

## The Evolution and Impact of DC Motors: A Reverse Engineering Analysis

### Introduction

Throughout our history, we always look for ways to innovate technologies to ease our way of living. We aim for automation in all jobs we do. Why? To be efficient and to increase productivity by achieving faster cycle times.

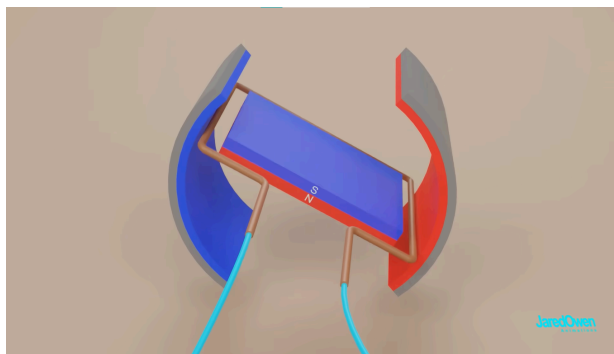
One example of it is the innovation of DC electric motors. DC Electric motors or DC motors are the basic electro-mechanical energy converter that makes use of angular momentum, electricity, and magnetism along with Faraday's theories of electric current, Tesla's, electro-magnetic theory, and inertia alternating current theories [1]. DC motors are very versatile pieces of machine, they can be found in all sorts of devices, from your computer, most likely has two: one that powers the cooling fan and another that rotates your hard drive. In a bedroom, motors are found in hair dryers and numerous toys; in a bathroom, they are found in extractor fans and electric shavers; and in a kitchen, they are found in almost every appliance, including dishwashers, clothes washers, coffee makers, microwaves, and electric can openers [2].

DC motors are widely used because of their efficiency and automation when generating rotational power from electricity. This paper will conduct the reverse engineering analysis of electric motors. To understand how it is innovated and the importance of this invention in our modern day lifestyle.

### Dc Motor

As with any inventions that have been made, DC motors also got their final form from different discoveries and theories from different scientists and inventors. What makes DC motors special is their ability to convert electric power to rotational force using different kinds of components that are grouped as rotor and stator, which are structured together perfectly.

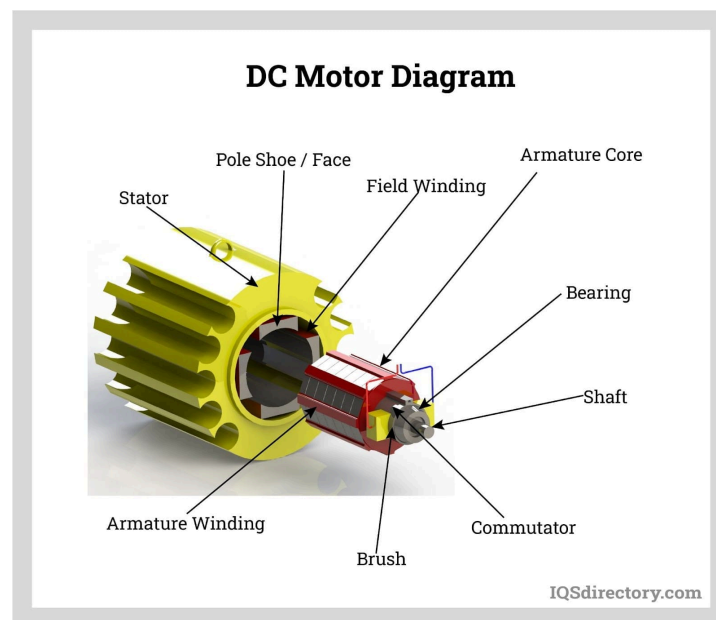
DC motors consist of two major parts: the rotor, which is the component that spins, and the stator, which are the static or immovable parts of the motor. The rotor has five parts, namely the shaft, armature, brush, commutator, and the armature windings. The shaft is the main rod that goes through the motor. The rotational force generated passes through the shaft and converts into mechanical energy. The armature is the winding of coils that carries current and transforms it into electromagnetic energy. It creates a magnetic field, which is the foundation of electric motors.



