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INTRODUCTION On the job training or OJT is one method by which students is given achance to apply the theories and computations that they have learned from theschool. It also helps the students to acquire relevant knowledge and skills byperforming in actual work setting. Colleges and universities require their studentsto undergo such training within a specific number of hours as part of thecurriculum.━or the students! an OJT or internship program provides opportunities togo through the actual methodologies of a specific job using the real tools!equipments and documents. In effect! the workplace becomes a developmentvenue for a student trainee to learn more about his chosen field and practicewhat he has learn from academy.On the other hand! an effective OJT program also benefits the companieswho accept trainees. ━irst OJT or intern provides additional manpower for alesser labor cost than a regular employee. "ost of them are all eager to learn theropes so chances are high that they will cooperate.#mployers can use this internship strategy as a method in recruiting newemployees. $ince the trainer or the supervisor can follow the trainees% progress!he can gauge based on performance! behavior and attitude if the trainee willmake a good recruit after the completion of his internship. 1 OJT%s can bring fresh ideas into the organi&ation. 'iven the opportunity tospeak their minds freely and without fear! they maybe able to contributesignificantly in brainstorming sessions or research and eventually help improvethe organi&ations productivity. (hile training the interns! employers are in factalso teaching their employees to process of guiding the trainees stretches their patience! develops teaching skills and makes them more sensitive to the needsand mind set of the younger generation. The course of supervision also teachesthem how to share what they know and be receptive to questions.)ence! theinternship also becomes an avenue in training for future managers of thecompany. *ccommodating on+the+job trainees can truly be beneficial not only to thetrainees but also to the companies that provide opportunities for this type of learning. There is wisdom in the front lines. $uch training can be an investmentthat will be valuable to the company later on. This is also why trainees shouldtake their internship seriously as it can become a powerful tool and possibly evena source of recommendation when they take that big lift from being students tocareer professionals. 2 CHAPTER IPERSONAL PROFILE This chapter presents the personal data of the student+trainee highlightingthe college of her origin! as well as her field of speciali&ation. BATANGAS STATE UNIVERSITY The ,atangas $tate -niversity has an enduring and eventful history of service to the people particularly to the youth in the province of ,atangas. The,$- traces its history from ━/01 when it was established as a manual trainingengaged in tracing the youth for gainful occupation particularly in woodworking.The *merican educators at that time so the need to trainmen as builders andcarpenters to help develop towns and business centers. In ━/02! the manual training school was recogni&es. It was named,atangas Trade $chool and was transferred to its present site. Its emphasis wason wood arts and building construction courses. 3ater! the course in machineshop was introduced! The ,atangas Trade $chool was renamed 4ablo ,orbon "emorial Trade$chool in honor of)onorable 4ablo ,orbon! a ,atangueno who held position inthree branches of government! namely as governor! member of 4hilippine 3 HIPAA for Covered Entities Medical Mandatory Collection Arc Flash Training (NFPA 70E) 8 Hour Refresher Training Active Shooter Response Training Aerosol Transmissible Diseases Overview Air Emissions Management Overview Arc Flash and Electrical Safety Best Practices (NFPA 70E) Overview Asbestos Hazards Awareness Overview Back Care and Ergonomics Overview Back Safety and Injury Prevention Overview Behavior-Based Safety Overview Bloodborne Pathogens (BBP) Overview Bloodborne Pathogens for Healthcare Workers Overview Cardiopulmonary Resuscitation (CPR) Overview Chemical Safety Overview Cold Stress Overview Cold, Flu, and Transmissible Illness Prevention Compressed Gas Overview Computer Security Overview Confined Spaces Entry - Permit Required Overview Confined Spaces Overview Conveyor Safety COVID-19 Masks, Coverings, and Respirators Disinfecting the Workplace for COVID-19 Distracted Driving Overview Driver Safety Overview Dropped and Fallen Objects Drug & Alcohol-Free Workplace Overview Drug and Alcohol Testing for Employees Overview Earthquake Preparedness Electrical Safety: Hazards, Controls, and Best Practices Overview Electrical Safety: General Awareness Overview Emergency and Fire Preparedness Overview Emergency Planning and Community Right-to-Know Act (EPCRA) Overview Employee Safety Orientation Overview Environmental Management Fundamentals Overview Excavation, Trenching, and Shoring Overview Eye Safety Eyewashes and Safety Showers Fall Protection - Construction Overview Fatigue and Stress Awareness Fire Extinguisher Safety Overview Fire Extinguishers: Monthly Inspections Fire Safety and Patient Evacuation Overview Hand and Power Tool Safety Overview Hand Safety Overview Hazardous Waste Management Overview HAZCOM Overview HAZWOPER - Decontamination Overview HAZWOPER - Hazardous Materials Chemistry Overview HAZWOPER - Introduction Overview HAZWOPER - Personal Protective Equipment (PPE) Overview Hearing Conservation Overview Heat Stress Overview HIPAA for Covered Entities Overview Hot Work Overview Hurricane Preparedness Indoor Air Quality Overview Industrial Ergonomics Overview Intro to Ammonia Hazards Benzene Safety Overview Intro to Beryllium Hazards Intro to Cadmium Hazards Intro to Caught In-Between Hazards Intro to Combustible Dust Hazards Intro to Hexavalent Chromium Hazards Intro to Hydraulic Safety Intro to Loading Dock Safety Intro to Mold and Mildew Awareness Intro to Off-Road Vehicle Safety: ATVs and UTVs Intro to Pallet Jack Safety Intro to Personal Safety Intro to Pressure and Power Washer Safety Intro to Safe Material Storage Intro to Site Security Intro to Skid Steer Loaders Intro to Spray Finishing Hazards Intro to Utility Cart Safety Intro to Wildfire Smoke Safety Ladder Safety Overview Lead Awareness Overview Line Breaking Overview Lock and Tag Overview Lockout Tagout for Authorized Workers Overview Machine Guarding Overview Medical Hazard Communication Overview Mobile Elevating Work Platforms: Aerial and Scissor Lift Safety Overview Mosquito, Tick, and Vector-Borne Illnesses Office Ergonomics Overview Office Safety Overview Oil Spill Prevention, Control, and Countermeasures (SPCC) Overview Overhead and Gantry Crane Safety Overview Personal Fall Arrest Systems Overview Powered Industrial Truck Safety Overview Process Safety Management Overview Reporting Sexual Harassment Resilience and Stress Management Respiratory Protection Overview Rigging Safety Overview Scaffold Safety Overview Sexual Harassment and Discrimination Prevention for Managers Overview Sexual Harassment and Discrimination Prevention Overview Silica Hazards Overview Slips, Trips, & Falls Overview Stairway Hazards Stormwater Management Overview Tornado Preparedness Traffic Control (Flagger) Overview Violence in the Workplace Overview Wastewater Management Overview Winter Weather Driving Workplace Signs, Labels, and Tags Workspace Cleanliness The Respectful Workplace Compliance HIPAA Training for EMS Menu Principal / Recherche Recherche 在学习编程的过程中,我们或许会遇到端口被占用的情况,因而导致程序启动不了。这种情况只需要找到占用端口的进程,然后在中关闭改进程即可解决问题。后面补加的图。 本次课程我们将会讲解从移动端app数据抓取到数据存储的完整实战流程。通过这门课我们会学习到。 本文介绍了多任务端app应用数据抓取。如果觉得文章对你有用处,记得转发一波哦,博主也支持为铁粉丝制作专属动态壁纸哦~ 可以查看这篇文章配置:如果要抓取https包,还需要安装这个证书:启动mitmproxymitm.it,选择匹配的证书下载安装(见下图),设置=》安全=》信任的凭据=》用户。 app小程序手机端Python爬虫实战16-设置滑动手机视频停止条件。 代码】app小程序手机端Python爬虫实战15-通过U2实现滑动手机视频。 如果觉得文章对你有用处,记得转发一波哦,博主也支持为铁粉丝制作专属动态壁纸哦~ 本文介绍了fiddler如何抓取手机端数据包。如果觉得文章对你有用处,记得转发一波哦,博主也支持为铁粉丝制作专属动态壁纸哦~ 本文介绍了python如何将代码制作成可以pip的库,将自己的python代码打包成库,让别人pip安装调用?。如果觉得文章对你有用处,记得转发一波哦,博主也支持为铁粉丝制作专属动态壁纸哦~ 本文介绍了Uiautomator2自动化抓取工具。如果觉得文章对你有用处,记得转发一波哦,博主也支持为铁粉丝制作专属动态壁纸哦~ 运行后,会在本地生成phone.file这个页面的布局源代码就是xml文件,因为它是一个xml文件,我们就可以用xpath去寻找它。 本文介绍了Windows系统VisualSVN-Server下载安装和配置。如果觉得文章对你有用处,记得转发一波哦,博主也支持为铁粉丝制作专属动态壁纸哦~ 息屏幕#点亮屏幕#解锁d.unlock()#查看屏幕状态#点回到桌面#回到上一个#左右滑动本文介绍了Uiautomator2自动化抓取工具实现九宫格滑动解锁。如果觉得文章对你有用处,记得转发一波哦,博主也支持为铁粉丝制作专属动态壁纸哦~... 坐标点定位是一种偷懒的方式,它不需要关注控件的层级关系,只需要控件的坐标位置即可定位,它对应的属性名叫做position。(191,654)另一种方式可以点击上图中的%,就是按比例。 本文介绍了Uiautomator2UiSelector通过resourceId、层级定位方式。如果觉得文章对你有用处,记得转发一波哦,博主也支持为铁粉丝制作专属动态壁纸哦~ 本文介绍了Uiautomator2UiSelector文本、className定位方式。如果觉得文章对你有用处,记得转发一波哦,博主也支持为铁粉丝制作专属动态壁纸哦~ Use of various control systems for operating equipment For a hierarchical presentation of automation topics, see Outline of automation. For other uses, see Automation (disambiguation). "Automate" redirects here. For other uses, see Automate (disambiguation). Not to be confused with Automaton. Minimum human intervention is required to control many large facilities such as this electrical generating station. Part of a series onAutomation Trade shows ASP-DAC DAC DATE ICCAD Awards IEEE Robotics and Automation Award Robots Industrial robot Autonomous research robot Domestic robot General purpose Home automation Banking automation Laboratory automation Integrated library system Broadcast automation Console automation Building automation Specific purpose Automated attendant Automated guided vehicle Automated highway system Automated pool cleaner Automated reasoning Automated teller machine Automatic painting (robotic) Autonomous mobile robot Pop music automation Remotely operated vehicle Robotic lawn mower Telephone switchboard Vending machine Social movements Technocracy movement Venus Project Zeitgeist Movement vte Automation describes a wide range of technologies that reduce human intervention in processes. Human intervention is reduced by predetermining decision criteria, subprocess relationships, and related actions — and embodying those predeterminations in machines.