What is Arduino and How It Has Impacted the Hardware World

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1 Introduction

From DIY hobbyists to researchers, Arduino has been an important part of the maker's toolkit. It is a family of programmable boards with additional modules that record and send information. They introduce many hardware concepts to anyone willing to learn. Its popularity allowed the project to grow, providing even more opportunities to develop and experiment without having prior experience with electronics. It sparked the revolution of the fields of mechatronics, *Internet of Things* (IoT) and research. By providing the ground works for change and upgrades, the open-source design became favorite to many people. This allowed the community to expand and continue adding to the ecosystem. With low requirements to start, it became popular to many hobbies, but the vast and powerful systems are utilized by researchers and industry leading experts. This report will introduce the general Arduino system, why it is so popular, its features and how it is used.

2 Main

2.1 What is Arduino & how it became so popular

In its nearly 20 years of history, Arduino has become a widely known and versatile tool. It is a small programmable device. It is like a calculator that runs one program. There is no operating system and it has limited processing power. Metal rods and ports called pins and headers are used to connect wires or input and output devices. This makes the tool very flexible for different applications and allows fast prototyping. USB connector is used to connect to computer and upload code. There are many languages implemented, like Rust, Go, Assembler and Python, but most popular are C and C++.

The first boards were designed at the *Interaction Design Institute Ivrea* (IDII), in Italy and used by students and researchers. The low cost and simple design allowed for fast and cheap experiments with many learning opportunities. It provided simplified programming workflow by eliminating the need for external programming module, introducing better *Integrated Development Environment* (IDE) and implementing a simpler programming language. This made the boards easy to use and more accessible to people with no experience in the field of hardware development. Other boards at the time required external programmers and broad knowledge of programming and electronics before starting to work on projects. The platform stands behind the idea of open-source work, which means that code and systems

are open. People are invited to contribute, change and be creative without restrictions. This helped Arduino rise in popularity.

2.2 Specifications & Features

The boards utilize many micro-controllers, with the most used being *8-bit RISC* (*Reduced Instruction Set Computer*) chips like the atmega328 and *32-bit ARM (Advanced RISC Machines)* chips like the Cortex-M3. Different form factors were introduced to suit different needs. Small systems are designed for faster deployment and confined spaces, while big systems with more *inputs and outputs* (I/O) for experimentation.

Additional sensors can be used to record environmental data. This includes pressure, temperature, light, rotation, movement and more. Even complex sensors like cameras can be used to provide video input. Interfaces like buttons, knobs, sliders, touchscreens can be used to enhance the user experience and make projects suitable for public usage. Output systems were developed like displays and light systems to show information to the users. Some of the modules have smaller chips in them to make the communication between boards simpler.

Another type of board was introduced called Shield, which made connecting to sensors easier. These Shields have built-in sensors and simpler connectors. This helped beginners experiment more with the systems without the fear of messing something up. They can add displays with touchscreen like the “Arduino Giga Display” Shield or get precise location with the “Arduino MKR GPS” Shield. Third party ones, like the “RAMPS 1.4” Shield, can allow boards to become the brains of 3D printers or robots.

The General-Purpose Input Ouput (GPIO) ports allow for direct control of voltage output and reading input. Most of the boards have pins with Analog to Digital Conversion (ADC) input capabilities, while very few of them have Digital to Analog Conversion (DAC) output. This problem is mostly solved by using Pulse Width Modulation (PWM) output.

The boards have many communication capabilities. Protocols are implemented from libraries, like *Inter-Integrated Circuit* (I2C), U*niversal Asynchronous Receiver/Transmitter* (UART) and *Serial Peripheral Interfaces* (SPI). They don’t require any additional system, except a board to communicate with. Different network interfaces modules *(like Bluetooth, WiFi, Modem and Ethernet)* can provide connection to the internet and servers. Libraries help the work flow by simplifying the complex parts of communication and data transfer.

Manufacturers constructed new designs like the “Seeed” and “ESP”. These boards were inspired by the Arduino and the idea of the project. They introduced more built-in sensors and network interfaces in compact systems. This made collecting and sharing data easier. Small teams and people with experience in *Printed Circuit Board* (PCB) design are able to create custom Arduino boards, which expands the ecosystem.

2.4 Uses

Many students are first introduced to the hardware world by the Arduino platform. The project is well documented and many tutorials exist to help anyone start using the platform on their own. This also invited hobbyists to the community. The low barrier to start allows artists to introduce electronics into their works. The powerful features and fast prototyping capabilities invited researchers and industry professionals to use the boards. This inspired the Arduino team to introduce the “PRO” boards, which add more functionality and faster chips. They also upgraded their cloud infrastructure.

The vast ecosystem of input and output extensions allow different robots to be build. The small form factor and network capabilities were heavily utilized in the IoT world. The extendable capabilities of the pins and ports allowed for fast prototyping. The open-source nature of the project makes exploring and expanding the Arduino world possible by anyone.

There are many online examples of projects made with Arduino or other compatible boards. From humble weather stations and clocks to drones and cars. For example, Liong Ma have a wide range of projects, many of them documented on his Youtube channel.

3. Conclusion

The Arduino platform is one of the most important development systems in the hardware world. The extendable functionality, accessible resources and powerful features made the boards very useful in any field. It introduced many people to the hardware and electronics world. It is used from science labs and industry machines to classrooms and home projects. With open-source design and expanding community, the Arduino boards will continue to evolve, teach people and reshape industries.

4. Some of the sources:

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https://www.jaycon.com/arduino-products-what-are-they/ - pre-arduino days information

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