

# **J&P Industries: Flood Environment Housing and Next Generation Family Cars**

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## **1 Abstract**

In our engineering class we were given the task of designing and engineering a house that could withstand a flood and accommodate a family of five people, one of them handicapped, and a pet. We also enhanced a 4-wheel drive chassis to create a car this family could use. This paper details the research and design of the products.

## **2 Corporation Overview**

J&P Industries is a company that prides itself on the safety and functionality of its products. While other companies may immediately get a nail and hammer once an idea pops into their head, we take the time and effort to plan our projects, adding the quality and safety that are essential to our philosophy.

## **3 The Amphibian: Housing for Flood Areas**

### ***3.1 Product Overview***

People live in flood areas all over the world, from the Netherlands to New Orleans. For centuries they have been dealing with the consequences of living in these areas: belongings lost and homes destroyed. This destruction has both an emotional and financial impact on these people, who need to completely rebuild their houses and replace furniture and other necessities. Today, there is a great need for a solution to this problem so that people do not need to restart their lives after every flood.

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To solve this problem, J&P Industries has designed a new style of housing that will be able to withstand devastating floods. The Amphibian is a state-of-the art modern housing style designed to ensure that both people and their possessions will be safe in the case of a flood. These houses are adaptable based on the flood levels of the area in which they are placed and the size and demographics of the families they serve. Our basic model easily accommodates five people and a pet; it is even equipped with an elevator to ensure handicapped accessibility. Our versatile, flood-proof houses will guarantee that people will never again have to start over from scratch when a flood hits their town.

### *3.2 Research*

To ensure that these houses were truly suited for flood areas, we did research on the types of floods that the house must be able to withstand and on ideas that already exist or are being developed to solve this problem.

We began by looking at the flood levels that devastate many areas in the American Midwest. Floods are categorized as a yearly flood (however, this is not considered a flood by many because water does not uniformly cover the landscape), a 10-year flood, and a 100-year flood. A 10-year flood comes on an average of 10 years, and does not usually rise above 6 or 7 feet. However, a 100-year flood can rise as high as 11 feet or more. People around the world have experimented with various solutions to this problem.

We researched different places around the world where flooding is regular. The houses were able to adapt in various ways, from becoming a boat to having a waterproof veneer around the exterior. Holland is an example of a place where people have been engineering constantly to push back the water. The marshy soil on the coastline was extremely fertile for farming, but the potential farmland was subject to tidal flooding. A permanent dam would not suffice, as the sponginess of the soil, so useful for farming, actually leaked water underneath the dams. Hundreds of years ago, Dutch farmers used the most

abundant renewable energy source around to pump harmful saltwater out of their farmland: the wind. Windmills use the power of the wind to constantly pump the leaking seawater back into the ocean. In Holland, where more than half of the land is below sea level, dams and windmills together create the most feasible solution. Though formerly able to combat tidal flooding, the dams and windmills are becoming insufficient to handle the rising waters caused by global warming. Recently, architects have teamed up with environmental engineers to create a new type of house, a house that could potentially rise with the water. However, this solution poses another plethora of problems. For instance, the plumbing, electricity, gas, and sewage would have to all be safely disconnected or extended as the house rose. On the other hand, some houses in New Orleans use a different method to overcome hurricane-induced flooding. FEMA recommends either raising the house or building a veneer around the exterior. We decided that the most economically feasible way to create a house that would be nearly impervious to flooding would be to build one that was raised one floor, high enough to evade a 100-year flood.

### *3.3 Selection and Preparation*

After our research, we were able to develop a model that we believed would work the best for flood-area housing. Instead of designing a house that floats with the water level, or is surrounded by a steel wall, or sealed to be waterproof, we decided to design a house that was permanently elevated. The main reason for this choice was that an elevated house was the most effective way to limit the repairs needed after a flood while still being cost-effective. Both the steel wall and the waterproof house require scarce and costly materials. Also, they are not very practical. The base of the steel wall would need to be placed very deep into the ground to prevent it from sliding around when the ground gets wet. Because dirt turns into mud when mixed with water, it is possible that the ground the wall is buried in will become too soft to hold up the wall against the pressure of floodwater. The waterproof house is not practical either, because it would be very hard to ensure that all parts of the house were coated and the doors and windows

completely sealed when closed. While the floating house did not have these problems, it did have another, that of utilities running through pipeline and cables. When the house rose, the plumbing and electrical wires would not rise with it, and as a result would either break due to the force of the rising or would have to be severed to allow the house to rise in the first place. This would then later require a full rewiring of the house's electrical system and a full reworking of the plumbing and sewage system, an arduous and expensive task. Clearly, these designs are deficient in several ways. On the other hand, an elevated house is cost-effective and practical and does not have this utilities problem.

