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I'm extremely grateful to my parents for their love, prayers, caring and sacrifices for educating and preparing me for my future. Also I express my thanks to my sister, brothers, sister in law and brother in laws for their support and encouragement.

Special thanks goes to my friends and colleagues, I would never forget all the chats and beautiful moments I shared with you.

I'm very grateful to all the people I have met along the way and have contributed to the development of my research.

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Dedication

This thesis is dedicated to: my parents, who have always loved me unconditionally and whose good examples have taught me to work hard for the things that I aspire to achieve. My brothers and sister, to all my family, my friends who encourage and support me,

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Summary

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INTRODUCTION

Automation is the application of machines to tasks once performed by human beings or, increasingly, to tasks that would otherwise be impossible.

Although the term mechanization is often used to refer to the simple replacement of human labor by machines, automation generally implies the integration of machines into a self-governing system. Automation has revolutionized those areas in which it has been introduced, and there is scarcely an aspect of modern life that has been unaffected by it.

The term automation was coined in the automobile industry about 1946 to describe the increased use of automatic devices and controls in mechanized production lines. The origin of the word is attributed to D.S. Harder, an engineering manager at the Ford Motor Company at the time. The term is used widely in a manufacturing context, but it is also applied outside manufacturing in connection with a variety of systems in which there is a significant substitution of mechanical, electrical, or computerized action for human effort and intelligence.

In general usage, automation can be defined as a technology concerned with performing a process by means of programmed commands combined with automatic feedback control to ensure proper execution of the instructions. The resulting system is capable of operating without human intervention. The development of this technology has become increasingly dependent on the use of computers and computer-related technologies. Consequently, automated systems have become increasingly sophisticated and complex. Advanced systems represent a level of capability and performance that surpass in many ways the abilities of humans to accomplish the same activities.

Automation technology has matured to a point where a number of other Technologies have developed from it and have achieved a recognition and status of their own. [1]

CHAPTER I

HISTORICAL DEVELOPMENT AND IMPACT OF AUTOMATION

1.1Historical Development of Automation

Over time, we've grown reliant on automated technology. It's found in almost every part of our lives, from automatic doors, to factory line robots, to business process automation.

Nowadays, artificial intelligence is the talk of the town, and the dreaded robot takeover seems to be looming ever closer. We have Chabot handling customer service, AI in our back pockets, and increasingly 'smart' homes.

But how did we get here? We explore the history of automation.

1.1.1. History of automation 1925-1945

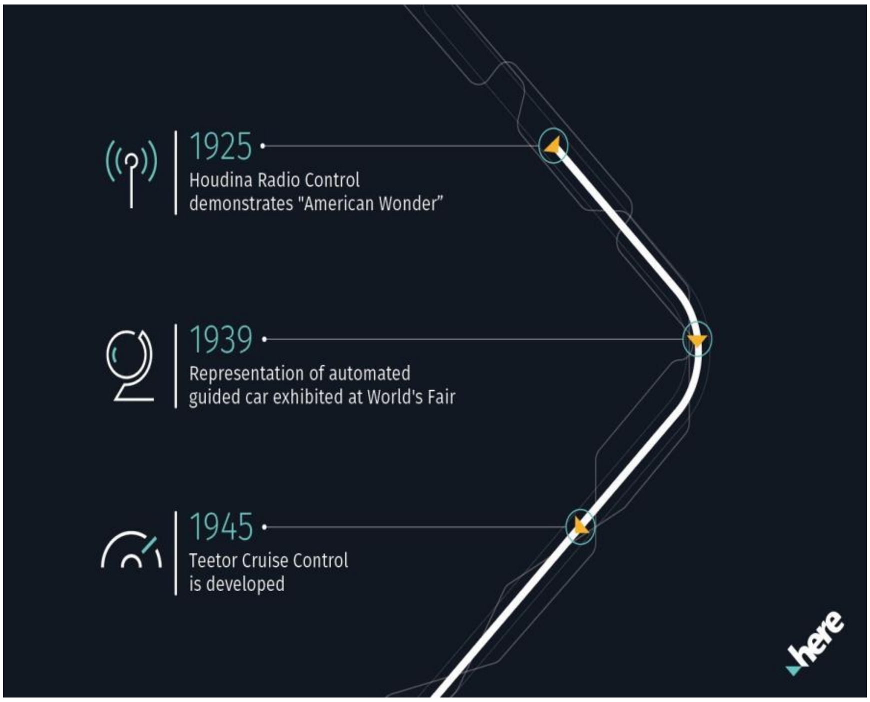


Figure 1.1(history of automation 1925-1945)

In 1925, Houdina Radio Control demonstrated the radio-controlled "American Wonder" in New York City. The demonstration featured a 1926

Chandler equipped with a transmitting antennae on the hood. It was operated by a second car that followed it and sent out radio impulses which were caught by the transmitting antennae.

1939:

An early depiction of an automated car was Norman Bel Geddes's Futurama exhibit at the 1939 World's Fair. Geddes' envisioned radio-controlled electric cars that were propelled via electromagnetic fields generated from circuits embedded in the roadway.

1945:

Engineer Ralph Teetor receives a patent for the first modern Cruise Control, which he called the Controlomatic, the Touchomatic, and the Speedo stat. Teetor had spent 10 years experimenting with the device after being annoyed by riding in cars with his Lawyer, who would slow down when talking, and speed up when listening.

1.1.2. History of automation 1953-1960

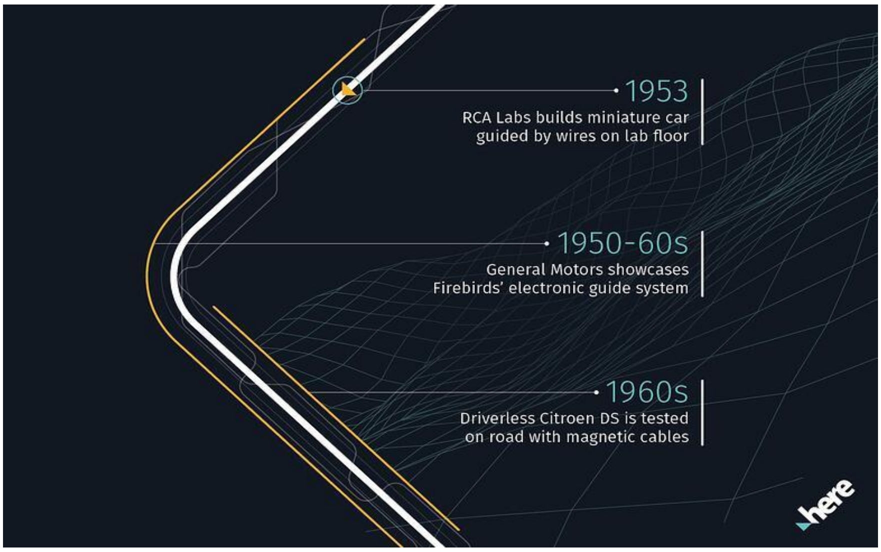


Figure 1.2(history of automation 1953-1960)

1953:

RCA Labs successfully builds a miniature car that was guided and controlled by wires laid in a pattern on the floor of a laboratory. In 1958, a full size system was successfully demonstrated by RCA Labs and the State of Nebraska on a strip of public highway just outside Lincoln.

1950-60s:

Also during the 1950s throughout the 1960s, General Motors showcased the Firebirds, a series of experimental cars that were described to have an "electronic guide system [that] can rush it over an automatic highway while the driver relaxes". The GM Firebird II is equipped with receivers for detector circuits embedded in roadways

1960s:

During the 1960s, the U.K.'s Transport and Road Research Laboratory tested a driverless car guided by magnetic cables embedded in the road. It went through a test track at 80 miles per hour (130 km/h) without deviation of speed or direction in any weather conditions. Funding for these experiments was withdrawn in the mid-1970s.

