I. Recognize the Need
   A. Market Pull
   B. Technology Push

- Harley Davidson’s business was suffering as a result of faster sportbike models becoming increasingly popular. The company realized in order to be able to compete with these bikes and grab the market’s attention, they would need to make some design changes to current Harley’s, or design a new one. There was a need for an introduction of new technologies to revamp Harley Davidson’s business. Harley had multiple ideas such as implementing a new VR-1000 engine, a liquid cooling system rather than the normal air cooling system, and a totally new bike design, and the introduction of a radiator. All of these technologies were needed to compete in the market and redefine what Harley Davidson stands for.

II. Define the Problem

- Harley Davidson had not released a new model of bike for a significant amount of time and the company was losing customers to newer/faster sportbike models. Harley Davidson wanted to create a new bike of their own that was more technologically advanced and had greater performance capabilities (speed, acceleration, sound) while still maintaining the iconic Harley look and handling. Another problem that the company had was that they didn’t want to pull any existing parts and designs from other bikes and wanted to completely build a new bike from the ground up. This made for a much more difficult challenge. Also, the engine (VR-1000) that they wanted to put in the bike, was too powerful for any existing bike chassis/skeleton and therefore a new chassis had to be designed.

III. Gather Information

- They looked to Harley Davidson’s racing bike division for ideas for the new more powerful model. The engines in the racing bikes were liquid cooled and could rev at a much higher rate which gave it more power. The bikes also had a stronger frame to deal with the stresses that came along with the extra power from the liquid cooled engine. They also pulled inspiration from drag bikes, designing the new V-Rod to be more direct and use parts to increase its acceleration.

IV. Generate Conceptual Ideas
   A. Brainstorming

- The design team was lead by Will G. Davidson. He and his team first sketched out profiles for the bike trying to create the classic harley look but with a bit extra power into it. They took those ideas to CAD programs to create a more detailed idea of the bike. The
team worked in tandem with the engineering team to make sure their designs were possible. There was a constant back and forth between the teams where ideas were shot down by both sides. Once a relatively complete design was approved by the engineering team they went on to create it out of 3d materials to get a better idea of how the bike would look in reality.

V. Compare, Combine and Select Ideas

- The name for the bike, the V-Rod, didn’t come easy. It took them over a year for them to decide on that name. They ended upon a combination of the engine name, VR1000, and its dragster influences, hot rod. Harley pulled consultants from porsche, master engine designers, to get fresh eyes on the issues posed by using the new liquid cooled engine. They ran into issues with the original single bar frame so they switched to a double bar frame which gave more support but it kept the classic shape of the Harley Davidson. The gas tank had to be moved to under the seat because with the larger engine it didn't have enough room for gas; they also decided to fabricate the gas tank out of plastic because it is more heat resistant and is a lot more form fitting which solved the problem of inadequate amounts of fuel.

VI. Analyze and Design

- They used clay often during the design process, especially while working with the exhaust. Because the exhaust needed to have a large amount of air circulating through it, the design team was tasked with making it look very good to the consumers’ eye. This was also the case for the new radiator, which also needed a lot of airflow. Originally, the radiator did not receive enough air, so the team installed flaps that caused a “vortex-like” flow into the bike. Though the radiator had to look good, it also needed to be efficient. Thus, the engineering team worked closely with the design team to create parts that were both appealing to the eye and producible and practical in the entire scheme of the bike.

VII. Fabricate and Test Prototypes

- The welded the first prototype in the Harley-Davidson machine shop and tested it. While doing that, they found out that there was no place for the gas tank as the engine took up most of the space and then they decided to place it under the seat. Frank then built a full scale model of the engine using fibreglass frame, a couple of tires and modelling clay. After all the fabrication was done, the V-Rod was put through various tests. They tested the parts for road durability (approximately 80,000 miles over months of driving), heat and weather durability, and water intrusion. They even perfected the sound of the bike in a special Echoic chamber. They also ran the engine in a simulator for 500 hours straight until they found an engine that would hold up to all the stress.
VIII. Communicate the Design
   A. Verbally
   B. Graphically
   C. Written

- Through the entire process, the engineering team thoroughly documented the nuances of every part. This made it easy for their factory assembly lines to be able to produce the bikes in mass quantities. It also opened doors for improvements of the model in years to come, as well as customization of the original V-Rod. Harley-Davidson finally unveiled the V-Rod at their dealer show in Los Angeles in 2001. After six years of work, the V-Rod was now able to be mass produced and sold to the public.