[1] Automation,[2] includes the use of various equipment and control systems such as machinery, processes in factories, boilers,[3] and heat-treating ovens, switching on telephone networks, steering, and stabilization of ships, aircraft, and other applications and vehicles with reduced human intervention.[4] Automation covers applications ranging from a household thermostat controlling a boiler, to a large industrial control system with tens of thousands of input measurements and output control signals. Automation has also found space in the banking sector. In control complexity, it can range from simple on-off control to multi-variable high-level algorithms. In the simplest type of an automatic control loop, a controller compares a measured value of a process with a desired set value and processes the resulting error signal to change some input to the process, in such a way that the process stays at its set point despite disturbances. This closed-loop control is an application of negative feedback to a system. The mathematical basis of control theory was begun in the 18th century and advanced rapidly in the 20th. Automation has been achieved by various means including mechanical, hydraulic, pneumatic, electrical, electronic devices, and computers, usually in combination. Complicated systems, such as modern factories, airplanes, and ships typically use all these combined techniques. The benefit of automation includes labor savings, reducing waste, savings in electricity costs, savings in material costs, and improvements to quality, accuracy, and precision. The World Bank's World Development Report 2019 shows evidence that the new industries and jobs in the technology sector outweigh the economic effects of workers being displaced by automation.[5] Job losses and downward mobility blamed on Automation has been cited as one of many factors in the resurgence of nationalist, protectionist and populist politics in the US, UK and France, among other countries since the 2010s.[6][7][8][9][10] The term automation, inspired by the earlier word automatic (coming from automaton), was not widely used before 1947, when Ford established an automation department.[2] It was during this time that industry was rapidly adopting feedback controllers, which were introduced in the 1930s.[11] Open-loop and closed-loop (feedback) control Fundamentally, there are two types of control loops: open-loop control, and closed-loop control. In open-loop control, the control action from the controller is independent of the "process output" (or "controlled process variable"). A good example of this is a central heating boiler controlled only by a timer, so that heat is applied for a constant time, regardless of the temperature of the building. (The control action is switching the boiler off and on. The process output is building temperature.) In closed-loop control, the control action from the controller is dependent on the process output. In the case of the boiler analogy, this would include a temperature sensor to monitor the building temperature, and thereby feed a signal back to the controller to ensure it maintains the building at the temperature set on the thermostat. A closed-loop controller, therefore, has a feedback loop that ensures the controller exerts a control action to give a process output equal to the "reference input" or "set point". For this reason, closed-loop control is also called feedback control.[12] The definition of a closed-loop control system according to the British Standard Institution is 'a control system possessing monitoring feedback, the deviation signal formed as a result of this feedback being used to control the action of a final control element in such a way as to tend to reduce the deviation to zero.'[13] Likewise, a Feedback Control System is a system that tends to maintain a prescribed relationship of one system variable to another by comparing functions of these variables and using the difference as a means of control.[13] The advanced type of automation that revolutionized manufacturing, aircraft, communications, and other industries, is feedback control, which is usually continuous and involves taking measurements using a sensor and making calculated adjustments to keep the measured variable within a set range.[11][14] The theoretical basis of closed-loop automation is control theory. Control actions Main article: Control system Discrete control (on/off) One of the simplest types of control is on-off control. An example is a thermostat used on household appliances which either open or close an electrical contact. (Thermostats were originally developed as true feedback-control mechanisms rather than the on-off common household appliance thermostat.) Sequence control, in which a programmed sequence of discrete operations is performed, often based on system logic that involves system states. An elevator control system is an example of sequence control. PID controller Main article: PID controller A block diagram of a PID controller in a feedback loop, r(t) is the desired process value or "set point", and y(t) is the measured process value. A proportional–integral–derivative controller (PID controller) is a control loop feedback mechanism (controller) widely used in industrial control systems. In a PID loop, the controller continuously calculates an error value e (t) {\displaystyle e(t)} as the difference between a desired setpoint and a measured process variable and applies a correction based on proportional, integral, and derivative terms, respectively (sometimes denoted P, I, and D) which give their name to the controller type. The theoretical understanding and application date from the 1920s, and they are implemented in nearly all analog control systems; originally in mechanical controllers, and then using discrete electronics and latterly in industrial process computers. Sequential control and logical sequence or system state control Main article: Programmable logic controller Sequential control may be either to a fixed sequence or to a logical one that will perform different actions depending on various system states. An example of an adjustable but otherwise fixed sequence is a timer on a lawn sprinkler. States refer to the various conditions that can occur in a use or sequence scenario of the system. An example is an elevator, which uses logic based on the system state to perform certain actions in response to its state and operator input. For example, if the operator presses the floor n button, the system will respond depending on whether the elevator is stopped or moving, going up or down, or if the door is open or closed, and other conditions.[15] Early development of sequential control was relay logic, by which electrical relays engage electrical contacts which either start or interrupt power to a device. Relays were first used in telegraph networks before being developed for controlling other devices, such as when starting and stopping industrial-sized electric motors or opening and closing solenoid valves. Using relays for control purposes allowed event-driven control, where actions could be triggered out of sequence, in response to external events. These were more flexible in their response than the rigid single-sequence cam timers. More complicated examples involved maintaining safe sequences for devices such as swing bridge controls, where a lock bolt needed to be disengaged before the bridge could be moved, and the lock bolt could not be released until the safety gates had already been closed. The total number of relays and cam timers can number into the hundreds or even thousands in some factories. Early programming techniques and languages were needed to make such systems manageable, one of the first being ladder logic, where diagrams of the interconnected relays resembled the rungs of a ladder. Special computers called programmable logic controllers were later designed to replace these collections of hardware with a single, more easily re-programmed unit. In a typical hard wired motor start and stop circuit (called a control circuit) a motor is started by pushing a "Start" or "Run" button that activates a pair of electrical relays. The "lock-in" relay locks in contacts that keep the control circuit energized when the push-button is released. (The start button is a normally open contact and the stop button is normally closed contact.) Another relay energizes a switch that powers the device that throws the motor starter switch (three sets of contacts for three-phase industrial power) in the main power circuit. Large motors use high voltage and experience high in-rush current, making speed important in making and breaking contact. This can be dangerous for personnel and property with manual switches. The "lock-in" contacts in the start circuit and the main power contacts for the motor are held engaged by their respective electromagnets until a "stop" or "off" button is pressed, which de-energizes the lock in relay.