1.1.3. History of automation 1961-1987

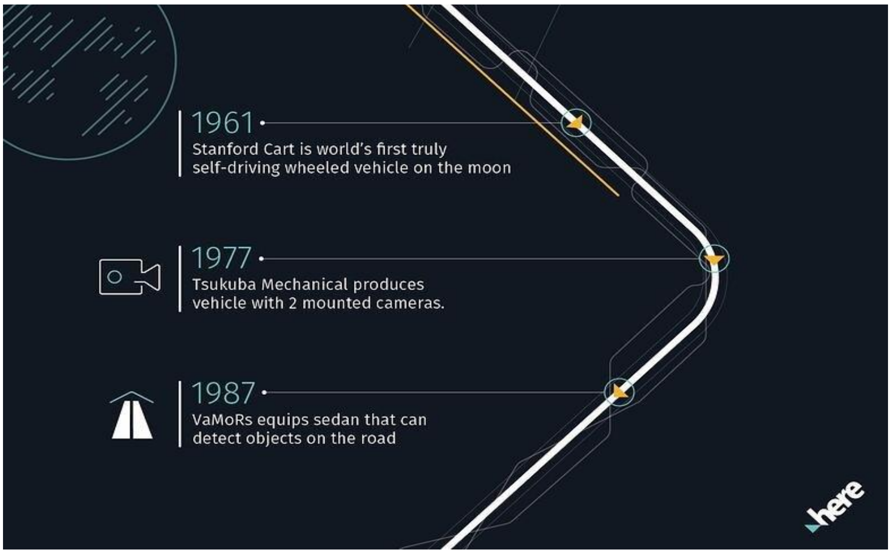


Figure 1.3(history of automation 1961-1987)

1961:

The space race inspires James Adams, a graduate engineer at Stanford, to create a remote-control lunar explorer. The key issue to be solved was the 2.5 second delay between when a command was sent from earth to when that command was received on the moon. The result: the first self-driving vehicle using cameras and location detection to navigate.

1977:

Japan-based Tsukuba Mechanical produced an autonomous passenger vehicle with two mounted cameras. The car was capable of recognizing street markings while traveling at nearly 20 miles per hour.

1987:

German engineer Ernst Discmans, equipped a sedan with a bank of cameras and 60 micro-processing modules to detect objects on the road—in front of and behind the vehicle. Dikeman's key innovation was "dynamic vision," which allowed the imaging system to filter out extraneous "noise" and focus only on relevant objects. Today, this type of imaging is crucial in helping self-driving vehicles identify potential hazards and their locations. VA Mors proved so successful that it was able to navigate Germany’s famous Autobahn at speeds of up to 60 miles per hour.

1.1.4. History of automation1989-2005

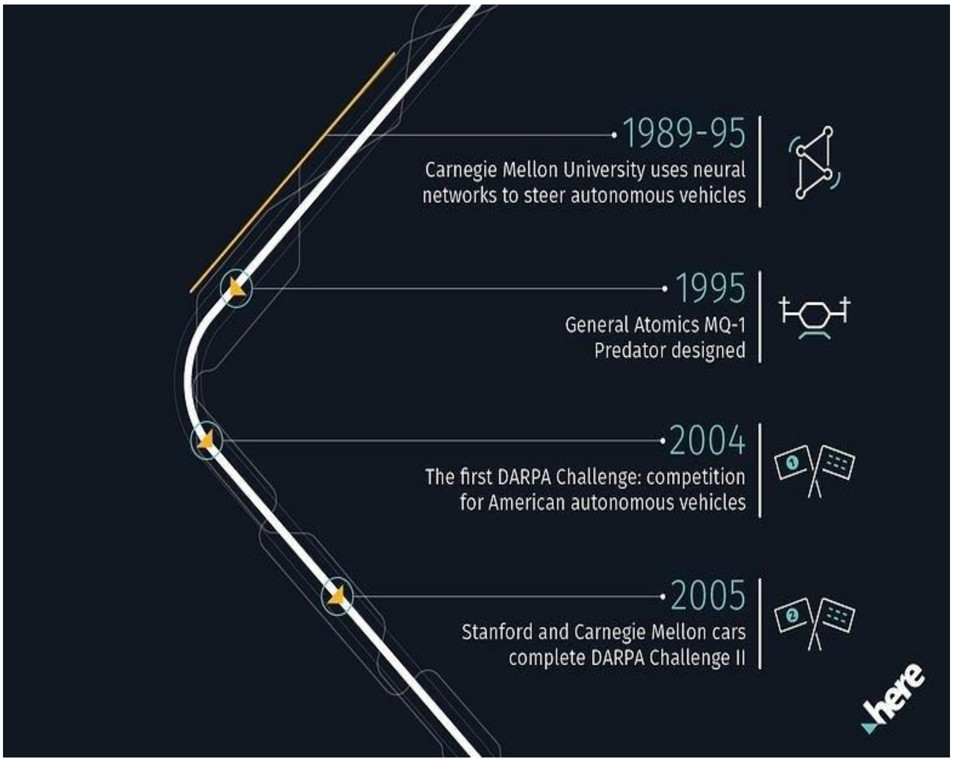


Figure 1.4(history of automation 1989-2005)

1989-95:

by 1989, Carnegie Mellon University had pioneered the use of neural networks to steer and otherwise control autonomous vehicles, forming the basis of contemporary control strategies. In 1995, Carnegie Mellon University's Navlab project completed a 3,100 miles (5,000 km) cross-country journey, of which 98.2% was autonomously controlled, dubbed "No Hands Across America".This car, however, was semi-autonomous by nature: it used neural networks to control the steering wheel, but throttle and brakes were human-controlled, chiefly for safety reasons.

1995:

General Atomics releases the MQ-1 Predator, the first modern unmanned aerial vehicle (UAV), capable of 14 hours of continuous flight. General Atomics developed the drone from the leftovers of a previous reconnaissance program called Amber. While the Predator was remotely controlled by a live pilot, it paved the way for autonomous UAVs like the Global Hawk in 1998.

2004:

DARPA Challenge I - The U.S. Department of Defense's research arm, DARPA, sponsored their first Grand Challenge that pushed autonomous driving technologies forward. A prize of $1,000,000 was offered to any team that built a car that could autonomously drive itself 150 miles across the Mojave Desert. No car completed the course, the furthest distance traveled was a mere 7.3 miles.

2005:

DARPA Grand Challenge II – DARPA increases the prize to 2,000,000 and the course re-focuses on navigating turns and tunnels over 132 miles. Stanford and Carnegie Mellon Universities produce 3 cars among them that finish the course within 30 minutes of each other.

1.1.5. History of automation 2009-2017

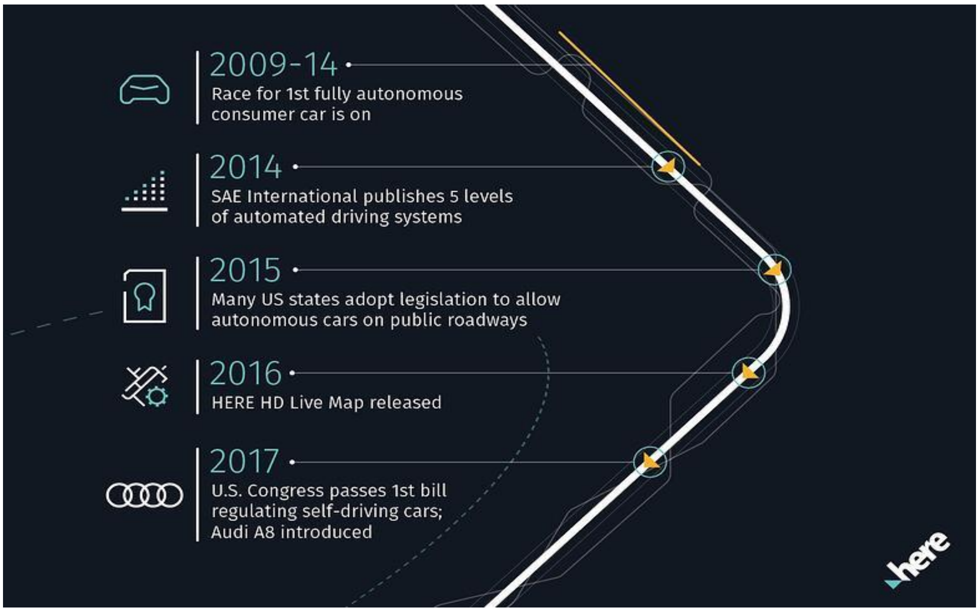


Figure 1.5 (history of automation 2009-2017)

2009-14

the race for the first fully autonomous consumer car is on. Car companies begin partnering with tech companies to give consumers a glimpses of increasing levels of autonomous driving, such as the Mercedes S 500 and the Tesla S. Early automatic features include hands-free driving on highways and automatic parallel parking.

2014

Defined levels of autonomy – SAE International publishes the 5 levels of automated driving systems based on the level of driver participation needed to operate the vehicle. The levels range from zero (fully manual) to five (full-time automation). The U.S. NHTSA adopts the same definitions in 2016.

