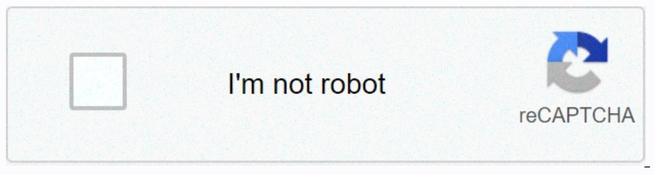

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Long before humans qualified as Homo sapiens, they had used tools. As time went on, the tools they created became more and more advanced. Today, the tools of the trade, like those used to make prototypes of amazing and innovative new products, are so complex and cool, you and I will probably never own them. We don't need that. But for people who invent cutting-edge products, these tools are a must. An interesting prototype made with the tools we will read about on the following pages is the rotating circular water slide pictured above. The team members at Discovery's show Prototype This! also tried to make a 6x6 all terrain runner and robots like the box. The Prototype This! team consists of five scientists and engineers with different disciplines such as animatronics, mechanical engineering and electronics. Together they work to create wild futuristic prototypes in a short time. Ad Unlike the tools that collect cobwebs in the corner of your garage, these high-tech tools are what it takes to push the boundaries of human innovation and create amazing new potential products. On the following pages we take a look at some of the tools used on Prototype This! and explores the interesting functions they perform. Content Common 2D printers have become ubiquitous products in modern times. Three-dimensional printers, on the other hand, are still able to turn some heads. Whether you're an architect or an artist, teacher or product designer, a 3D printer can be exactly what you're looking for. In some ways, the technology is similar to 2D printing because it uses software to break down 3D models into 2D layers - or cross-sectional - of the desired prototype. There are a number of methods to perform 3D printing, but it is usually done in layers. For example, in one method, layers of fine powder are deposited on the flowering prototype, followed in turn by a layer of liquid binder. When an object is printed, it can be coated with sealant to strengthen it. Also, many of the machine's components are similar to those in ordinary printers, but that's where the technologies differ. Ad For one thing, compared to 2D printers, 3D printers are slow. Sure, some are faster than others - Z Corporation makes one of the faster on the market - but even it builds only an inch or two an hour (depending on the size and shape of what is printed). Their ZPrinter 450 lays down layers between 0.0035 and 0.0040 inches thick (.089 to 0.102 millimeters), and it can build prototypes that are 8 inches by 10 inches by 8 inches in size (20 x 25 by 20 centimeters). Z Corporation has another model, the Spectrum Z510, which can build slightly larger prototypes with greater resolution and at about the same speed as the 450. ZPrinter rings up at about $45,000 and Z510 at about $73,000 [source: Prototype Magazine, Prototype Magazine]. Despite potential drawbacks - including the hefty price tag - the possibilities for a 3D ZPrinter are interesting to think about. You can print auxiliary maps of the seabed, prototype products for pitch meetings, model human hearts for research or create architectural models to give construction workers a better visual picture of the design plans. And the best - everything is in color. Different materials can be used in the printing process to create different properties in the finished products; they can be made more rubbery for example. Depending on the company, a variety of techniques and materials can be used that affect the characteristics of the finished product. For example, some make stronger prototypes, some offer more colorful results, others greater precision. On the next page, let's take a closer look at the cutting-edge software that makes 3D printing possible. To print a 3D prototype, the first thing you need is a 3D model. Using special software it is possible to create virtual designs that can be fed into a 3D printer and presto - you have a desktop visual of your product. CAD (computer-assisted design) software first pioneered in the early 1960s, and it became popular on the commercial stage in the 1970s. Since then, a huge field of engineers and designers of all kinds has used the technology to design everything from aircraft engines to the kitchen sink. Advertising SolidWorks is a company that makes top-of-the-line mechanical CAD software, with a variety of tools and features to design, manipulate, compile, correlate and evaluate potential products. SolidWorks software enables users to transform 2D into 3D, use a variety of tools to quickly and efficiently develop the design, simulate the assembly and operation of the prototype, compare and share their finished product and much more. When using the SolidWorks software, it is possible to not only manipulate 2D images and create professional drawings that are ready for the production line, but also to create detailed 3D image maps. These can be sent to 3D printers, and you can have a prototype of your design in minutes (or hours depending on the size). An example of an application of solidworks 3D CAD software was created by MAKO Surgical Group. They designed and built the MAKO Tactile Guidance System - a robotic arm that helps surgeons perform less invasive, more successful operations. The machine not only helps to control the surgeon's movement, it can also let them know where it is safe and appropriate to cut. SolidWorks software proved useful not only for subdesign, but also for mapping the virtual space surgeons navigate. The guys on Prototype This! do not make surgical equipment with their tools, but read about another tool they are to create their own unique prototypes. If you work with electronics and electrical systems, chances are very good you've heard of - and probably own - a