[16] This state diagram shows how UML can be used for designing a door system that can only be opened and closed. Commonly interlocks are added to a control circuit. Suppose that the motor in the example is powering machinery that has a critical need for lubrication. In this case, an interlock could be added to ensure that the oil pump is running before the motor starts. Timers, limit switches, and electric eyes are other common elements in control circuits. Solenoid valves are widely used on compressed air or hydraulic fluid for powering actuators on mechanical components. While motors are used to supply continuous rotary motion, actuators are typically a better choice for intermittently creating a limited range of movement for a mechanical component, such as moving various mechanical arms, opening or closing valves, raising heavy press-rolls, applying pressure to presses. Computer control Computers can perform both sequential control and feedback control, and typically a single computer will do both in an industrial application. Programmable logic controllers (PLCs) are a type of special-purpose microprocessor that replaced many hardware components such as timers and drum sequencers used in relay logic type systems. General-purpose process control computers have increasingly replaced stand-alone controllers, with a single computer able to perform the operations of hundreds of controllers. Process control computers can process data from a network of PLCs, instruments, and controllers to implement typical (such as PID) control of many individual variables or, in some cases, to implement complex control algorithms using multiple inputs and mathematical manipulations. They can also analyze data and create real-time graphical displays for operators and run reports for operators, engineers, and management. Control of an automated teller machine (ATM) is an example of an interactive process in which a computer will perform a logic derived response to a user selection based on information retrieved from a networked database. The ATM process has similarities with other online transaction processes. The different logical responses are called scenarios. Such processes are typically designed with the aid of use cases and flowcharts, which guide the writing of the software code. The earliest feedback control mechanism was the water clock invented by Greek engineer Ctesibius (285–222 BC). History Early history Ctesibius's clepsydra (3rd century BC) It was a preoccupation of the Greeks and Arabs (in the period between about 300 BC and about 1200 AD) to keep accurate track of time. In Ptolemaic Egypt, about 270 BC, Ctesibius described a float regulator for a water clock, a device not unlike the ball and cock in a modern flush toilet. This was the earliest feedback controlled mechanism.[17] The appearance of the mechanical clock in the 14th century made the water clock and its feedback control system obsolete. The Persian Banū Mūsā brothers, in their Book of Ingenious Devices (850 AD), described a number of automatic controls.[18] Two-step level controls for fluids, a form of discontinuous variable structure controls, was developed by the Banu Musa brothers.[19] They also described a feedback controller.[20][21] The design of feedback control systems up through the Industrial Revolution was by trial-and-error, together with a great deal of engineering intuition. Thus, it was more of an art than a science. It was not until the mid-19th century that the stability of feedback control systems were analyzed using mathematics, the formal language of automatic control theory.[citation needed] The centrifugal governor was invented by Christiaan Huygens in the seventeenth century, and used to adjust the gap between millstones.[22][23][24] Industrial Revolution in Western Europe Steam engines promoted automation through the need to control engine speed and power. The introduction of prime movers, or self-driven machines advanced grain mills, furnaces, boilers, and the steam engine created a new requirement for automatic control systems including temperature regulators (invented in 1624; see Cornelius Drebbel), pressure regulators (1681), float regulators (1700) and speed control devices. Another control mechanism was used to tent the sails of windmills. It was patented by Edmund Lee in 1745.[25] Also in 1745, Jacques de Vaucanson invented the first automated loom. Around 1800, Joseph Marie Jacquard created a punch-card system to program looms.[26] In 1771 Richard Arkwright invented the first fully automated spinning mill driven by water power, known at the time as the water frame.[27] An automatic flour mill was developed by Oliver Evans in 1785, making it the first completely automated industrial process.[28][29] A flyball governor is an early example of a feedback control system. An increase in speed would make the counterweights move outward, sliding a linkage that tended to close the valve supplying steam, and so slowing the engine. A centrifugal governor was used by a Mr. Bunce of England in 1784 as part of a model steam crane.[30][31] The centrifugal governor was adopted by James Watt for use on a steam engine in 1788 after Watt's partner Boulton saw one at a flour mill Boulton & Watt were building.[25] The governor could not actually hold a set speed; the engine would assume a new constant speed in response to load changes. The governor was able to handle smaller variations such as those caused by fluctuating heat load to the boiler. Also, there was a tendency for oscillation whenever there was a speed change. As a consequence, engines equipped with this governor were not suitable for operations requiring constant speed, such as cotton spinning.[25] Several improvements to the governor, plus improvements to valve cut-off timing on the steam engine, made the engine suitable for most industrial uses before the end of the 19th century. Advances in the steam engine stayed well ahead of science, both thermodynamics and control theory.[25] The governor received relatively little scientific attention until James Clerk Maxwell published a paper that established the beginning of a theoretical basis for understanding control theory. 20th century Relay logic was introduced with factory electrification, which underwent rapid adaption from 1900 through the 1920s. Central electric power stations were also undergoing rapid growth and the operation of new high-pressure boilers, steam turbines and electrical substations created a large demand for instruments and controls. Central control rooms became common in the 1920s, but as late as the early 1930s, most process controls were on-off. Operators typically monitored charts drawn by recorders that plotted data from instruments. To make corrections, operators manually opened or closed valves or turned switches on or off. Control rooms also used color-coded lights to send signals to workers in the plant to manually make certain changes.[32] The development of the electronic amplifier during the 1920s, which was important for long-distance telephony, required a higher signal-to-noise ratio, which was solved by negative feedback noise cancellation. This and other telephony applications contributed to the control theory. In the 1940s and 1950s, German mathematician Irmgard Flügge-Lotz developed the theory of discontinuous automatic controls, which found military applications during the Second World War to fire control systems and aircraft navigation systems.[11] Controllers, which were able to make calculated changes in response to deviations from a set point rather than on-off control, began being introduced in the 1930s. Controllers allowed manufacturing to continue showing productivity gains to offset the declining influence of factory electrification.[33] Factory productivity was greatly increased by electrification in the 1920s. U.S. manufacturing productivity growth fell from 5.2%/yr 1919–29 to 2.76%/yr 1929–41. Alexander Field notes that spending on non-medical instruments increased significantly from 1929 to 1933 and remained strong thereafter.[33] The First and Second World Wars saw major advancements in the field of mass communication and signal processing. Other key advances in automatic controls include differential equations, stability theory and system theory (1938), frequency domain analysis (1940), ship control (1950), and stochastic analysis (1941). Starting in 1958, various systems based on solid-state[34][35] digital logic modules for hard-wired programmed logic controllers (the predecessors of programmable logic controllers (PLC)) emerged to replace electro-mechanical relay logic in industrial control systems for process control and automation, including early Telefunken/AEG Logistat, Siemens Simatic, Philips/Mullard/Valvo [de] Norbit, BBC Sigmatronic, ACEC Logacec, Akkord [de] Estacord, Krone Mibakron, Bistat, Datapac, Norlog, SSR, or Procontic systems.[34][36][37][38][39][40] In 1959 Texaco's Port Arthur Refinery became the first chemical plant to use digital control.[41] Conversion of factories to digital control began to spread rapidly in the 1970s as the price of computer hardware fell. Significant applications The automatic telephone switchboard was introduced in 1892 along with dial telephones. By 1929, 31.9% of the Bell system was automatic.[42]:158 Automatic telephone switching originally used vacuum tube amplifiers and electro-mechanical switches, which consumed a large amount of electricity. Call volume eventually grew so fast that it was feared the telephone system would consume all electricity production, prompting Bell Labs to begin research on the transistor.[43] The logic performed by telephone switching relays was the inspiration for the digital computer. The first commercially successful glass bottle blowing machine was an automatic model introduced in 1905.