2015

While automated cars aren't explicitly illegal in most states, Virginia, California, Nevada, Michigan, Florida, and Washington D.C. all openly adopt legislation to allow autonomous cars on public roadways for testing purposes.

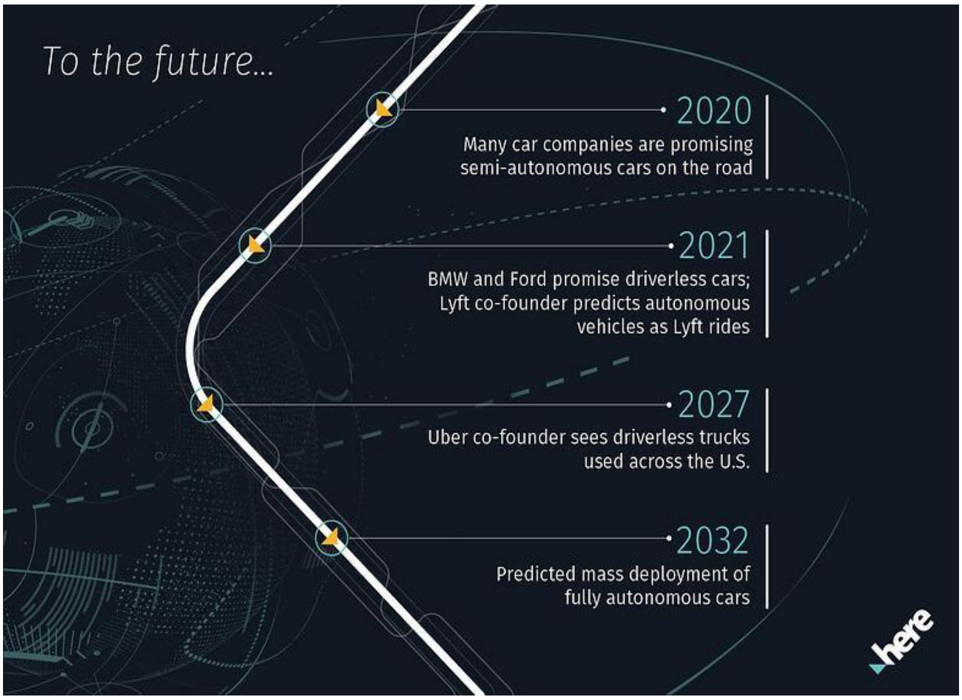
2016

HERE HD Live Map is released, combining layers of data into an advanced view of the roadway. The view presents traditional map data, along with analytic driven data based on the live condition of the road. This mapping technology enables a pathway for consumer cars to approach higher levels of autonomy on the roadway.

2017

U.S. Congress unanimously passes first bill toward regulation of self-driving cars. The Safely Ensuring Lives Future Deployment and Research in Vehicle Evolution Act (SELF DRIVE Act) allows for car companies developing autonomous vehicles, and vehicle manufacturers to put as many as 100,000 self-driving cars on the road for testing and helping to determine regulation.

Audi introduces the Audi A8. The flagship vehicle is equipped with the most powerful in-car navigation system produced to date, and has the capability of "Level 3" autonomous driving.



To the Future…

2020

Car companies such as Nissan, Toyota, and Renault are promising autonomous cars on the road, capable of entering/exiting highways and navigating city intersections.[2]

1.2. Automation and Society

Over the years, the social merits of automation have been argued by labour leaders, business executives, government officials, and college professors. The biggest controversy has focused on how automation affects employment. There are other important aspects of automation, including its effect on productivity, economic competition, education, and quality of life. These issues are explored here.

1.2.1. Impact on the individual

Nearly all industrial installations of automation, and in particular robotics, involve a replacement of human labour by an automated system. Therefore, one of the direct effects of automation in factory operations is the dislocation of human labour from the workplace. The long-term effects of automation on employment and unemployment rates are debatable. Most studies in this area have been controversial and inconclusive. Workers have indeed lost jobs through automation, but population increases and consumer demand for the products of automation have compensated for these losses. Labour unions have argued, and many companies have adopted the policy, that workers displaced by automation should be retrained for other positions, perhaps increasing their skill levels in the process. This argument succeeds so long as the company and the economy in general are growing at a rate fast enough to create new positions as the jobs replaced by automation are lost.

Of particular concern for many labour specialists is the impact of industrial robots on the work force, since robot installations involve a direct substitution of machines for humans, sometimes at a ratio of two to three humans per robot. The opposing argument within the United States is that robots can increase productivity in American factories, thereby making these firms more competitive and ensuring that jobs are not lost to overseas companies. The effect of robotics on labour has been relatively minor, because the number of robots in the United States is small compared with the number of human workers. As of the early 1990s, there were fewer than 100,000 robots installed in American factories, compared with a total work force of more than 100 million persons, about 20 million of whom work in factories.

Automation affects not only the number of workers in factories but also the type of work that is done. The automated factory is oriented toward the use of computer systems and sophisticated programmable machines rather than manual labour. Greater emphasis is placed on knowledge-based work and technical skill rather than physical work. The types of jobs found in modern factories include more machine maintenance, improved scheduling and process optimization, systems analysis, and computer programming and operation. Consequently, workers in automated facilities must be technologically proficient to perform these jobs. Professional and semiprofessional positions, as well as traditional labour jobs, are affected by this shift in emphasis toward factory automation.

1.2.2. Impact on society

Besides affecting individual workers, automation has an impact on society in general. Productivity is a fundamental economic issue that is influenced by automation. The productivity of a process is traditionally defined as the ratio of output units to the units of labour input. A properly justified automation project will increase productivity owing to increases in production rate and reductions in labour content. Over the years, productivity gains have led to reduced prices for products and increased prosperity for society.

A number of issues related to education and training have been raised by the increased use of automation, robotics, computer systems, and related technologies. As automation has increased, there has developed a shortage of technically trained personnel to implement these technologies competently. This shortage has had a direct influence on the rate at which automated systems can be introduced. The shortage of skilled staffing in automation technologies raises the need for vocational and technical training to develop the required work-force skills. Unfortunately the educational system is also in need of technically qualified instructors to teach these subjects, and the laboratory equipment available in schools does not always represent the state-of-the-art technology typically used in industry.[3]

CHAPTER II

MANUFACTURING OF THE COMPONENTS OF AUTOMATED

2.1. COMPONENTS OF AUTOMATED SYSTEMS

Many modern automated systems, such as those used in automobile factories, petrochemical plants, and supermarkets, are extremely complex and require numerous feedback loops. Each of these subsystems consists of only five basic components: (1) action element, (2) sensing mechanism, (3) control element, (4) decision element, and (5) program.

2.1.1. Action elements

Action elements: Are those parts of an automated system that provide energy to achieve the desired task or goal. Energy can be applied in several different forms, such as heat to change the temperature of a room or electricity to run motors, which in turn drive conveyors for moving materials. [4]

The principal source of power in automated systems is electricity. Electric power has many advantages in automated as well as non-automated processes

Electrical power is widely available at moderate cost. It is an important part of our industrial infrastructure. Electrical power can be readily converted 10 alternative energy forms: mechanical, thermal, light, acoustic, hydraulic, and pneumatic.

2.1.1.1. ***Power for the Process****:* In production, the term *process* refers to the manufacturing operation that is performed on a work unit. In Table 3.1, a list of common manufacturing processes is compiled along with the form of power required and the resulting action on the work unit. Most of the power in manufacturing plants is consumed by these kinds of operations, the "power form" indicated in the middle column of the table refers to the energy that is applied directly to the process. As indicated above, the power source for each operation is usually converted from electricity.

In addition to driving the manufacturing process itself, power is also required for the following material handling functions

2.1.1.2. ***Loading and unloading the work unit**:* All of the processes listed in Table 2.1 are accomplished on discrete parts. These parts must be moved into the proper position and orientation for the process to be performed. And power is required for this transport and placement function. At the conclusion of the process, the work unit must similarly be removed. If the process is completely automated, then some form of mechanized power is used. If the process is manually operated or semi-automated, then human power may be used to position and locate the work unit.