### *3.4 Conceptualization*

While there are other designs of elevated houses, our houses have several unique aspects that make them stand out from the rest. Instead of simply wasting the space under the house, we made part of the space into a garage, since cars would be exposed to the flood in any case, and some of the other space we made into storage space for items that could withstand exposure to water. We also left space under the house that could be used as a covered outdoor area. There is a pet area on the third floor to provide access to facilities like play areas. The house also accommodates handicapped people by offering an elevator and a suite on the first floor. We also have a dock that is necessary because it allows food, water, and other supplies to be transported into the house by boat. It also ensures that the family will not be trapped inside the house during the flood. These aspects of our house's design make it a distinctive choice for housing in flood areas.

### *3.5 Synthesis and Product Details*

#### *3.5.1 Materials*

The main materials used in the design of the model of the house are wood and hot glue. We made all of the walls and floors as well as the elevator and the elevator shaft out of sheets of balsa and birch wood. We made the stairs and the dock out of Popsicle sticks. To attach the various pieces of our house together, we used hot glue. To raise the house, we used wooden pillars, and we also used wooden pillars as rafters to provide support for each level of the house. The walls are reinforced by wooden pole cross-sections. The whole house is built on a foam board foundation.

#### *3.5.2 Improvements*

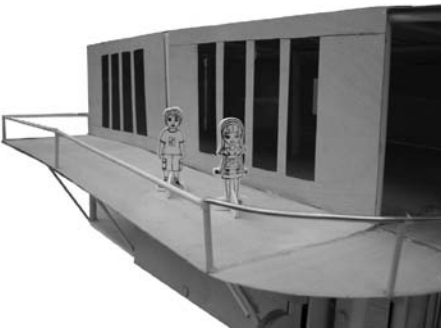
In the process of designing the house, we made a few alterations and improvements from our original plans. One improvement was an above-ground greenhouse, although the owner can choose to make it part of the interior of the house or a sunroom. This garden allows one to grow fresh fruits and vegetables even in areas where houses are placed so close together that there is little room for gardening. It also provides people with a potential source for fresh food in a flood, because the greenhouse walls shelter the plants from the elements. We also changed the design of our dock. Originally, we were going to have a set dock from which one could raise and lower a raft. But this design had the potential for failure since it would be hard to raise and lower a raft with people in it by hand if the electricity were to fail, as often occurs in a flood. So, we changed the design, and our house now has a dock that adjusts to the water level. One end is secured to the house, while the other end, where the raft is located, is free to float as water rises. This eliminates the need of lowering and raising the raft by hand and makes the raft handicap-accessible. These improvements help to make our design more accommodating to all people and provide for a better quality of life during a flood.

### 3.5.3 Figures and Photos of Product Details



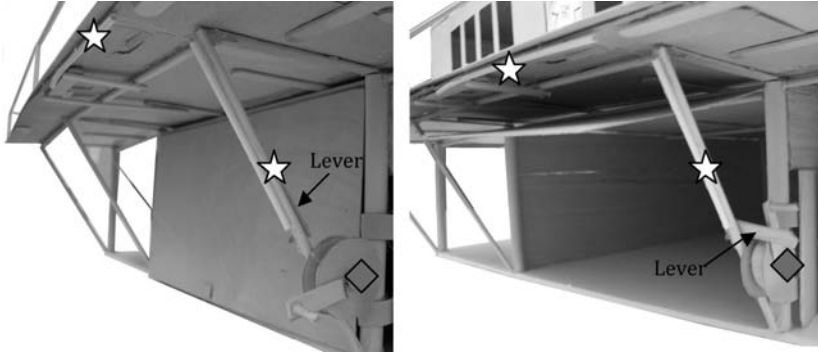
**Photo 1:** *Whole house.*

At this stage the house is still incomplete, since the top floor still needs walls and the garden has not yet been added. But the overall appearance of the house is clear. The stairs and the elevator shaft can be seen on the bottom right. The garage is in the middle of the bottom. The second floor windows are designed to maximize natural lighting inside the house.



