relieve weight from the hinges.

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Receives Power

The power system only has one subsystem which is to monitor the closure status of the gate, since the mechanism can only draw power to release the latch. The mechanism must receive power and direct it to the latch to allow movement of the gate.

Compatibility

The compatibility system is divided into three subsystems: mounting, latching, and stationary. It is crucial to the structure of the system that the mechanism is mounted to the gate and gate post securely at a level height. When the gate shuts, the lock must remain closed, so the gate remains stationary. The latching of the gate needs to account for bouncing and sagging, in the x and y directions respectively, so that the latches remain aligned.

Cross Reference Table

A functional decomposition cross reference table is used to establish the relative importance of the major functions, or systems, of the hierarchy chart. The importance of the major functions will be dependent upon the number of minor functions that interact with them. To develop the cross-reference table below, Team 510 reviewed the hierarchy chart. The four systems were considered the major functions, while the corresponding functions were considered the minor functions. The two types of functions were each put on an axis of the cross-reference table. Beginning with the first minor function, each box in that row is to be marked if the major function corresponding with that column is dependent upon that minor function.

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Table 1: Functional Decomposition Cross Reference Table

	Systems			
Minor Functions	**Resistance**	**Lock Mechanism**	**Receives Power**	**Compatibility**
Resist Mechanical Wear	**X**	**X**		
Account for Thermal Expansion	**X**	**X**		
Resist Environmental Factors	**X**			**X**
Release Passively		**X**		
Engage Lock	**X**	**X**	**X**	
Relieve Gate Weight from the Hinge		**X**		**X**
Draw Power to Release Latch	**X**		**X**	
Mount to Gate Post	**X**			**X**
Keep Gate Closed		**X**		**X**
Account for Bounce in X-Axis		**X**		**X**

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Account for Sag in Z-Axis		**X**		**X**
Function Ranking	**3**	**1**	**4**	**2**

Smart Integration

By calculating the amount of "x" in Table 1, the primary system highlighted within the functional decomposition is the lock mechanism. This system has eight out of eleven minor functions connected to it. Most of the minor functions directly impact the locking function and can be managed through design control, while the remaining functions cannot but must be accommodated instead. The compatibility and resistance systems are matched in importance for the functional decomposition. Since Team 510 is designing a universal product, it is taken into consideration that not every consumer will have the same factors, i.e. gate type, gate post type, environment, or installation. Different scenarios are considered. Coming from the customer needs, the project should not rely too much on power. Thus, the last ranking system receives power. It has two minor functions: engaging and releasing the latch.

Action and Outcome

The main purpose of this mechanism, based on the previously explained function, is to close and lock a swinging gate. The overall outcome of this is to create a gate lock mechanism that accounts for misalignment caused by sag, which can be achieved by redesigning the gate latch itself. For this to occur, the mechanism must engage the lock, as this minor function affects the most major functions.

Functional Resolution

The product should ideally utilize power to unlock the latch, allowing the gate to be opened by the gate opener arm, while accommodating potential misalignment from vertical sag and horizontal bounce, and ensuring the gate is securely closed, all while being compatible with various swing gate designs.