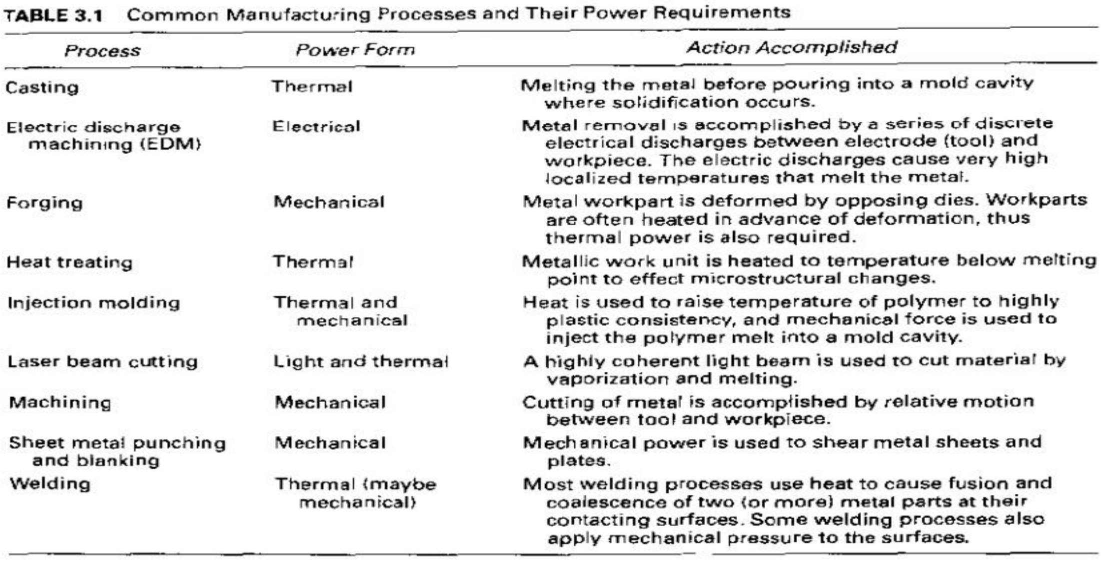


TABLE 3.1 Common Manufacturing Processes and Their Power Requirements

Process	*Power Form*	*Action Accomplished*
Casting	Thermal	Melting the metal before pouring into a mold cavity where solidification occurs.
Electric discharge machining (EDM)	Electrical	Metal removal is accomplished by a series of discrete electrical discharges between electrode (tool) and workpiece. The electric discharges cause very high localized temperatures that melt the metal.
Forging	Mechanical	Metal workpart is deformed by opposing dies. Workparts are often heated in advance of deformation, thus thermal power is also required.
Heat treating	Thermal	Metallic work unit is heated to temperature below melting point to effect microstructural changes.
Injection molding	Thermal and mechanical	Heat is used to raise temperature of polymer to highly plastic consistency, and mechanical force is used to inject the polymer melt into a mold cavity.
Laser beam cutting	Light and thermal	A highly coherent light beam is used to cut material by vaporization and melting.
Machining	Mechanical	Cutting of metal is accomplished by relative motion between tool and workpiece.
Sheet metal punching and blanking	Mechanical	Mechanical power is used to shear metal sheets and plates.
Welding	Thermal (maybe mechanical)	Most welding processes use heat to cause fusion and coalescence of two (or more) metal parts at their contacting surfaces. Some welding processes also apply mechanical pressure to the surfaces.

Figure 2.1(common manufacturing processes and their power requirements)

2.1.1.3. ***Power for Automation:*** Above and beyond the basic power requirements for the manufacturing operation, additional power is required for automation. The additional power is used for the following functions:

2.1.1.4. *Controllerter unit*: Modern industrial controllers are based on digital computers, which require electrical power to read the program of instructions, make the control calculations, and execute the instructions by transmitting the proper commands to the actuating devices.

2.1.1.5 *The control signal:* The commands sent by the controller unit are carried out by means of electromechanical devices, such as switches and motors, called *actuators*. The commands are generally transmitted by means of low voltage control signals. To accomplish the commands, the actuators require more power, and so the control signals must be amplified to provide the proper power level for the actuating device.

2.1.1.6 *Data acquisition and information processing*: In most control systems, data must be collected from the process and used as input to the control algorithms. In addition, a requirement of the process may include keeping records of process performance or product quality. These data acquisition and record keeping functions require power, although in modest amounts. [5]

2.1.2. Sensing mechanisms

Sensing mechanisms measure either the performance of an automated system or a particular property of an object processed by the system. The measurements obtained make it possible to determine whether the operation or process is proceeding as desired. The sensors are often connected to indicators such as dials and gauges. A thermocouple inserted in a pipe, for example, measures the temperature of a liquid flowing through the pipe; the temperature reading is then indicated on a thermometer. [6]

And because of the importance of sensors in the automated systems, this is how to make different sensors.

2.1.2.1. Active and Passive Sensors

Sensors that have been mentioned so far are called passive sensors. They do not need separate power to operate. Active sensors, on the other hand, are sensors that need their own power. An easy way to distinguish active sensors from passive ones is to count the number of pins it has. Active sensors have an extra third pin to get the power it needs while passive sensors have only two.

Active sensors are more complex, but they open up a broad range of sensing possibilities. Examples of active sensors include Infrared sensors [it detects presence, distance], Hall Effect sensors [detects magnetic field], noise sensors, vibration sensors, etc.

A .Making Passive Sensors

Here you will see how to make three passive sensors: touch, light, and temperature. All passive sensors only need two pins (pin 1 and 2).

A.1. Touch Sensors

Touch sensors are one of the simplest sensors but yet they are most useful. The general ideas is very simple: you have two conductive objects that would touch each other when activated (i.e. pressed, stepped on) or vice versa. Here are some examples of touch sensors.

A.1.1Paper and Aluminum foil.

This is probably the easiest way to make a touch sensor. You attach some aluminum foil to two pieces of paper that are folded in a way that will make the foil touch when pressed. You then connect one lead to each foil. You can, of course, replace aluminum foil with other conductive elements (i.e. paper clips or nails).

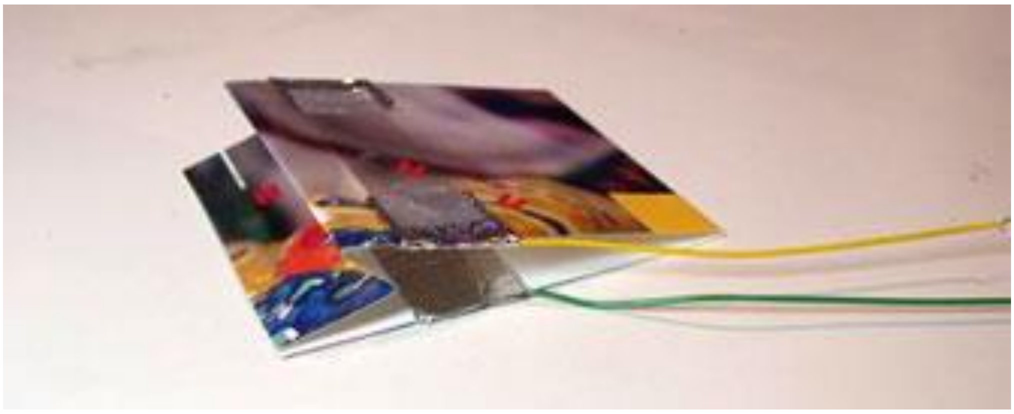


Figure 2.2(paper and aluminum foil sensor)

A.1.2.Ice-cream sticks and aluminum foil.

Ice-cream sticks are excellent for making simple structures. It is stronger than paper. Therefore, when used with aluminum foil, we can make touch sensors that are much more rigid. The following Picture shows one example.

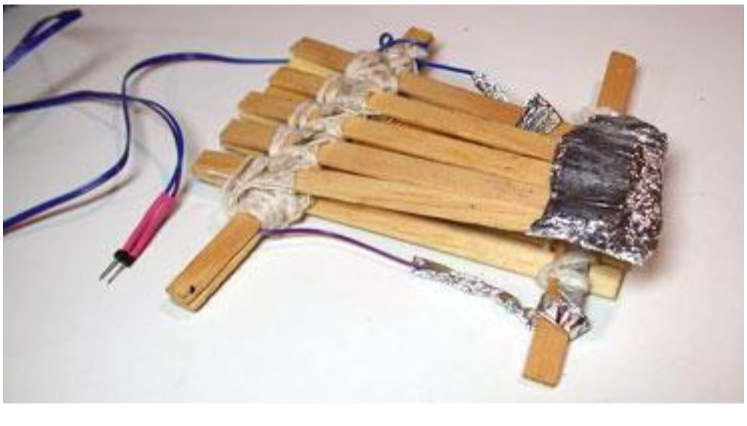


Figure 2.3(Ice-cream sticks and aluminum foil sensor.)