**Photo 2:** *Second-floor balcony and windows.*

Photo 2 is a view of the second-floor balcony and the windows of the dining room (left) and the living room (right). People have been placed on the patio to provide a sense of the scaling of the house. As one can see, the house has fairly high ceilings and the balcony is quite large. There is more than enough room for the family to eat dinner outside or to simply enjoy a nice evening together. The safety railing was added to stop people from accidentally slipping off.



Photos 3 & 4: Garage door and crank system.

Photos 3 and 4 above show the garage and the crank system used to operate the garage door. The photo on the left is of the closed garage, while the photo on the right is of the opened garage. The white stars indicate the location of the white tubing containing the cable that connects the door and the crank. The crank system is visible beneath the grey rhombuses. On the left the crank is in the “rest” position since the garage door is closed. On the right, the crank is in the upright position and is kept from unwinding by a lever (labeled in both pictures) that moves up and down.

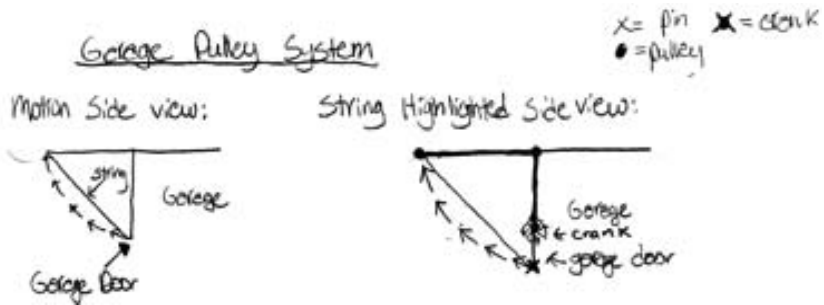


Figure 1: Garage pulley system.

Figure 1 shows the various components of the garage pulley system and how the system works. As the crank is turned, the string gets pulled and shortened and the garage door rises.

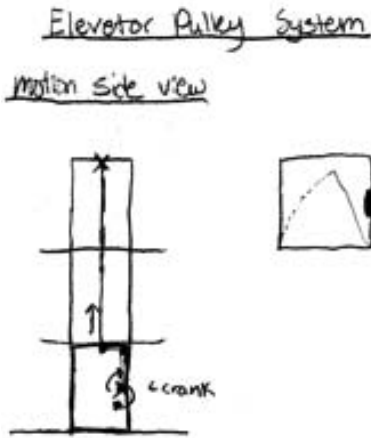
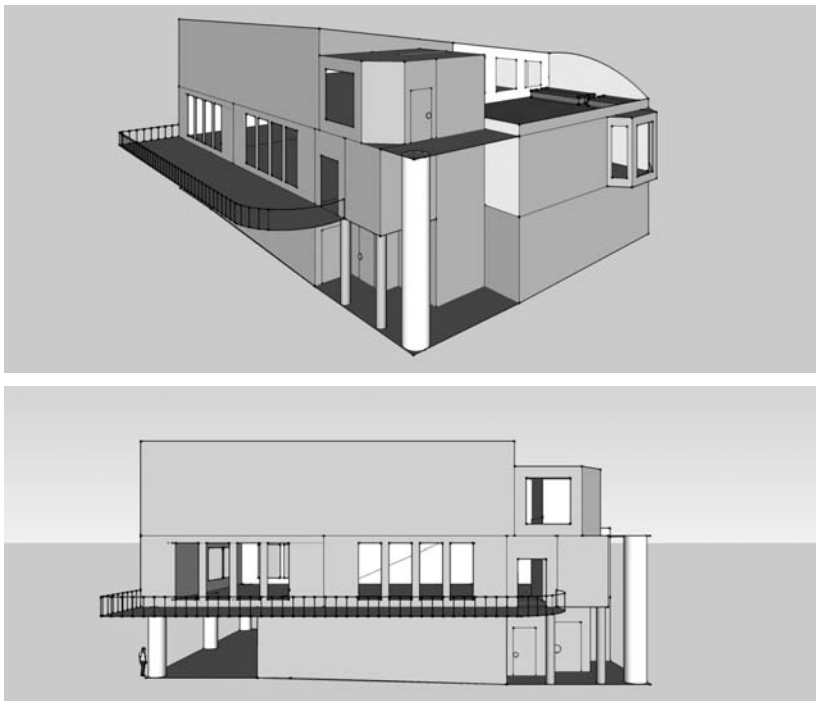