[44] The machine, operated by a two-man crew working 12-hour shifts, could produce 17,280 bottles in 24 hours, compared to 2,880 bottles made by a crew of six men and boys working in a shop for a day. The cost of making bottles by machine was 10 to 12 cents per gross compared to $1.80 per gross by the manual glassblowers and helpers. Sectional electric drives were developed using control theory. Sectional electric drives are used on different sections of a machine where a precise differential must be maintained between the sections. In steel rolling, the metal elongates as it passes through pairs of rollers, which must run at successively faster speeds. In paper making the paper, the sheet shrinks as it passes around steam heated drying arranged in groups, which must run at successively slower speeds. The first application of a sectional electric drive was on a paper machine in 1919.[45] One of the most important developments in the steel industry during the 20th century was continuous wide strip rolling, developed by Armco in 1928.[46] Automated pharmacology production Before automation, many chemicals were made in batches. In 1930, with the widespread use of instruments and the emerging use of controllers, the founder of Dow Chemical Co. was advocating continuous production.[47] Self-acting machine tools that displaced hand dexterity so they could be operated by boys and unskilled laborers were developed by James Nasmyth in the 1840s.[48] Machine tools were automated with Numerical control (NC) using punched paper tape in the 1950s. This soon evolved into computerized numerical control (CNC). Today extensive automation is practiced in practically every type of manufacturing and assembly process. Some of the larger processes include electrical power generation, oil refining, chemicals, steel mills, plastics, cement plants, fertilizer plants, pulp and paper mills, automobile and truck assembly, aircraft production, glass manufacturing, natural gas separation plants, food and beverage processing, canning and bottling and manufacture of various kinds of parts. Robots are especially useful in hazardous applications like automobile spray painting. Robots are also used to assemble electronic circuit boards. Automotive welding is done with robots and automatic welders are used in applications like pipelines. Space/computer age With the advent of the space age in 1957, controls design, particularly in the United States, turned away from the frequency-domain techniques of classical control theory and backed into the differential equation techniques of the late 19th century, which were couched in the time domain. During the 1940s and 1950s, German mathematician Irmgard Flugge-Lotz developed the theory of discontinuous automatic control, which became widely used in hysteresis control systems such as navigation systems, fire-control systems, and electronics. Through Flugge-Lotz and others, the modern era saw time-domain design for nonlinear systems (1961), navigation (1960), optimal control and estimation theory (1962), nonlinear control theory (1969), digital control and filtering theory (1974), and the personal computer (1983). Advantages, disadvantages, and limitations Perhaps the most cited advantage of automation in industry is that it is associated with faster production and cheaper labor costs. Another benefit could be that it replaces hard, physical, or monotonous work.[49] Additionally, tasks that take place in hazardous environments or that are otherwise beyond human capabilities can be done by machines, as machines can operate even under extreme temperatures or in atmospheres that are radioactive or toxic. They can also be maintained with simple quality checks. However, at the time being, not all tasks can be automated, and some tasks are more expensive to automate than others. Initial costs of installing the machinery in factory settings are high, and failure to maintain a system could result in the loss of the product itself. Moreover, some studies seem to indicate that industrial automation could impose ill effects beyond operational concerns, including worker displacement due to systemic loss of employment and compounded environmental damage; however, these findings are both convoluted and controversial in nature, and could potentially be circumvented.[50] The main advantages of automation are: Increased throughput or productivity Improved quality Increased predictability Improved robustness (consistency), of processes or product Increased consistency of output Reduced direct human labor costs and expenses Reduced cycle time Increased accuracy Relieving humans of monotonously repetitive work [51] Required work in development, deployment, maintenance, and operation of automated processes — often structured as "jobs" Increased human freedom to do other things Automation primarily describes machines replacing human action, but it is also loosely associated with mechanization, machines replacing human labor. Coupled with mechanization, extending human capabilities in terms of size, strength, speed, endurance, visual range & acuity, hearing frequency & precision, electromagnetic sensing & effecting, etc., advantages include: [52] Relieving humans of dangerous work stresses and occupational injuries (e.g., fewer strained backs from lifting heavy objects) Removing humans from dangerous environments (e.g. fire, space, volcanoes, nuclear facilities, underwater, etc.) The main disadvantages of automation are: High initial cost Faster production without human intervention can mean faster unchecked production of defects where automated processes are defective. Scaled-up capacities can mean scaled-up problems when systems fail — releasing dangerous toxins, forces, energies, etc., at scaled-up rates. Human adaptiveness is often poorly understood by automation initiators. It is often difficult to anticipate every contingency and develop fully preplanned automated responses for every situation. The discoveries inherent in automating processes can require unanticipated iterations to resolve, causing unanticipated costs and delays. People anticipating employment income may be seriously disrupted by others deploying automation where no similar income is readily available. Paradox of automation The paradox of automation says that the more efficient the automated system, the more crucial the human contribution of the operators. Humans are less involved, but their involvement becomes more critical. Lisanne Bainbridge, a cognitive psychologist, identified these issues notably in her widely cited paper "Ironies of Automation."[53] If an automated system has an error, it will multiply that error until it is fixed or shut down. This is where human operators come in.[54] A fatal example of this was Air France Flight 447, where a failure of automation put the pilots into a manual situation they were not prepared for.[55] Limitations This section does not cite any sources. Please help improve this section by adding citations to reliable sources. Unsourced material may be challenged and removed. (May 2019) (Learn how and when to remove this template message) Current technology is unable to automate all the desired tasks. Many operations using automation have large amounts of invested capital and produce high volumes of product, making malfunctions extremely costly and potentially hazardous. Therefore, some personnel is needed to ensure that the entire system functions properly and that safety and product quality are maintained.[56] As a process becomes increasingly automated, there is less and less labor to be saved or quality improvement to be gained. This is an example of both diminishing returns and the logistic function. As more and more processes become automated, there are fewer remaining non-automated processes. This is an example of the exhaustion of opportunities. New technological paradigms may, however, set new limits that surpass the previous limits. Current limitations Many roles for humans in industrial processes presently lie beyond the scope of automation. Human-level pattern recognition, language comprehension, and language production ability are well beyond the capabilities of modern mechanical and computer systems (but see Watson computer). Tasks requiring subjective assessment or synthesis of complex sensory data, such as scents and sounds, as well as high-level tasks such as strategic planning, currently require human expertise. In many cases, the use of humans is more cost-effective than mechanical approaches even where the automation of industrial tasks is possible. Overcoming these obstacles is a theorized path to post-scarcity economics. Societal impact and unemployment Main article: Technological unemployment Increased automation often causes workers to feel anxious about losing their jobs as technology renders their skills or experience unnecessary. Early in the Industrial Revolution, when inventions like the steam engine were making some job categories expendable, workers forcefully resisted these changes. Luddites, for instance, were English textile workers who protested the introduction of weaving machines by destroying them.[57] More recently, some residents of Chandler, Arizona, have slashed tires and pelted rocks at driver-less cars, in protest over the cars' perceived threat to human safety and job prospects.[58] The relative anxiety about automation reflected in opinion polls seems to correlate closely with the strength of organized labor in that region or nation. For example, while a study by the Pew Research Center indicated that 72% of Americans are worried about increasing automation in the workplace, 80% of Swedes see automation and artificial intelligence as a good thing, due to the country's still-powerful unions and a more robust national safety net.[59] In the United States, 47% of all current jobs have the potential to be fully automated by 2033, according to the research of experts Carl Benedikt Frey and Michael Osborne. Furthermore, wages and educational attainment appear to be strongly negatively correlated with an occupation's risk of being automated.