A.2.Light Sensors

The most common light sensor is called **LDR** (Light Dependent Resistor). They are also known as "Photo cells." A LDR is basically a resistor that changes its resistance when light intensity changes. You often see them in automatic light stands.

Since LDRs are simply resistors, you can just simply connect the two pins from the sensor to the Go-go board.

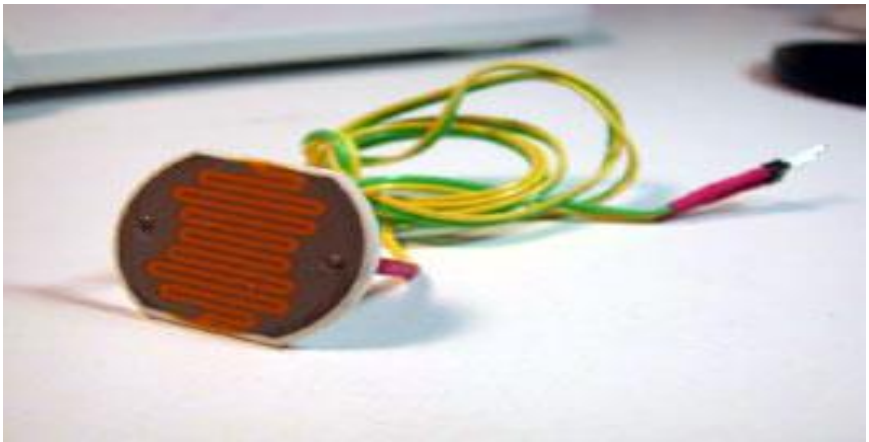


Figure 2.4(light sensor)

A.3. A Simple Humidity Sensor

You can simply connect two wires or paper clips to pins 1 and 2 of the Go-go board to measure humidity in the soil. When the soil gets moist, it conducts more electricity. Thus, the sensor readings you get will change as the soil humidity changes. This same idea can be used to make a water detector sensor. When the two wires touch water, the sensor readings will change.

You can improve the humidity sensor by connecting the two wires to a piece of gypsum, plaster, or any other material that absorbs water. The idea is still the same but you are improving the purity of the conductive medium. The sensor's behavior will not change too much from one place to another. Gypsum is the material they use to make building interiors (ceilings, walls, etc.). Plaster is also used to cover walls and to make a patient's cast.

Figure 2.5(A Simple Humidity Sensor)

A.4. Temperature Sensors

To make a temperature sensor, you will need to find a thermistor. Some thermistors are simply resistors that changes their resistance as temperature changes. Other thermistors are active sensors that need extra power to function.

Figure 2.6(temperature sensor)

B. Making Active Sensors

Here are examples of useful active sensors.

B.1.Reflective Light Sensors

This type of sensor is useful when you want to detect object presence without touching it. For example, you want to detect when someone walks through a door, or when someone's hand gets too close.

A simple idea for this sensor is to beam light on to a **LDR** (light sensor). If something passes by, it blocks the light and the LDR detects it. If the light source is a light bulb, then you are simply detecting shadows. If you use a laser pointer as you light source, you detection range can be very far and you readings will be very precise.

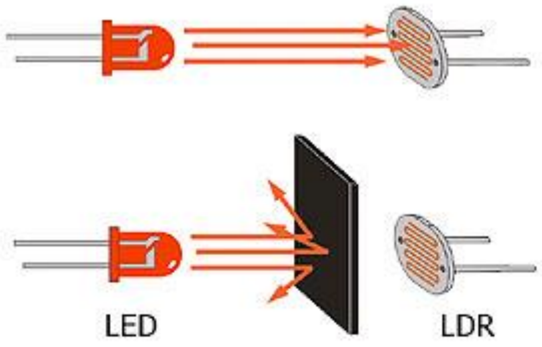


Figure 2.7(light sensor)

There is another idea to accomplish the same task. You can beam light outwards and measure the amount of light that is reflected back. When there is nothing to block the light, the reflected light will be very small. However, if an object blocks the light, it reflects more the light back. This is what we call a reflective light sensor. The benefit of this kind of sensor is that the sensor is located all in one place and no alignment is needed when you change the direction of the sensor.

You can make reflective sensors simply with an LED and an LDR. You need to use a bright LED. This works but the detection range will be limited (less than 1 inch). There can also be a lot of interferences from external light sources as well.

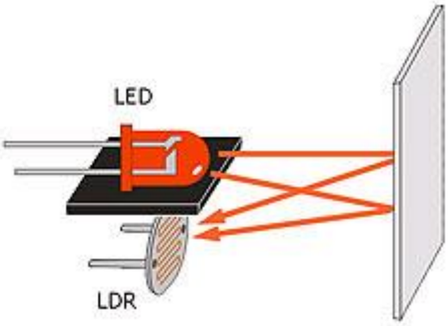


Figure 2.8(reflective sensors)

Here is a schematic of how this sensor can be built for the Go-go board. The **resistor** is there to limit the current that goes through the LED. The smaller the resistor value the brighter the LED.

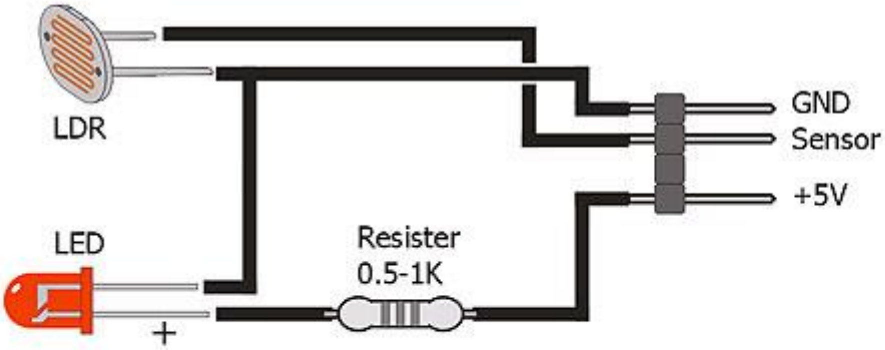


Figure 2.9(reflective sensor)

B.2. Using Infrared (IR) Light

A better version of the above reflective sensor is to use **Infrared light** (IR), as there is much less interferences. IR is a kind of light that humans cannot see. This is nice when you do not want people to see your sensor (i.e. in security systems).

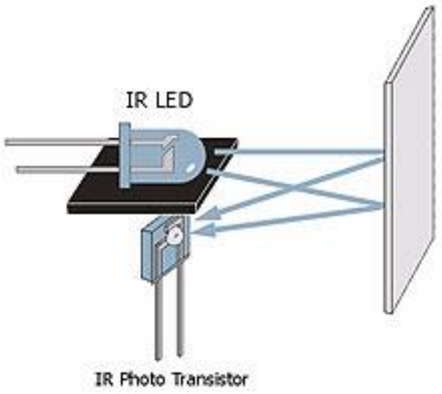


Figure 2.10(Infrared (IR) Light)

Notice in the diagram that we use an **IR phototransistor** instead of the LDR. In this case, the two functions the same way, but the IR phototransistor is much more sensitive to IR light than an LDR. The following is a schematic of how to build this sensor.

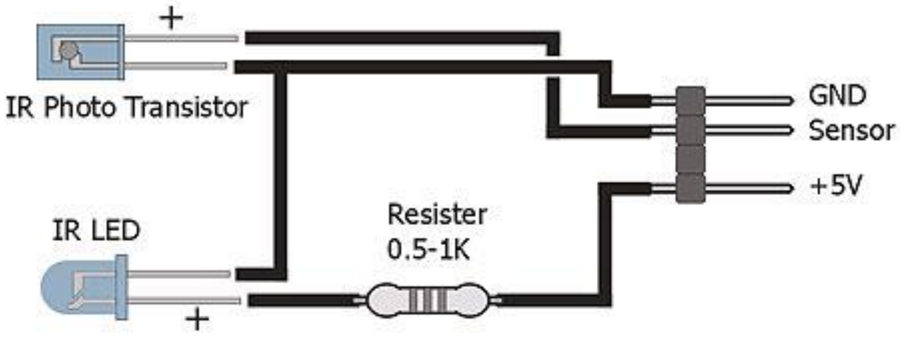


Figure 2.11(IR phototransistor)

B.3. Commercial Reflective Sensors

You can also buy commercial IR reflective sensors as well. They normally come in a compact size and the sensor readings are more reliable.