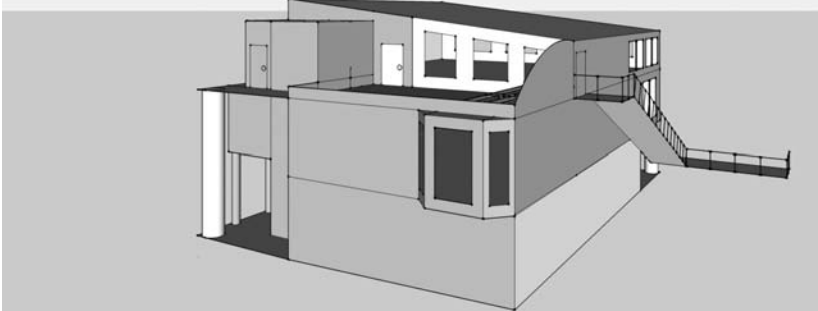
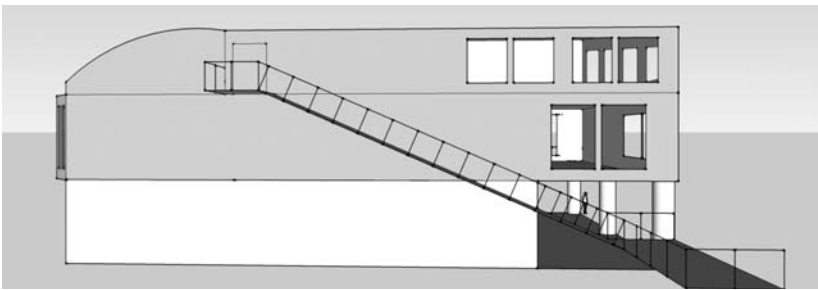
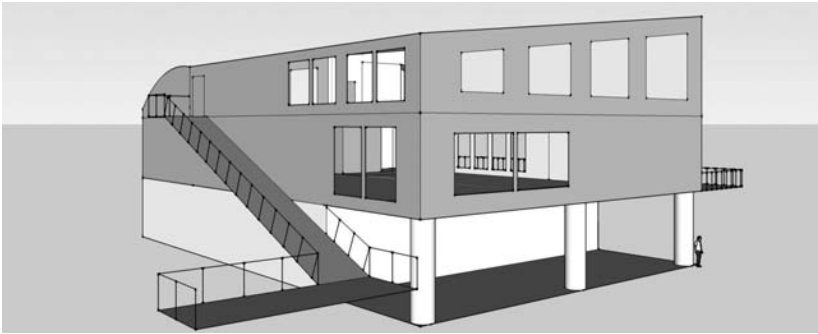
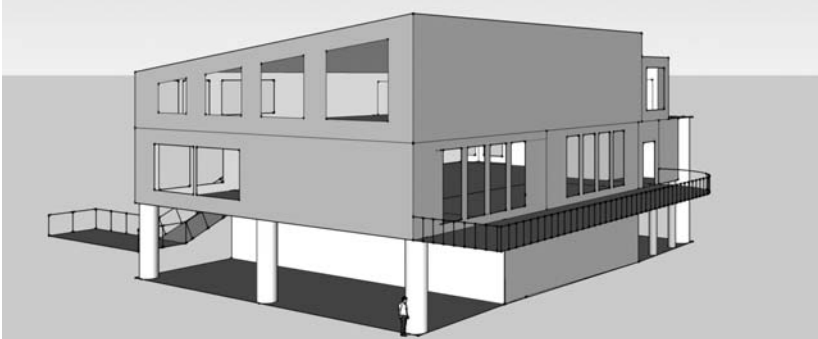
Figure 2: Elevator Pulley System.

