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## The Stages of Engineering Design

Engineers go through the stages of engineering design when developing or innovating a product. These stages include recognizing the need, identifying the problem, gathering research, generating ideas, comparing and selecting the best idea, analyzing this design, testing prototypes, and finally communicating the design. Harley Davidson implemented this process when developing the V-Rod motorcycle.

The first step they took was recognizing the need for a new model because they were losing customers to competing companies. These new companies were creating faster motorcycles based off the design of race cycles. The next step they took was defining the problem. To keep the allegiance of their customers, they wanted the bike to scream Harley but also have the speed of a race bike.

They first gathered inspiration from dragsters. They needed a liquid cooled engine instead of an air cooled one. This would enable them to build a faster bike. Harley Davidson wanted to build something that was revolutionary to the motorcycle business and bring the spotlight back onto themselves.

The next step Harley took was generating ideas that would allow them to have a breakthrough design. One example of this was creating the frame from two rails instead of one. This allowed them to fit the larger engine in the frame as well as create a sleek design. They also included a radiator which was new to Harley bikes and also used a plastic gas tank instead of their traditional metal ones.

Harley worked with Porsche to design an engine that would be powerful, fit into the frame, met emission and sound requirements, and be cost effective. The team of engineers had to compromise between having an aesthetic and practical design. An example of this was with the radiator. They added fins to the sides of it to get better airflow. It allowed the air to better circulate through the radiator, but it also was fashionable. Harley selected the long handle design from custom bikes and put them into the bike. They did this by changing the angle of the front steering chamber. This made the bike have a sleek custom design without losing steering control. The design team also spent over a year picking a name for the bike that would appeal to customers, but did not violate trademark names or patents.

The sixth step that the Harley team took was to analyze the components of their new bike. They constructed a clay model because it allowed them to easily change the parts that they didn't like. The designers also added the exhaust and plastic gas tank to this clay model. The team chose to hydro form the aluminum chassis for many reasons. It allowed for fewer welds so the bike looked a lot nicer, and it made the frame a lot stronger. Once the bike was created, they put it through multiple tests. Harley put the bike in a copper wall room filled with radio waves to ensure the bike would not short out due to high levels of radiation. Another

issue they needed to resolve was meeting sound standards. The bike was placed in an anechoic chamber to make sure it sounded like a Harley, yet meet standards.

The next step of the engineering process was to test their prototypes for weaknesses. All of the bikes were spray painted black to make sure nobody would steal their designs. They simulated the Dusseldorf test on the engine to see if it could run for 500 hours on rough terrain. This included rough hills, bumps and high speed sections. The bike was also sent to Arizona to test how the bike handled long period of idling in hot conditions. The V-Rod was driven for an hour and then placed in a heat shed for an hour. This repeated all day to ensure it could withstand bike parades. The bike was also sprayed with high pressured water for thirty hours to check for water tight seals. After these various tests, the bike was manufactured in Kansas City, Missouri. Special robots were used to build the bike in this state of the art facility.

Harley communicated the final product in the form of a show where they revealed it to the public. They presented information about the bike such as speed and gas consumption through charts and graphs. Throughout the design process, various engineers communicated with the design team to ensure everyone was on the same page. It was important that they communicated their ideas clearly so the design team could develop a functional bike.

The stages of engineering design proved invaluable to Harley Davidson in creating the V-Rod. It took six years of trial and error to develop a bike that was revolutionary for its time. After many years of hard work, the V-Rod was ready to hit the road.