[Example of commercial IR reflective sensors]

Here is an example of how to assemble a commercial IR reflective sensor (digikey.com part number QRD1114-ND).

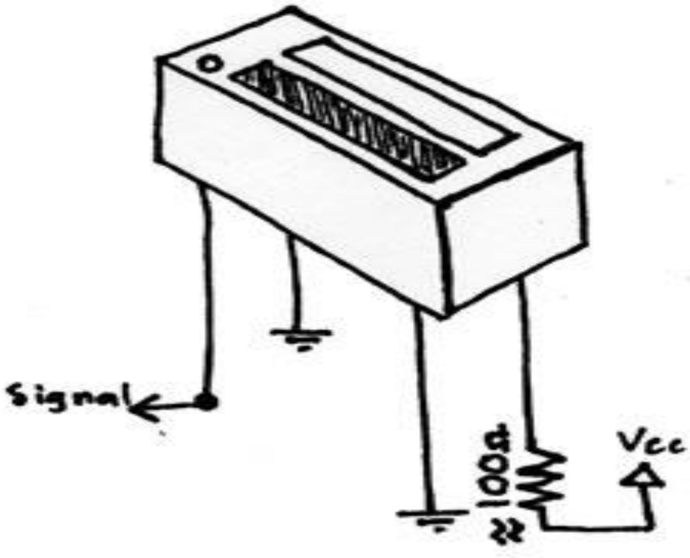


Figure 2.12(commercial IR reflective sensor)

B.4. Hall Effect (magnetic field) Sensor.

You can use this sensor to detect the presence of magnets. The applications are similar to the IR reflective sensor but they do not depend on light, which often means they are more reliable. However, you need to have a magnet while light is almost everywhere.[7]

Here's an example of how to assemble a Hall Effect sensor (from digikey.com, part number DN6848-ND)

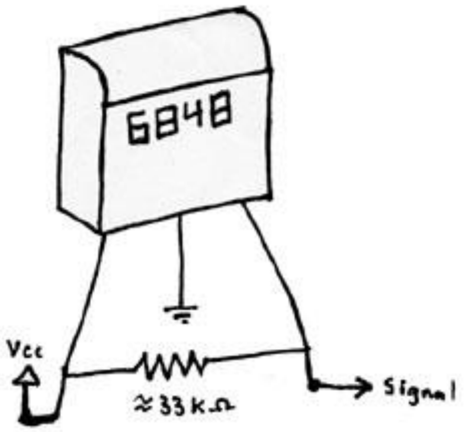


Figure 2.13 (Hall Effect sensor)

Figure 2.14(Hall Effect sensor)

2.1.3. Control elements:

Control elements use information provided by the sensing mechanisms to regulate the action elements of a system. For instance, a control device in a fluid-flow system causes a valve to open, allowing a liquid to flow into a tank. In response to measurements from a sensor, the control may automatically close the valve.

2.1.4. Decision elements

Decision elements differentiate automated systems from ordinary mechanized systems. In the latter, a human operator has to monitor sensor gauges and decide whether or not to activate the control elements. In an automated system, this decision-making is performed either by a comparer such as a thermostat or by a program stored in the memory of a computer.

2.1.5. Programs.

Programs of complex automated systems include both process and command information. The process information contains data that indicate how the various components of the system have to function in order to achieve a desired result. The command information consists of a series of instructions that tell the system's control elements how to perform certain specific operations.

2.1.5.1. Program of Instructions

The actions performed by an automated process are defined by a program of instructions whether the manufacturing operation involves low, medium, or high production, each part or product style made in the operation requires one or more processing steps that are unique to that style, these processing steps are performed during a work cycle. A new part is completed during each work cycle (in some manufacturing operations, more than one part is produced during the work cycle; e.g., a plastic injection molding operation may produce multiple parts each cycle using a multiple cavity mold). The particular processing steps for the work cycle are specified in a *work cycle program.* Work cycle programs are called *part programs* in numerical control. Other process control applications use different names for this type of program.

2.1.5.2. Work Cycle Programs

Work Cycle Program: In the simplest automated processes, the work cycle consists of essentially one step, which is to maintain a single process parameter at a defined level, for example, maintain the temperature of a furnace at a designated value for the duration of a heat treatment cycle. (We assume that loading and unloading of the work units into and from the furnace is performed manually and is therefore not part of the automatic cycle.) In this case, programming simply involves sensing the temperature dial on the furnace, to change the program, the operator simply changes the temperature setting. An extension of this simple case is when the single step process is defined by more than one process parameter, for example, a furnace in which both temperature and atmosphere are controlled.

In more complicated systems, the process involves a work cycle consisting of multiple steps that are repeated with no deviation from one cycle to the next. Most discrete part manufacturing operations are in this category a typical sequence of steps (simplified) is:

1*/ Load the part into the production machine.

2*/ perform the process.

3*/ unload the part.

During each step, there are one or more activities that involve changes in one or more process parameters. *Process parameters* are inputs to the process. Such as temperature setting of a furnace, coordinate axis value in a positioning system, valve opened or closed in a fluid flow system, and motor on or off. Process parameters are distinguished from *process variables,* which are outputs from the process; for example, the actual temperature of the furnace, the actual position of the axis, the actual flow rate of the fluid in the pipe, and the rotational speed of the motor. As our list of examples suggests, the changes in process parameter values may be continuous (gradual changes during the processing step; for example, gradually increasing temperature during a heat treatment cycle) or discrete (stepwise changes; for example, on/off). Different process parameters fully be involved in each step.

2.2. Automation in Daily Life

In addition to the manufacturing applications of automation technology, there have been significant achievements in such areas as communications, transportation, service industries, and consumer products. Some of the more significant applications are described in this section.

2.2.1. Communication

One of the earliest practical applications of automation was in telephone switching. The first switching machines, invented near the end of the 19th century, were simple mechanical switches that were remotely controlled by the telephone user pushing buttons or turning a dial on the phone. Modern electronic telephone switching systems are based on highly sophisticated digital computers that perform functions such as monitoring thousands of telephone lines, determining which lines require service, storing the digits of each telephone number as it is being dialed, setting up the required connections, sending electrical signals to ring the receiver’s phone, monitoring the call during its progress, and disconnecting the phone when the call is completed. These systems also are used to time and bill toll calls and to transmit billing information and other data relative to the business operations of the phone company. In addition to the various functions mentioned, the newest electronic systems automatically transfer calls to alternate numbers, call back the user when busy lines become free, and perform other customer services in response to dialed codes. These systems also perform function tests on their own operations, diagnose problems when they arise, and print out detailed instructions for repairs.

Other applications of automation in communications systems include local area networks, communications satellites, and automated mail-sorting machines. A local area network (LAN) operates like an automated telephone company within a single building or group of buildings. Local area networks are generally capable of transmitting not only voice but also digital data between terminals in the system. Communications satellites have become essential for communicating telephone or video signals across great distances. Such communications would not be possible without the automated guidance systems that place and retain the satellites in predetermined orbits. Automatic mail-sorting machines have been developed for use in many post offices throughout the world to read codes on envelopes and sort the envelopes according to destination.

2.2.2. Transportation

Automation has been applied in various ways in the transportation industries. Applications include airline reservation systems, automatic pilots in aircraft and locomotives, and urban mass-transit systems. The airlines use computerized reservation systems to continuously monitor the status of all flights. With these systems, ticket agents at widely dispersed locations can obtain information about the availability of seats on any flight in a matter of seconds. The reservation systems compare requests for space with the status of each flight, grant space when available, and automatically update the reservation status files. Passengers can even receive their seat assignments well in advance of flight departures.

Nearly all commercial aircraft are equipped with instruments called automatic pilots. Under normal flying conditions, these systems guide an airplane over a predetermined route by detecting changes in the aircraft's orientation and heading from gyroscopes and similar instruments and by providing appropriate control signals to the plane's steering mechanism. Automatic navigation systems and instrument landing systems operate by using radio signals from ground beacons that provide the aircraft with course directions for guidance. When an airplane is within the traffic pattern for ground control, its human pilot normally assumes control.