Figure 2 diagram highlights the elevator crank system. As one turns the crank, the string shortens and the elevator rises.

3.5.4 Google Sketch Up Drawing of House (Several Perspectives)







### 3.6 *Evaluation*

When we came to build the model of our house, we had to take certain measures into account. The first was the size of the house. We originally had quite a large design with many more rooms than our current design has, but we had to take into account the limited size of the base of the house, which was dictated by the size of the available foam board foundation. As a result of this limitation, we had to consolidate our design and make sure every bit of space was used as efficiently as possible. Limiting the size also reduced the cost of the house since fewer materials were needed and all of the materials were being used as efficiently as possible. We also had to take into account the size of the people to make sure the scaling was right for the height of each floor, for the distance between each step on the stairs, and for room sizing.

When we were building the model, we also realized that we would have to change details other than size to meet our design goals. For example, we had to change our elevator pulley design, because our original design of having a horizontal series of pulleys laid flat across the top of the elevator was not feasible. Instead, we changed it to a vertical pulley system that attached to the top of the elevator shaft at one end and to the top of the elevator car at the other. We also changed our original pulley system used to open the garage. We decided that the best way to design a mechanism to lift the garage door was to attach one side of the cable to the middle of the door and then pass the cable through a series of pipes to lead the cable to the crank. This way the cable would stay in place and the door would open easily. Overall, our finished product did fulfill all of our design goals: a house that can withstand a flood, is handicap-accessible, and is comfortable while being commercially feasible and cost-effective.

### 3.7 *Optimization*

At J&P Industries, we are always focused on the future, developing new products and improving previous ones. Thus, while this generation of amphibian housing will keep people and their belongings safe from

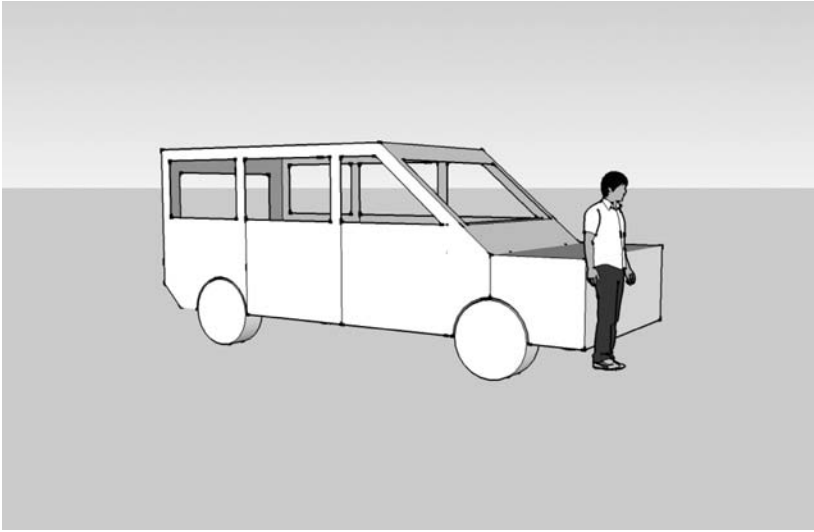
floods, we also have several plans for new features and enhancements that we plan to add in the next generation of houses to further improve the utility and practicality of these houses.

One of these new features is the addition of solar panels to the house as an alternative means of supplying energy. The addition of these solar panels would not only make the house more eco-friendly but would also provide a back-up source of energy during a flood if the power lines were down or if electricity were simply shut off. Because UV radiation, which is what solar panels use, is able to pass through clouds and thus reaches Earth even in cloudy conditions, these solar panels would ensure a supply of electricity to cook food and gain access to information during a flood.