<https://www.youtube.com/watch?v=CWulQ1ZSE3c>

Commonly, there are two brushes in a DC motor. These brushes are spring-loaded, which makes constant contact with the commutator. The commutator is a split ring that delivers electric current to armature windings, based on the interaction between North and South poles in a DC motor. The rotor rotates due to the armature's north pole being drawn to the field winding's south pole, generating steady torque in a single direction. Since the DC motor works because of electromagnets, meaning more wires wrapped around it creates more torque. With the help of the armature windings, it produces more torque since it creates more electromagnetic force [3].

While the stator, it consists of non-movable parts. The frame, sometimes referred to as the yoke. It holds the whole mechanism together and protects it from outside influences that can damage the parts inside. To charge the static magnets attached to the yoke, field windings, which are made out of copper wires, charge the static magnets [3].



<https://evbn.org/electric-motors-types-applications-construction-and-benefits-1677780790/>

DC motors are used everywhere from simple inventions to big machines. Its primary purpose is to generate rotational motion from an electrical source, which many people need since electricity is the main source of power in our era. Moreover, its performance is remarkable for a low cost and energy efficiency [4]. DC motors are incredible in generating torque at low speeds and its precise rotational control which many engineers and inventors want for their machines [4].

## **Application Of The Engineering Design Process**

### **Recognizing the Need**

The problem before, industries needed efficient automation methods for manufacturing, pumping, and transportation, and DC motors provided electricity-powered machinery, making it easier to control and distribute than steam engines.

### **Defining and Understanding the Need**

Developing the motor, it has to be energy efficient, durable, compact, and scalable, and it features controlling the speed and torque. But during the time where the DC motor was theorized, many implications were presented. There are limitations on resources and its costs. Additionally, engineers have to find a way to reverse the current direction without harming the other components.

### **Preliminary Research and Preparation**

The DC motor's main drawbacks were its commutator and battery power cost. William Sturgeon initially created the first working commutator to solve the problem of reversing the current and with the improvement of battery efficiency as research advances, it also solved the issues with its battery [5].

### **Conceptualizing Ideas**

Early design of the DC motor should have explored other factors including armature winding configurations, magnet design, commutator mechanism, motor size and configuration, and energy sources, including testing with batteries and generators to determine compatibility and efficiency, and experimenting with different configurations for application-specific needs.

### **Synthesizing Results**

Designers tested prototypes, analyzed data, gathered user feedback, refined designs, and conducted analysis to balance performance to cost, material availability, and manufacturing feasibility. They used user feedback to identify strengths and weaknesses, and combined successful elements from different prototypes.

### **Evaluating Good Ideas**

Impressive ideas should be evaluated based on performance, reliability, scalability, ease of manufacturing, cost-effectiveness, and safety, ensuring high efficiency, durability, adaptability, simplicity in design, cost-effectiveness, and safety.

### **Optimizing the Solution**

The DC motor design underwent refinements, including an improved commutator, optimized windings, enhanced heat management, material upgrades, and efficiency enhancements, aiming to reduce sparking, wear, and mechanical losses, thereby improving performance and durability.

### **Presenting the Final Solution**

The DC motor's final design was presented to stakeholders through demonstrations, technical documentation, market pitches, collaborations with industries, and proposals for mass production, showcasing its capabilities, reliability, efficiency, and versatility.

**Insights and Observations**

Through DC motors reverse engineering analysis researchers demonstrate how science collaborates with creativity and practical problem-solving for revolutionary innovations. DC motors demonstrate how continued optimization between performance and durability and cost-effective solutions becomes essential when developing equipment for precise regulation and energy-efficiency features. The process reveals both the importance of gathering teamwork and feedback in developing refined designs. Knowledge of DC motor elements together with their operational functions permits us to value their instrumental role in energizing numerous everyday products. Through careful engineering approaches we generate problem solving methods that advance progress while providing technological accessibility for all users.

**Conclusion**

Modern society benefits from DC motors which continue advancing human power by making machines easily operable and performing more effectively. The product resulted from eras of cooperation among theorists presenting complete specimens of scientific progress and collaborative research requirements for developing modern technological solutions. DC motors serve diverse applications ranging from small consumer devices to large industrial equipment challenging three main features: reliability and energy efficiency and precision. A thorough examination of DC motors helps us understand engineering techniques that address problems while enhancing daily life. DC motors serve an essential role in technological infrastructure which drives social evolution through human-made progress.

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