Examples of automated rail transportation include American urban mass-transit systems such as BART (Bay Area Rapid Transit) in San Francisco; MARTA (Metropolitan Atlanta Rapid Transit Authority) in Atlanta, Georgia; and the Metrorail in Washington, D.C. The BART system serves as a useful example; it consists of more than 75 miles (120 kilometers) of track, with about 100 trains operating at peak hours between roughly 30 stations. The trains sometimes attain speeds of 80 miles per hour with intervals between trains of as little as 90 seconds. In each train there is one operator whose role is that of an observer and communicator and who can override the automatic system in case of emergency. The automatic system protects the trains by assuring a safe distance between them and by controlling their speed. Another function of the system is to control train routings and make adjustments in the operation of each train to keep the entire system operating on schedule. As a train enters the station, it automatically transmits its identification, destination, and length, thus lighting up a display board for passenger information and transmitting information to the control centers. Signals are automatically returned to the train to regulate its time in the station and its running time to the next station. At the beginning of the day, an ideal schedule is determined; as the day progresses, the performance of each train is compared with the schedule, and adjustments are made to each train's operation as required. The entire system is controlled by two identical computers, so that if one malfunctions, the other assumes complete control. In the event of a complete failure of the computer control system, the system reverts to manual control.

2.2.3. Service industries

Automation of service industries includes an assortment of applications as diverse as the services themselves, which include health care, banking and other financial services, government, and retail trade.

In health care the use of automation in the form of computer systems has increased dramatically to improve services and relieve the burden on medical staffs. In hospitals computer terminals on each nursing care floor record data on patient status, medications administered, and other relevant information. Some of these systems are used to perform additional functions such as ordering drugs from the hospital pharmacy and calling for orderlies. The system provides an official record of the nursing care given to patients and is used by the nursing staff to give a report at shift-change time. The computer system is connected to the hospital's business office so that proper charges can be made to each patient's account for services rendered and medicines provided.

Robotics is likely to play a role in future health care delivery systems. The work that is done in hospitals by nurses, orderlies, and similar staff personnel includes some tasks that are routine and repetitive. Duties that might be automated using robots include making beds, delivering linens, and moving supplies between locations in the hospital. Robots might even become involved in certain aspects of patient care such as transporting patients to services in the hospital, passing food trays, and similar functions in which it is not critical that a hospital staff member be present. Research is currently under way to develop robots that would be capable of providing assistance to paraplegics and other physically handicapped persons. These robots would respond to voice commands and would be able to interpret statements in natural language (e.g., everyday English) from patients requesting service.

Banking and financial institutions have embraced automation in their operations—principally through computer technology—to facilitate the processing of large volumes of documents and financial transactions. The sorting of checks is done by optical character-recognition systems utilizing the special alphanumeric characters at the bottom of checks. Bank balances are computed and recorded using computer systems installed by virtually all financial institutions. Major Banks have established electronic banking systems, including automatic teller machines. Located in places convenient for their customers, these automatic tellers permit users to complete basic transactions without requiring the assistance of bank personnel.

The stock exchanges rely on computer-automated systems to report transactions by ticker tape or closed circuit television. Brokerage houses use a computerized record-keeping system to track their customers' accounts. Monthly statements indicating the status of each account are automatically prepared and mailed to customers. Account executives employ video monitors in their offices, backed by a massive database, to retrieve current information on each stock almost instantaneously while they discuss possible purchases with their clients. Stock certificates are typically issued with machine-readable identifications to facilitate record keeping in sales and exchanges.

Credit card transactions have also become highly automated. Restaurants, retailers, and other organizations are using systems that automatically check the validity of a credit card and the credit standing of the cardholder in a matter of seconds as the customer waits for the transaction to be finalized. Some credit card transactions trigger immediate transfer of funds equal to the amount of the sale from the cardholder's account into the merchant's account.

Many government services are automated by means of computers and computerized databases. The Internal Revenue Service (IRS) of the U.S. government must review and approve the tax returns of millions of taxpayers each year. The detailed checking of returns is a task that has traditionally been done by large staffs of professional auditors on a sampled basis. In 1985 the IRS began using a computerized system to automate the auditing procedure for the 1984 returns. This system is programmed to perform the complex tax calculations on each return being audited. As tax laws change, the system is reprogrammed to do the calculations for the year. The computerized auditing system has permitted a substantial increase in the work load of the IRS auditing department without a corresponding increase in staffing.

Retail trade has seen a number of changes in its operations as a result of automation. Selling merchandise has typically been a very labor-intensive activity, with sales associates needed to assist customers with their selections and then finalize transactions at the cash register. Each transaction depletes the store’s inventory, so the item purchased must be identified for reorder. Much clerical effort is expended by the store when inventory is managed by strictly manual procedures. Computerized systems have been installed in most modern retail stores to speed sales transactions and automatically update inventory records as the stock of each item is reduced. The systems are based on the Universal Product Code (UPC), originally adopted by the grocery industry in 1973, which uses optical bar-code technology. A bar code is an identification symbol consisting of a series of wide and narrow bars attached to each product that can be scanned and recognized by a bar-code reader. At the cash registers, these readers quickly identify the items being purchased. As the sales associate scans across the symbol using a laser beam reader, the product is properly identified and its price is entered into the sales transaction. Simultaneously, a record of the sale is made in the inventory files so that the item can be reordered.

2.2.4.Consumer products

Consumer products ranging from automobiles to small appliances have been automated for the benefit of the user. Microwave ovens, washing machines, dryers, refrigerators, video recorders, and other modern household appliances typically contain a microprocessor that works as the computer controller for the device. The consumer operates the appliance by programming the controller to perform the required functions, including timing (ovens, dryers), power levels (microwave ovens), input channels (video recorders), and other cycle options (washing machines). The programming of the device is done simply by pressing a series of buttons in the proper sequence, so the user does not think of the procedure as programming a computer.

The automobile is an example of a highly automated consumer product. The modern automobile is typically equipped with several microprocessors that operate a variety of functions, including engine control (fuel-air ratio, for example), the clock, the radio, and cruise control.[8]

DISCUSSION

AND

CONCLUSION

3.1. Monte Carlo method

3.1.1. Introduction

In general terms, the Monte Carlo method (or Monte Carlo simulation) can be used to describe any technique that approximates solutions to quantitative problems through statistical sampling. As used here, 'Monte Carlo simulation' is more specifically used to describe a method for propagating (translating) uncertainties in model inputs into uncertainties in model outputs (results). Hence, it is a type of simulation that explicitly and quantitatively represents uncertainties. Monte Carlo simulation relies on the process of explicitly representing uncertainties by specifying inputs as probability distributions. If the inputs describing a system are uncertain, the prediction of future performance is necessarily uncertain. That is, the result of any analysis based on inputs represented by probability distributions is itself a probability distribution. Whereas the result of a single simulation of an uncertain system is a qualified statement ("if we build the dam, the salmon population could go extinct"), the result of a probabilistic (Monte Carlo) simulation is a quantified probability ("if we build the dam, there is a 20% chance that the salmon population will go extinct"). Such a result (in this case, quantifying the risk of extinction) is typically much more useful to decision-makers who utilize the simulation results. In order to compute the probability distribution of predicted performance, it is necessary to propagate (translate) the input uncertainties into uncertainties in the results. A variety of methods exist for propagating uncertainty. Monte Carlo simulation is perhaps the most common technique for propagating the uncertainty in the various aspects of a system to the predicted performance.