[60] Even highly skilled professional jobs like a lawyer, doctor, engineer, journalist are at risk of automation.[61] Prospects are particularly bleak for occupations that do not presently require a university degree, such as truck driving.[62] Even in high-tech corridors like Silicon Valley, concern is spreading about a future in which a sizable percentage of adults have little chance of sustaining gainful employment.[63] "In The Second Machine Age, Erik Brynjolfsson and Andrew McAfee argue that "...there's never been a better time to be a worker with special skills or the right education, because these people can use technology to create and capture value. However, there's never been a worse time to be a worker with only 'ordinary' skills and abilities to offer, because computers, robots, and other digital technologies are acquiring these skills and abilities at an extraordinary rate."[64] As the example of Sweden suggests, however, the transition to a more automated future need not inspire panic, if there is sufficient political will to promote the retraining of workers whose positions are being rendered obsolete. According to a 2020 study in the Journal of Political Economy, automation has robust negative effects on employment and wages: "One more robot per thousand workers reduces the employment-to-population ratio by 0.2 percentage points and wages by 0.42%."[65] Research by Carl Benedikt Frey and Michael Osborne of the Oxford Martin School argued that employees engaged in "tasks following well-defined procedures that can easily be performed by sophisticated algorithms" are at risk of displacement, and 47% of jobs in the US were at risk. The study, released as a working paper in 2013 and published in 2017, predicted that automation would put low-paid physical occupations most at risk, by surveying a group of colleagues on their opinions.[66] However, according to a study published in McKinsey Quarterly[67] in 2015 the impact of computerization in most cases is not the replacement of employees but automation of portions of the tasks they perform.[68] The methodology of the McKinsey study has been heavily criticized for being intransparent and relying on subjective assessments.[69] The methodology of Frey and Osborne has been subjected to criticism, as lacking evidence, historical awareness, or credible methodology.[70][71] In addition the OECD, found that across the 21 OECD countries, 9% of jobs are automatable.[72] The Obama administration has pointed out that every 3 months "about 6 percent of jobs in the economy are destroyed by shrinking or closing businesses, while a slightly larger percentage of jobs are added."[73] A recent MIT economics study of automation in the United States from 1990 to 2007 found that there may be a negative impact on employment and wages when robots are introduced to an industry. When one robot is added per one thousand workers, the employment to population ratio decreases between 0.18 and 0.34 percentages and wages are reduced by 0.25–0.5 percentage points. During the time period studied, the US did not have many robots in the economy which restricts the impact of automation. However, automation is expected to triple (conservative estimate) or quadruple (a generous estimate) leading these numbers to become substantially higher.[74] Based on a formula by Gilles Saint-Paul, an economist at Toulouse 1 University, the demand for unskilled human capital declines at a slower rate than the demand for skilled human capital increases.[75] In the long run and for society as a whole it has led to cheaper products, lower average work hours, and new industries forming (i.e., robotics industries, computer industries, design industries). These new industries provide many high salary skill-based jobs to the economy. By 2030, between 3 and 14 percent of the global workforce will be forced to switch job categories due to automation eliminating jobs in an entire sector. While the number of jobs lost to automation is often offset by jobs gained from technological advances, the same type of job loss is not the same one replaced and that leading to increasing unemployment in the lower-middle class. This occurs largely in the US and developed countries where technological advances contribute to higher demand for highly skilled labor but demand for middle-wage labor continues to fall. Economists call this trend "income polarization" where unskilled labor wages are driven down and skilled labor is driven up and it is predicted to continue in developed economies.[76] Unemployment is becoming a problem in the United States due to the exponential growth rate of automation and technology. According to Kim, Kim, and Lee (2017:1), "[a] seminal study by Frey and Osborne in 2013 predicted that 47% of the 702 examined occupations in the United States faced a high risk of decreased employment rate within the next 10–25 years as a result of computerization." As many jobs are becoming obsolete, which is causing job displacement, one possible solution would be for the government to assist with a universal basic income (UBI) program. UBI would be a guaranteed, non-taxed income of around 1000 dollars per month, paid to all U.S. citizens over the age of 21. UBI would help those who are displaced take on jobs that pay less money and still afford to get by. It would also give those that are employed with jobs that are likely to be replaced by automation and technology extra money to spend on education and training on new demanding employment skills. UBI, however, should be seen as a short-term solution as it doesn't fully address the issue of income inequality which will be exacerbated by job displacement. Lights-out manufacturing Main article: Lights out (manufacturing) Lights-out manufacturing is a production system with no human workers, to eliminate labor costs. Lights out manufacturing grew in popularity in the U.S. when General Motors in 1982 implemented humans "hands-off" manufacturing to "replace risk-averse bureaucracy with automation and robots". However, the factory never reached full "lights out" status.[77] The expansion of lights out manufacturing requires:[78] Reliability of equipment Long-term mechanic capabilities Planned preventive maintenance Commitment from the staff Health and environment This section possibly contains original research. Please improve it by verifying the claims made and adding inline citations. Statements consisting only of original research should be removed. (March 2018) (Learn how and when to remove this template message) The costs of automation to the environment are different depending on the technology, product or engine automated. There are automated engines that consume more energy resources from the Earth in comparison with previous engines and vice versa.[citation needed] Hazardous operations, such as oil refining, the manufacturing of industrial chemicals, and all forms of metal working, were always early contenders for automation.[dubious – discuss][citation needed] The automation of vehicles could prove to have a substantial impact on the environment, although the nature of this impact could be beneficial or harmful depending on several factors. Because automated vehicles are much less likely to get into accidents compared to human-driven vehicles, some precautions built into current models (such as anti-lock brakes or laminated glass) would not be required for self-driving versions. Removing these safety features would also significantly reduce the weight of the vehicle, thus increasing fuel economy and reducing emissions per mile. Self-driving vehicles are also more precise concerning acceleration and breaking, and this could contribute to reduced emissions. Self-driving cars could also potentially utilize fuel-efficient features such as route mapping that can calculate and take the most efficient routes. Despite this potential to reduce emissions, some researchers theorize that an increase in the production of self-driving cars could lead to a boom of vehicle ownership and use. This boom could potentially negate any environmental benefits of self-driving cars if a large enough number of people begin driving personal vehicles more frequently.[79] Automation of homes and home appliances is also thought to impact the environment, but the benefits of these features are also questioned. A study of energy consumption of automated homes in Finland showed that smart homes could reduce energy consumption by monitoring levels of consumption in different areas of the home and adjusting consumption to reduce energy leaks (e.g. automatically reducing consumption during the nighttime when activity is low). This study, along with others, indicated that the smart home's ability to monitor and adjust consumption levels would reduce unnecessary energy usage. However, new research suggests that smart homes might not be as efficient as non-automated homes. A more recent study has indicated that, while monitoring and adjusting consumption levels does decrease unnecessary energy use, this process requires monitoring systems that also consume a significant amount of energy. This study suggested that the energy required to run these systems is so much so that it negates any benefits of the systems themselves, resulting in little to no ecological benefit.