Another new feature we plan to add to our current design is a better drainage system. While the house does have a slanted roof and slightly slanted deck to allow rainwater to runoff, it does not have a complete drainage system. So we plan to add gutters along the edge of the second-floor deck and the roof and then down the side of the house to provide a pathway for draining water to the ground. We also plan to add a drainage system to the above-ground garden. The base of the garden bed will be a three to four-inch deep slanted box made of metal. The end at the edge of the roof will be open, so water will catch in this metal box and then travel off the roof. The above-ground garden will be lined with sand to allow for the most water retention, so that the water does not simply travel through the dirt and out the metal base.

A third new feature that we plan to include in our next design is an elevated garage. Currently the garage is on the ground floor, meaning that in a flood any cars inside the garage will be damaged. To guarantee that even cars are safe in a flood, we plan to make the garage an extended part of the second floor. There will be a ramp from the ground to the entrance of the garage to get the cars up to the raised garage. These improvements and enhancements will polish our current design to make the house even more convenient and accommodating.

## 4 The Legacy: The Next Generation of Family Cars



**Figure 3:** *The Legacy.*

### **4.1 Product Overview**

Automobiles have the highest rate of accidents among all modes of transportation. This is because the driver of a car is in full control, whereas planes, trains, and boats have auxiliary systems that can step in and help prevent accidents. Most new airplanes include a fly-by-wire system, where the pilot's control of the yoke is not directly related to the maneuvering of the plane.

We decided to combat the fundamental cause of most car accidents, human error. If a driver failed to notice that he or she was in imminent danger, an auxiliary system could use motion sensors as part of safety systems to stop the car before a collision occurred, helping to prevent serious injuries to the driver and passengers. We have also made the car more family-friendly by adding two more doors to the traditional four-door car. Easy access to the back seats allows every member of the family to get in and out quickly.

## 4.2 *Research*

### 4.2.1 *Suspension Systems*

The suspension system is a necessary aspect of any car. Increasing the friction between the car's tires and the road allows the driver to steer the car. It also makes the ride of the car more comfortable. The reason it is so important is that roads are bumpy, and when a car travels over these bumps, the wheels are pushed upwards. Without the suspension system, this vertical acceleration would cause the wheels to lift off the road and then come crashing down.

There are four main types of suspension: the coil spring, the air spring, the leaf spring, and the torsion bar. The coil spring is most common and works by compressing and expanding as the wheels move. The leaf spring is an older form of suspension used mainly on trucks. The torsion bar is a bar that attaches to the wheel and the car's frame (it works by twisting as the wheels move). The air spring works by a compression and expansion of a gas-filled chamber, providing resistance in either direction.

### 4.2.2 *Accidents and Collisions*

Over 6,000,000 accidents occur every year in the United States, and over 40,000 people die every year in these accidents. Up to 75% of these accidents occur at low speeds on city streets, usually because the driver is distracted. Car accidents are the leading killer of children in the United States. About 700 children die every day in car accidents.

Various safety precautions have already been taken to reduce these numbers. All cars now come equipped with seat belts, and special car seats have been developed to keep young children safe. But these steps are not enough. Some car manufacturers, like Volvo, are developing sensors that slow down or even stop the car when triggered to prevent an accident. According to Volvo, this new system could reduce whip-lash injuries by 50% and could drastically reduce damages to cars in low-speed accidents.

### 4.3 Conceptualization

We decided to focus on safety in the development of our car. There are several family- and safety-oriented cars on the market, but ours has some unique design features. First, it is a six-door car. This makes all the seats easily accessible, so any family member should be able to sit in any seat. The headlights are green when the car is going forward and red when going backwards. This notifies other cars on the road of the direction the car is going. Our design also includes proximity sensors that activate when the car gets too close to any object in front of it. When they activate, they bring the car to a stop to prevent a collision. The design also includes three roll bars on the top of the car as well as metal bars along the doors. The roll bars ensure that passengers will not be crushed or otherwise injured if the car rolls over. The metal bars in the side of the car provide protection to passengers sitting on the side in case the car is hit from the side. These bars will protect side passengers from a potentially fatal or crippling accident. These main design features make the car safe and family-friendly.