3.1.2. History

Monte Carlo simulation was named after the city in Monaco (famous for its casino) where games of chance (e.g., roulette) involve repetitive events with known probabilities. Although there were a number of isolated and undeveloped applications of Monte Carlo simulation principles at earlier dates, modern application of Monte Carlo methods date from the 1940s during work on the atomic bomb. Mathematician Stanislaw Ulam is credited with recognizing how computers could make Monte Carlo simulation of complex systems feasible:

The first thoughts and attempts I made to practice [the Monte Carlo Method] were suggested by a question which occurred to me in 1946 as I was convalescing from an illness and playing solitaires. The question was what are the chances that a Canfield solitaire laid out with 52 cards will come out successfully? After spending a lot of time trying to estimate them by pure combinatorial calculations, I wondered whether a more practical method than “abstract thinking” might not be to lay it out say one hundred times and simply observe and count the number of successful plays. This was already possible to envisage with the beginning of the new era of fast computers, and I immediately thought of problems of neutron diffusion and other questions of mathematical physics, and more generally how to change processes described by certain differential equations into an equivalent form interpretable as a succession of random operations. Later … [in 1946, I] described the idea to John von Neumann, and we began to plan actual calculations. [9]

3.1.3. Generality

The Monte Carlo method, also called Monte Carlo analysis, is a means of statistical evaluation of mathematical function s using random samples. This requires a good source of random numbers. There is always some error involved with this scheme, but the larger the number of random samples taken, the more accurate the result. In its pure mathematical form, the Monte Carlo method consists of finding the definite integral of a function by choosing a large number of independent-variable samples at random from within an interval or region, averaging the resulting dependent-variable values, and then dividing by the span of the interval or the size of the region over which the random samples were chosen. This differs from the classical method of approximating a definite integral, in which independent-variable samples are selected at equally-spaced points within an interval or region. The Monte Carlo method is most famous for its use during the Second World War in the design of the atomic bomb. It has also been used in diverse applications, such as the analysis of traffic flow on superhighways, the development of models for the evolution of stars, and attempts to predict fluctuations in the stock market. The scheme also finds applications in integrated circuit (IC) design, quantum mechanics , and communications engineering.[10]

3.2. Monte Carlo Simulation

The Monte Carlo simulation is a tool to investigate the transport of sputtered atoms and to assist engineers to optimize a given deposition setup. The model is based on numerical Monte Carlo simulations which are statistical methods that allow one to link a physical value to a random number. Every test is calculated independently of all the others. Final results are the average of the simulations. The Monte Carlo method can provide various kinds of information on properties of sputtered particle flows being deposited on the substrate, and allows a considerable contribution in understanding details of the sputtered atom transport in low-pressure gas as well as energy exchanges between sputtered atoms and gas molecules. The method is very useful for examining the design of real sputtering systems, which have a complex geometry.

Variation of the ions sputtering yield for different metals

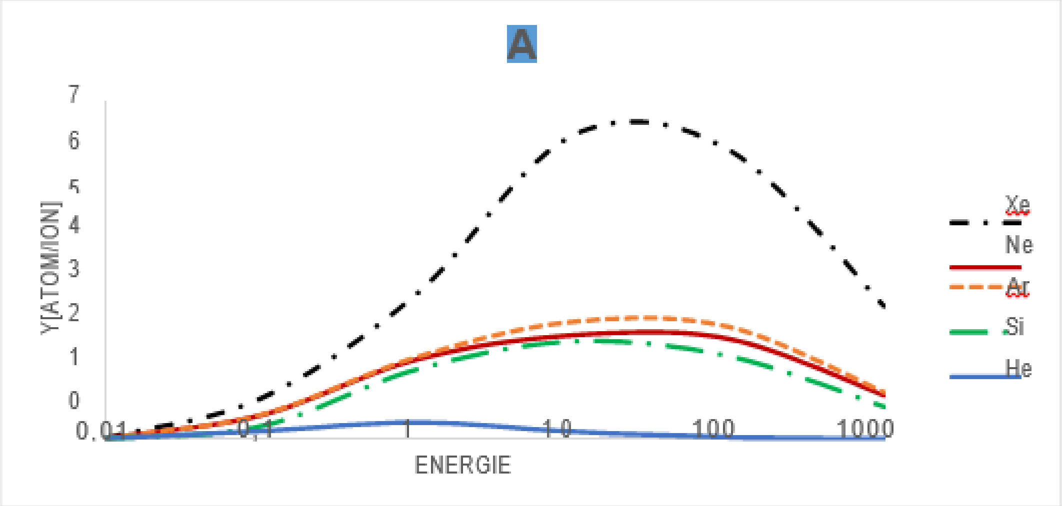


Figure 3.1 Variation of sputtering yield of Aluminum for different ions found by SRIM simulation.

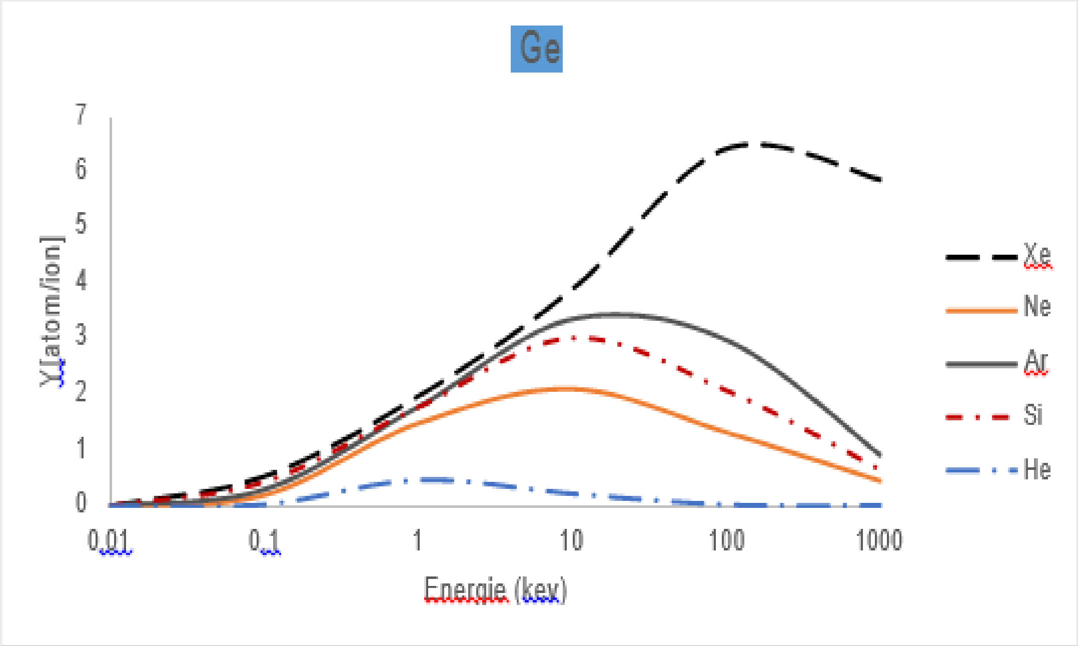


Figure 3.2 Variation of sputtering yield of Germanium for different ions found by SRIM simulation.

GENERAL

CONCLUSION

With the development of smaller technologies, semiconductor layer depositions are used in several demanding applications such as integrated circuits, transistors, diodes and RF appliances used in very high-speed devices, and metal layer depositions are used in the manufacture of different kinds of transportation, jewelry and contacts and also in construction, household items and consumer electronic.

The simulation with a Monte Carlo code has been applied in order to calculate the energy and the number of sputtered particles arriving at the substrate, which are both important parameters influencing the microstructure of the deposited thin film layers. the pressure and the distance between target and substrate are the two very important factors to modify the microstructure or crystallographic orientation of the deposited metal or semiconductor layers highly used in this ever-changing world and development processes.[11]

Should a system be automated? Before this question can be answered, the various positive and negative effects of introducing automation must be considered. Two primary types of effects are technical and economic. There are others, but they are more complex. One reason for the complexity is that the benefits and problems of automating a system vary considerably not only with each area of application but also with the people who work with the system or who are affected by it.

Because automated systems are able to perform routine decision-making tasks, they enable a company or organization to increase productivity. In other words, more goods are manufactured or more services rendered. Often quality can be improved as well. Such has been the case with the automation of the supermarket. The number of grocery items that can be checked out per minute has been greatly increased—in some cases nearly doubled—and the extensive delays occasionally experienced when a checkout clerk does not know the price of an item have been eliminated. More important, the automated reordering of goods has helped to even out the workload at warehouses and distributors, which is of particular importance to large supermarket chains. In addition, studies show that the computerized checkout system reduces errors in charging customers by as much as 75 percent.

Automation also makes possible the performance of tasks that are well beyond the limits of human capabilities, as for example the launching, tracking, and control of spacecraft. A project of this kind requires so many complex computations and such rapid control responses that it can only be accomplished through the employment of high-speed computerized systems.

Automated systems, however, do have certain limitations and drawbacks. Although usually very reliable, they can malfunction. Moreover, an entire system may fail to operate properly if there is a single error in setting it up. A backup system has to be provided or a human “override” capability built into the system so that operations can be handled manually. Automated systems also lack the flexibility of humans. Any significant change in their function may thus require extensive redesigning of the equipment. This problem has been mitigated by the use of computer programs that can be modified with relative ease, but action, sensing, and control components still have to be tailored to specific applications. This is one reason that large amounts of money are required as a company or industry becomes increasingly more automated. In the long term, automation generally yields economic benefits. An exception would be a situation where an operation has to be automated for technical or safety reasons only.[12]

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(advantages and disadvantages)