[80] Convertibility and turnaround time Main article: Turnaround time This section does not cite any sources. Please help improve this section by adding citations to reliable sources. Unsourced material may be challenged and removed. (May 2019) (Learn how and when to remove this template message) Another major shift in automation is the increased demand for flexibility and convertibility in manufacturing processes. Manufacturers are increasingly demanding the ability to easily switch from manufacturing Product A to manufacturing Product B without having to completely rebuild the production lines. Flexibility and distributed processes have led to the introduction of Automated Guided Vehicles with Natural Features Navigation. Digital electronics helped too. Former analog-based instrumentation was replaced by digital equivalents which can be more accurate and flexible, and offer greater scope for more sophisticated configuration, parametrization, and operation. This was accompanied by the fieldbus revolution which provided a networked (i.e. a single cable) means of communicating between control systems and field-level instrumentation, eliminating hard-wiring. Discrete manufacturing plants adopted these technologies fast. The more conservative process industries with their longer plant life cycles have been slower to adopt and analog-based measurement and control still dominate. The growing use of Industrial Ethernet on the factory floor is pushing these trends still further, enabling manufacturing plants to be integrated more tightly within the enterprise, via the internet if necessary. Global competition has also increased demand for Reconfigurable Manufacturing Systems. Automation tools Engineers can now have numerical control over automated devices. The result has been a rapidly expanding range of applications and human activities. Computer-aided technologies (or CAx) now serve as the basis for mathematical and organizational tools used to create complex systems. Notable examples of CAx include computer-aided design (CAD software) and computer-aided manufacturing (CAM software). The improved design, analysis, and manufacture of products enabled by CAx has been beneficial for industry.[81] Information technology, together with industrial machinery and processes, can assist in the design, implementation, and monitoring of control systems. One example of an industrial control system is a programmable logic controller (PLC). PLCs are specialized hardened computers which are frequently used to synchronize the flow of inputs from (physical) sensors and events with the flow of outputs to actuators and events.[82] An automated online assistant on a website, with an avatar for enhanced human–computer interaction Human-machine interfaces (HMI) or computer human interfaces (CHI), formerly known as man-machine interfaces, are usually employed to communicate with PLCs and other computers. Service personnel who monitor and control through HMIs can be called by different names. In the industrial process and manufacturing environments, they are called operators or something similar. In boiler houses and central utility departments, they are called stationary engineers.[83] Different types of automation tools exist: ANN – Artificial Neural Network DCS – Distributed Control System HMI – Human Machine Interface RPA – Robotic Process Automation SCADA – Supervisory Control and Data Acquisition PLC – Programmable Logic Controller Instrumentation Motion control Robotics Host simulation software (HSS) is a commonly used testing tool that is used to test the equipment software. HSS is used to test equipment performance concerning factory automation standards (timeouts, response time, processing time).[84] Cognitive automation Cognitive automation, as a subset of artificial intelligence, is an emerging genus of automation enabled by cognitive computing. Its primary concern is the automation of clerical tasks and workflows that consist of structuring unstructured data.[85] Cognitive automation relies on multiple disciplines: natural language processing, real-time computing, machine learning algorithms, big data analytics, and evidence-based learning.[86] According to Deloitte, cognitive automation enables the replication of human tasks and judgment "at rapid speeds and considerable scale."[87] Such tasks include: Document redaction Data extraction and document synthesis / reporting Contract management Natural language search Customer, employee, and stakeholder onboarding Manual activities and verifications Follow-up and email communications Recent and emerging applications Main article: Emerging technologies Automated power production Technologies like solar panels, wind turbines, and other renewable energy sources—together with smart grids, micro-grids, battery storage—can automate power production. Retail Main article: Automated retail Many supermarkets and even smaller stores are rapidly introducing self-checkout systems reducing the need for employing checkout workers. In the United States, the retail industry employs 15.9 million people as of 2017 (around 1 in 9 Americans in the workforce). Globally, an estimated 192 million workers could be affected by automation according to research by Eurasia Group.[88] A soft drink vending machine in Japan, an example of automated retail Online shopping could be considered a form of automated retail as the payment and checkout are through an automated online transaction processing system, with the share of online retail accounting jumping from 5.1% in 2011 to 8.3% in 2016.[citation needed] However, two-thirds of books, music, and films are now purchased online. In addition, automation and online shopping could reduce demands for shopping malls, and retail property, which in the USA is currently estimated to account for 31% of all commercial property or around 7 billion square feet (650 million square metres). Amazon has gained much of the growth in recent years for online shopping, accounting for half of the growth in online retail in 2016.[88] Other forms of automation can also be an integral part of online shopping, for example, the deployment of automated warehouse robotics such as that applied by Amazon using Kiva Systems. Food and drink Main article: Automated restaurant KUKA industrial robots being used at a bakery for food production The food retail industry has started to apply automation to the ordering process; McDonald's has introduced touch screen ordering and payment systems in many of its restaurants, reducing the need for as many cashier employees.[89] The University of Texas at Austin has introduced fully automated cafe retail locations.[90] Some Cafes and restaurants have utilized mobile and tablet "apps" to make the ordering process more efficient by customers ordering and paying on their device.[91] Some restaurants have automated food delivery to tables of customers using a Conveyor belt system. The use of robots is sometimes employed to replace waiting staff.[92] Construction Main article: Automation in construction Mining Main article: Automated mining Automated mining involves the removal of human labor from the mining process.[93] The mining industry is currently in the transition towards automation. Currently, it can still require a large amount of human capital, particularly in the third world where labor costs are low so there is less incentive for increasing efficiency through automation. Video surveillance The Defense Advanced Research Projects Agency (DARPA) started the research and development of automated visual surveillance and monitoring (VSAM) program, between 1997 and 1999, and airborne video surveillance (AVS) programs, from 1998 to 2002. Currently, there is a major effort underway in the vision community to develop a fully-automated tracking surveillance system. Automated video surveillance monitors people and vehicles in real-time within a busy environment. Existing automated surveillance systems are based on the environment they are primarily designed to observe, i.e., indoor, outdoor or airborne, the number of sensors that the automated system can handle and the mobility of sensors, i.e., stationary camera vs. mobile camera. The purpose of a surveillance system is to record properties and trajectories of objects in a given area, generate warnings or notify the designated authorities in case of occurrence of particular events.[94] Highway systems Main articles: Automated highway systems and Vehicular automation As demands for safety and mobility have grown and technological possibilities have multiplied, interest in automation has grown. Seeking to accelerate the development and introduction of fully automated vehicles and highways, the United States Congress authorized more than $650 million over six years for intelligent transport systems (ITS) and demonstration projects in the 1991 Intermodal Surface Transportation Efficiency Act (ISTEA). Congress legislated in ISTEA that:[95][T]he Secretary of Transportation shall develop an automated highway and vehicle prototype from which future fully automated intelligent vehicle-highway systems can be developed. Such development shall include research in human factors to ensure the success of the man-machine relationship. The goal of this program is to have the first fully automated highway roadway or an automated test track in operation by 1997. This system shall accommodate the installation of equipment in new and existing motor vehicles.Full automation commonly defined as requiring no control or very limited control by the driver; such automation would be accomplished through a combination of sensor, computer, and communications systems in vehicles and along the roadway. Fully automated driving would, in theory, allow closer vehicle spacing and higher speeds, which could enhance traffic capacity in places where additional road building is physically impossible, politically unacceptable, or prohibitively expensive. Automated controls also might enhance road safety by reducing the opportunity for driver error, which causes a large share of motor vehicle crashes. Other potential benefits include improved air quality (as a result of more-efficient traffic flows), increased fuel economy, and spin-off technologies generated during research and development related to automated highway systems.