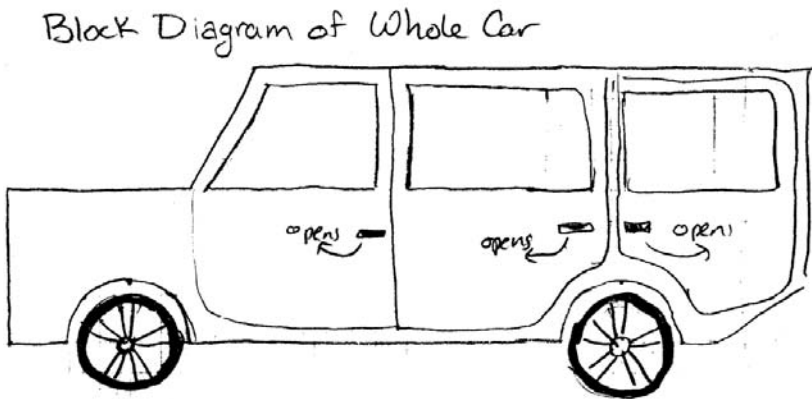


Figure 4: Whole Car.

Figure 4 shows the three doors on each side and the direction they open in.

## *4.4 Synthesis and Product Details*

### *4.4.1 Materials*

We used several different types of materials in our car design. The car has a wooden chassis and a wooden frame and body. It also has a metal axle and metal spring suspension. The car also has a small but powerful motor, headlights that change color depending on whether motion is forward or in reverse, and turn lights. Four 3 V batteries are used to power the motor and both sets of lights. Conjoined parts are attached using hot glue, with the exception of the electronic parts that are soldered together.

### *4.4.2 Improvements*

While developing our car, we came across various problems. The first problem we came across was the length of our car. The basic car size was not long enough to accommodate the six-door car we were designing. So the first improvement we made was to extend the axle of the car. This was an important enhancement because it expanded the size of the car so that three doors were able to easily fit on each side and there was more legroom.

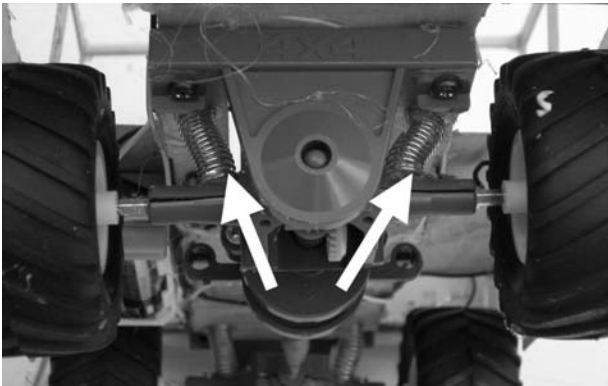
Another improvement to our original design was that we altered the suspension to a spring suspension from a beam suspension that worked by connecting one front wheel with the back wheel on the same side with a flexible piece of metal wire. Instead, the suspension is now attached separately to each wheel, which allows the car to drive over large bumps since the front and back wheels can rise and fall independently of the others. The spring suspension is also able to absorb more energy, which results in a smoother and more comfortable ride. The last improvement we made was to add turn signals to the car. Turn signals are important because they are essential to optimizing the safety of the car. They serve to inform everyone else on the road of the driver's aims and allow them to prepare for this.

#### 4.4.3 Figures and Photos of Product Details



**Photo 5:** *Whole car view.*

Photo 5, a view of the whole car, is an incomplete image, but it shows the headlights and the six windows that will become part of the six doors.



**Photo 6:** *Spring suspension system.*

Photo 6 shows the car's spring suspension system. The white arrows point to the springs that make up the system. This feature allows the wheels to rise and fall so the car can get over a bump. It also helps absorb shock to reduce the bumpiness and choppiness of the ride.