[96] Waste management Automated side loader operation Automated waste collection trucks prevent the need for as many workers as well as easing the level of labor required to provide the service.[97] Business process Main article: Business process automation Business process automation (BPA) is the technology-enabled automation of complex business processes.[98] It can help to streamline a business for simplicity, achieve digital transformation, increase service quality, improve service delivery or contain costs. BPA consists of integrating applications, restructuring labor resources and using software applications throughout the organization. Robotic process automation (RPA; or RPAAI for self-guided RPA 2.0) is an emerging field within BPA and uses artificial intelligence. BPAs can be implemented in a number of business areas including marketing, sales and workflow. Home Main article: Home automation Home automation (also called domotics) designates an emerging practice of increased automation of household appliances and features in residential dwellings, particularly through electronic means that allow for things impracticable, overly expensive or simply not possible in recent past decades. The rise in the usage of home automation solutions has taken a turn reflecting the increased dependency of people on such automation solutions. However, the increased comfort that gets added through these automation solutions is remarkable.[99] Laboratory Main article: Laboratory automation Automated laboratory instrument Automation is essential for many scientific and clinical applications.[100] Therefore, automation has been extensively employed in laboratories. From as early as 1980 fully automated laboratories have already been working.[101] However, automation has not become widespread in laboratories due to its high cost. This may change with the ability of integrating low-cost devices with standard laboratory equipment.[102][103] Autosamplers are common devices used in laboratory automation. Logistics automation Main article: Logistics automationLogistics automation is the application of computer software or automated machinery to improve the efficiency of logistics operations. Typically this refers to operations within a warehouse or distribution center, with broader tasks undertaken by supply chain engineering systems and enterprise resource planning systems. Industrial automation See also: Building automation and Laboratory automationIndustrial automation deals primarily with the automation of manufacturing, quality control, and material handling processes. General-purpose controllers for industrial processes include programmable logic controllers, stand-alone I/O modules, and computers. Industrial automation is to replace the human action and manual command-response activities with the use of mechanized equipment and logical programming commands. One trend is increased use of machine vision[104] to provide automatic inspection and robot guidance functions, another is a continuing increase in the use of robots. Industrial automation is simply required in industries. Energy efficiency in industrial processes has become a higher priority. Semiconductor companies like Infineon Technologies are offering 8-bit micro-controller applications for example found in motor controls, general purpose pumps, fans, and ebikes to reduce energy consumption and thus increase efficiency. Industrial Automation and Industry 4.0 See also: Work 4.0The rise of industrial automation is directly tied to the "Fourth Industrial Revolution", which is better known now as Industry 4.0. Originating from Germany, Industry 4.0 encompasses numerous devices, concepts, and machines,[105] as well as the advancement of the industrial internet of things (IIoT). An "Internet of Things is a seamless integration of diverse physical objects in the Internet through a virtual representation."[106] These new revolutionary advancements have drawn attention to the world of automation in an entirely new light and shown ways for it to grow to increase productivity and efficiency in machinery and manufacturing facilities. Industry 4.0 works with the IIoT and software/hardware to connect in a way that (through communication technologies) add enhancements and improve manufacturing processes. Being able to create smarter, safer, and more advanced manufacturing is now possible with these new technologies. It opens up a manufacturing platform that is more reliable, consistent, and efficient than before. Implementation of systems such as SCADA is an example of software that takes place in Industrial Automation today. SCADA is a supervisory data collection software, just one of the many used in Industrial Automation.[107] Industry 4.0 vastly covers many areas in manufacturing and will continue to do so as time goes on.[105] Industrial robotics Automated milling machines Industrial robotics is a sub-branch in industrial automation that aids in various manufacturing processes. Such manufacturing processes include machining, welding, painting, assembling and material handling to name a few.[108] Industrial robots use various mechanical, electrical as well as software systems to allow for high precision, accuracy and speed that far exceed any human performance. The birth of industrial robots came shortly after World War II as the United States saw the need for a quicker way to produce industrial and consumer goods.[109] Servos, digital logic and solid-state electronics allowed engineers to build better and faster systems and over time these systems were improved and revised to the point where a single robot is capable of running 24 hours a day with little or no maintenance. In 1997, there were 700,000 industrial robots in use, the number has risen to 1.8M in 2017[110] In recent years, artificial intelligence (AI) with robotics is also used in creating an automatic labeling solution, using robotic arms as the automatic label applicator, and AI for learning and detecting the products to be labelled.[111] Programmable Logic Controllers Industrial automation incorporates programmable logic controllers in the manufacturing process. Programmable logic controllers (PLCs) use a processing system which allows for variation of controls of inputs and outputs using simple programming. PLCs make use of programmable memory, storing instructions and functions like logic, sequencing, timing, counting, etc. Using a logic-based language, a PLC can receive a variety of inputs and return a variety of logical outputs, the input devices being sensors and output devices being motors, valves, etc. PLCs are similar to computers, however, while computers are optimized for calculations, PLCs are optimized for control tasks and use in industrial environments. They are built so that only basic logic-based programming knowledge is needed and to handle vibrations, high temperatures, humidity, and noise. The greatest advantage PLCs offer is their flexibility. With the same basic controllers, a PLC can operate a range of different control systems. PLCs make it unnecessary to rewire a system to change the control system. This flexibility leads to a cost-effective system for complex and varied control systems.[112] PLCs can range from small "building brick" devices with tens of I/O in a housing integral with the processor, to large rack-mounted modular devices with a count of thousands of I/O, and which are often networked to other PLC and SCADA systems. They can be designed for multiple arrangements of digital and analog inputs and outputs (I/O), extended temperature ranges, immunity to electrical noise, and resistance to vibration and impact. Programs to control machine operation are typically stored in battery-backed-up or non-volatile memory. It was from the automotive industry in the USA that the PLC was born. Before the PLC, control, sequencing, and safety interlock logic for manufacturing automobiles was mainly composed of relays, cam timers, drum sequencers, and dedicated closed-loop controllers. Since these could number in the hundreds or even thousands, the process for updating such facilities for the yearly model change-over was very time-consuming and expensive, as electricians needed to individually rewire the relays to change their operational characteristics. When digital computers became available, being general-purpose programmable devices, they were soon applied to control sequential and combinatorial logic in industrial processes. However, these early computers required specialist programmers and stringent operating environmental control for temperature, cleanliness, and power quality. To meet these challenges, the PLC was developed with several key attributes. It would tolerate the shop-floor environment, it would support discrete (bit-form) input and output in an easily extensible manner, it would not require years of training to use, and it would permit its operation to be monitored. Since many industrial processes have timescales easily addressed by millisecond response times, modern (fast, small, reliable) electronics greatly facilitate building reliable controllers, and performance could be traded off for reliability.[113] Agent-assisted automation Main article: Agent-assisted automation Agent-assisted automation refers to automation used by call center agents to handle customer inquiries. The key benefit of agent-assisted automation is compliance and error-proofing. Agents are sometimes not fully trained or they forget or ignore key steps in the process. The use of automation ensures that what is supposed to happen on the call actually does, every time. There are two basic types: desktop automation and automated voice solutions. Desktop automation refers to

software programming that makes it easier for the call center agent to work across multiple desktop tools. The automation would take the information entered into one tool and populate it across the others so it did not have to be entered more than once, for example. Automated voice solutions allow the agents to remain on the line while disclosures and other important information is provided to customers in the form of pre-recorded audio files. Specialized applications of these automated voice solutions enable the agents to process credit cards without ever seeing or hearing the credit card numbers or CVV codes.[114] See also Electronics portal Automated storage and retrieval system Automation technician Cognitive computing Control engineering Cybernetics Critique of work Data-driven control system Dirty, dangerous and demeaning Feedforward control Futures studies Industrial Revolution Machine to machine Mobile manipulator Multi-agent system Post-work society Process control Productivity improving technologies Robot tax Robotic process automation Semi-automation Industry 4.0 Technological unemployment References Citations ^ Groover, Mikell (2014). Fundamentals of Modern Manufacturing: Materials, Processes, and Systems. ^ a b Rifkin, Jeremy (1995). The End of Work: The Decline of the Global Labor Force and the Dawn of the Post-Market Era. Putnam Publishing Group. pp. 66, 75. ISBN 978-0-87477-779-6. ^ Lyshevski, S.E. 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Unsourced material may be challenged and removed.Find sources: "8-bit computing" – news · newspapers · books · scholar · JSTOR (October 2009) (Learn how and when to remove this template message) This article relies too much on references to primary sources. Please improve this by adding secondary or tertiary sources. Find sources: "8-bit computing" – news · newspapers · books · scholar · JSTOR (August 2012) (Learn how and when to remove this template message) This article possibly contains original research. Please improve it by verifying the claims made and adding inline citations. Statements consisting only of original research should be removed. (May 2019) (Learn how and when to remove this template message) (Learn how and when to remove this template message) Computer architecture bit widths Bit 1248121618242628303132364045486064128256512bit slicing Application 8163264 Binary floating-point precision 16 (×½)2432 (×1)4064 (×2)80128 (×4)256 (×8) Decimal floating-point precision 3264128 vte In computer architecture, 8-bit integers or other data units are those that are 8 bits wide (1 octet). Also, 8-bit central processing unit (CPU) and arithmetic logic unit (ALU) architectures are those that are based on registers or data buses of that size. Memory addresses (and thus address buses) for 8-bit CPUs are generally larger than 8-bit, usually 16-bit. 8-bit microcomputers are microcomputers that use 8-bit microprocessors. The term '8-bit' is also applied to the character sets that could be used on computers with 8-bit bytes, the best known being various forms of extended ASCII, including the ISO/IEC 8859 series of national character sets – especially Latin 1 for English and Western European languages. The IBM System/360 introduced byte-addressable memory with 8-bit bytes, as opposed to bit-addressable or decimal digit-addressable or word-addressable memory, although its general-purpose registers were 32 bits wide, and addresses were contained in the lower 24 bits of those addresses. Different models of System/360 had different internal data path widths; the IBM System/360 Model 30 (1965) implemented the 32-bit System/360 architecture, but had an 8-bit native path width, and performed 32-bit arithmetic 8 bits at a time.[1] The first widely adopted 8-bit microprocessor was the Intel 8080, being used in many hobbyist computers of the late 1970s and early 1980s, often running the CP/M operating system; it had 8-bit data words and 16-bit addresses. The Zilog Z80 (compatible with the 8080) and the Motorola 6800 were also used in similar computers. The Z80 and the MOS Technology 6502 8-bit CPUs were widely used in home computers and second- and third-generation game consoles of the 1970s and 1980s. Many 8-bit CPUs or microcontrollers are the basis of today's ubiquitous embedded systems. Details An 8-bit register can store 28 different values. The range of integer values that can be stored in 8 bits depends on the integer representation used. With the two most common representations, the range is 0 through 255 (28 − 1) for representation as an (unsigned) binary number, and −128 (−1 × 27) through 127 (27 − 1) for representation as two's complement. 8-bit CPUs use an 8-bit data bus and can therefore access 8 bits of data in a single machine instruction. The address bus is typically a double octet (16 bits) wide, due to practical and economical considerations. This implies a direct address space of 64 KB (65,536 bytes) on most 8-bit processors. Most home computers from the 8-bit era fully exploited the address space, such as the BBC Micro (Model B) with 32 KB of RAM plus 32 KB of ROM. Others like the very popular Commodore 64 had full 64 KB RAM, plus 20 KB ROM, meaning with 16-bit addressing you could not use all of the RAM by default (e.g. from the included BASIC language interpreter in ROM);[2] without exploiting bank switching, which allows for breaking the 64 KB (RAM) limit in some systems. Other computers would have as low as 1 KB (plus 4 KB ROM), such as the Spectrum ZX80 (while the later very popular Sinclair ZX Spectrum had more memory), or even only 128 bytes of RAM (plus storage from a ROM cartridge), as in an early game console Atari 2600 and thus 8-bit addressing would have been enough for the RAM, if it wouldn't have needed to cover ROM too). The Commodore 128, and other 8-bit systems, meaning still with 16-bit addressing, could use more than 64 KB, i.e. 128 KB RAM, also the BBC Master with it expandable to 512 KB of RAM. Further information: Zero page While in general 8-bit CPUs have 16-bit addressing, in some architectures you have both, such as in the MOS Technology 6502 CPU, where the zero page is used extensively, saving one byte in the instructions accessing that page, and also having 16-bit addressing instructions that take 2 bytes for the address plus 1 for the opcode. Commonly index registers are 8-bit (while other "8-bit" CPUs, such as Motorola 6800 had 16-bit index registers), such as the 6502 CPU, and then the size of the arrays addressed using indexed addressing instructions are at most 256 bytes, without needing longer code, i.e. meaning 8-bit addressing to each individual array. Notable 8-bit CPUs Main article: Microprocessor chronology The first commercial 8-bit processor was the Intel 8008 (1972) which was originally intended for the Datapoint 2200 intelligent terminal. Most competitors to Intel started off with such character oriented 8-bit microprocessors. Modernized variants of these 8-bit machines are still one of the most common types of processor in embedded systems. Another notable 8-bit CPU is the MOS Technology 6502. It, and variants of it, were used in a number of personal computers, such as the Apple I and Apple II, the Atari 8-bit family, the BBC Micro, and the Commodore PET and Commodore VIC-20, and in a number of video game consoles, such as the Atari 2600 and the Nintendo Entertainment System. Early or popular 8-bit processors (incomplete) Manufacturer Processor Year Comment Intel 8008 1972 Datapoint 2200 compatible Signetics 2650 1973 Intel 8080 1974 8008 source compatible Motorola 6800 1974 Fairchild F8 1975 MOS 6502 1975 Similar to 6800, but incompatible Microchip PIC 1975 Harvard architecture microcontroller Electronic Arrays EA9002 1976 8-bit data, 12-bit addressing RCA 1802 1976 Zilog Z80 1976 8080 binary compatible Intel 8085 1977 8080 binary compatible Zilog Z8 1978 Harvard architecture microcontroller Motorola 6809 1978 6800 source compatible Intel 8051 1980 Harvard architecture microcontroller Motorola 68008 1982 32-bit registers, 20-bit or 22-bit addressing, three 16-bit ALUs, 8-bit data bus; Motorola 68000 software-compatible, 6809 hardware-compatible MOS 6510 1982 Enhanced 6502 custom-made for use in the Commodore 64 Ricoh 2A03 1982 6502 clone minus BCD instructions for the Nintendo Entertainment System Zilog Z180 1985 Z80 binary compatible Motorola 68HC11 1985 Hudson HuC6280 1987 65C02 binary compatible Atmel AVR 1996 Zilog EZ80 1999 Z80 binary compatible Infineon XC800 2005 Freescale 68HC08 Motorola 6803 NEC 78K0[3] Use for training, prototyping, and general hardware education 8-bit processors continue to be designed today for general education about computer hardware, as well as for hobbyists' interests. One such CPU was designed and implemented using 7400-series integrated circuits on a breadboard.[4][5] Designing 8-bit CPU's and their respective assemblers is a common training exercise for engineering students, engineers, and hobbyists. FPGA's are used for this purpose. See also Kenbak-1 References ^ Amdahl, G. M.; Blaauw, G. A.; Brooks, F. P. (1964). "Architecture of the IBM System/360" (PDF). IBM Journal of Research and Development. 8 (2): 87–101. doi:10.1147/rd.82.0087. Archived (PDF) from the original on 2017-08-10. ^ "Bank Switching - C64-Wiki". www.c64-wiki.com. Retrieved 2021-04-08. ^ "NEC 78K0". NEC. Archived from the original on 2008-10-28. Retrieved 2009-02-10. ^ Oberhaus, Daniel (February 9, 2019). "This Guy Designed and Built an 8-bit CPU from Scratch". Motherboard. Retrieved November 4, 2021. ^ Constantino, Paulo. Homebuilt 8-bit CPU + Computer with graphics and sound made from scratch using 74HC Logic. Retrieved from "

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