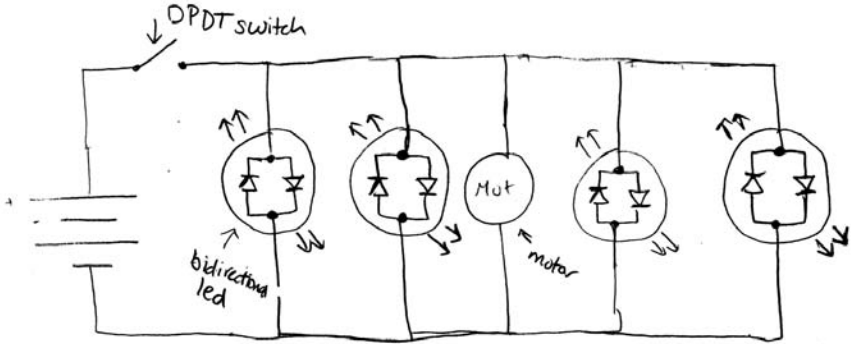


Figure 5: Motor, headlights, and taillights circuitry.

Figure 5 is a circuit diagram of the bidirectional motor of the car and the bidirectional LEDs used as headlights and taillights. The motor and the lights are connected in parallel, and there is a DPDT throw switch to control the direction of the current and thus switch the direction of the motor and the color of the lights.

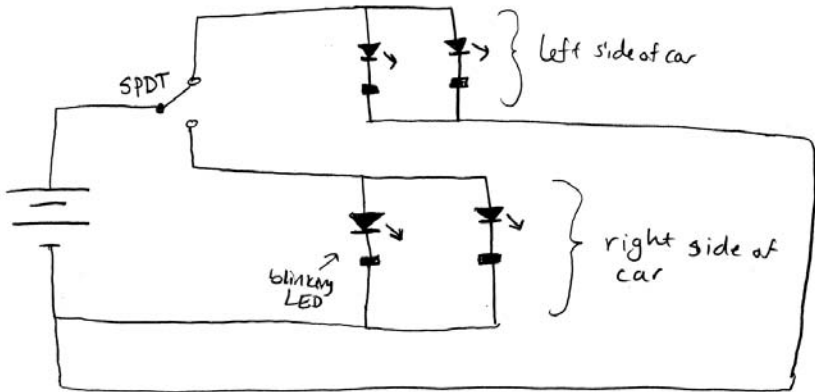


Figure 6: Turn signal circuitry.

Figure 6 is a circuit diagram of the turn signals on the car. There are four turn signals, but they are connected in two sets of parallel circuits made of two turn signals each. So when the SPST switch is pushed to the right, the two right turn signals turn on. But when the SPDT switch is turned to the left, the left side turn signals turn on.

#### 4.5 *Evaluation*

Our original design goal was to create a hovercraft that had motion sensors to help steer the hovercraft, since they tend to be hard to control. But after getting feedback on this idea and brainstorming about it, we decided to change our design goals completely. This is because we decided that it is not a commercially viable product; a hovercraft simply takes too much energy to run, and thus is not cost-effective or realistic. Our new design goals were to design a car that was safe and family-friendly.

We did fulfill some of our new design goals, but because we did not receive all of the materials we needed, we were unable to fulfill all of them. We did succeed in making the car family-friendly and eco-friendly by creating a lightweight car with six doors. We increased the safety of this car by adding forward and reverse headlights as well as turn signals. But we were not able to set up the proximity sensor system, which was supposed to prevent accidents by stopping the car if it got too close to another car, because we did not receive proximity sensors in time. Consequently, our corporation decided to add this feature into the next generation of J&P Industries' safety and family cars.

#### 4.6 *Optimization*

Since we are always looking to improve our products, we already have a few enhancements we plan to add to the next generation of the "Legacy" car model. The first new feature we plan to add is a brake system with brake lights. Currently, our car can only start and stop, so we plan to add a brake system that allows the car to slow down as well, an important feature for safety and comfort since the sudden stop can both jerk the passengers and surprise other drivers on the road. Another performance enhancement we plan to add to the next generation of safety vehicles is a more elaborate and detailed sensor system. This system will measure the car's speed and the distance between the car and any object in front of it. Using this information, it will calculate whether the car is traveling at a safe distance behind the car or not. If the distance is not safe, they will lightly trigger the brakes to slow the

car down until it is at a safe distance again, instead of just stopping the car as it does currently. The last feature we plan to add is a rearview camera. Because the car is long and larger than average, it may be hard to see what is going on behind the car. The rearview camera will help drivers see what is behind the car to make sure they don't back over any objects or hit any unseen people. These important new features will serve to increase the safety of the car. ●

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