multimeter. But to give the rest of us some background, a multimeter is a convenient device capable of measuring a wide range of parameters in the world of all things electrical. For example, they can usually measure connection, frequency, current, resistance, volts, ampere, ohm, temperature and more. This can be useful in many situations: test whether an electric current exists, detect the value of a resistance or check the charging in a battery. Actions like these can help determine malfunctions, solve a number of problems and be very important as security measures. Advertising Let's take a closer look at a popular brand of multimeter - Fluke. Fluke makes several multimeters with a variety of abilities suitable for a variety of users. Advanced features large, well-lit digital displays that can be used to view data trends through graphs and charts. This can be especially useful if you are having trouble tracking down an intermittent electrical problem. Other models are easier for simpler applications. Newer Fluke multimeters often have large memory capacities and longer battery life, making them a good choice for situations that require continuous monitoring. Many are reinforced to be safe in heavy industrial conditions, and they can be essential for troubleshooting and problem solving in hazardous environments such as plants, factories and other engineering facilities. Whether you're fixing a conveyor system, building a robot, or testing a fuse, a multimeter can be just what you need to get the job done safely and efficiently. On the next page, we're examining a similar tool with other important features. Oscilloscopes are much like multimeters, but in most cases they are much more powerful and take measurements and analyses to the next level. An important distinction is also that oscilloscopes focus solely on electrical signals, and when we say focus, we mean it. They actually let a user view the signals they're monitoring. An important tool to have on hand to design and test something that works with electronics and electrical systems, oscilloscope is used by people across a large cross-section of industry. You can find one in an air-defense testing facility, another in a car factory or even one in a variety of research labs. An oscilloscope can show the wave pattern of an electrical signal, and this allows someone to analyze whether it is the right pattern and strength. Ad Agilent Technologies is a company that makes oscilloscopes. Their top-of-the-line models cost upwards of $100,000, but many are more affordable [source: Agilent Technologies]. Let's take a closer look at what one of these affordable oscilloscopes can achieve. At a base price of close to $18,000, InfiniiVision MSO7104A Oscilloscope measures several aspects of electric waves in a 1 gigahertz bandwidth range [source: Agilent Technologies]. It is able to provide measurements to a high degree of accuracy, and perform several mathematical functions on the results to manipulate and study them. It has four analog and 16 digital channels that can be used to view and compare all the separate signals on its 12.1 inch screen. You can watch the waves come in at a maximum speed of 4 giga samples per second with a refresh rate of up to 100,000 waveforms per second, providing great detail and accuracy. InfiniiVision also has a great deal of memory, so you can record sample signals and play them for comparison and study. Now that we've looked at some cool tools for design and testing, let's move on to the factory floor. Laser engraving machines (also known as laser etsification machines, laser cutters and a number of other similar names describing their various functions) have become increasingly popular, both for the precision clarity of the results and the speed with which they operate. In the process, a laser beam is programmed to create a design on a variety of possible materials. These materials can be organic, such as paper, stone, wood, rubber and leather, or they can be plastic or metal. Lasers create a neatly polished edge as they evaporate or cut controlled parts of the material into your designated pattern. Laser diggers can be called cutting, engraving, scribbling, drilling, marking and other related modeling techniques. They can be used for pretty much anything you can think of that is etched or printed, whether it's a picture frame, trophy, printed circuit board, jewelry, you name it. Laser cutters can also be useful in industrial environments, whether for mass production, prototype production or something in between. Ad A laser cutter, VersaLASER VLS3.50, can shape, etch, write and cut objects in a workspace 24 x 12 inches (approx. 61 x 31 centimeters). This diverse and incredibly precise machine weighs in at 110 to 123 pounds (50 to 56 kilograms) and needs a computer all the way to itself to run, operating on either Windows XP or Windows Vista. It requires an exhaust system, and while the laser engraver is not so expensive to drive, it is expensive to acquire. VersaLASER also has a cylindrical axis to create a versatile effect. A basic way to understand laser engravers is to look at how similar they are to printers. Just instead of working by adding a material to a surface, they create details by taking it away. Let's look at a machine with a somewhat similar feature on the next page. A CNC machine – which stands for computernumeric control – is a type of computerised workshop device that replaces more workshop machines. CNCs are able to perform many regular store jobs like drilling, milling and turning - and they do everything by themselves, making the shape you define. CNC machines are computer-programmed to perform all the tasks a human would have had to do on a manual machine, as well as many tasks that humans simply are not able to do. Whether it's cutting a sinuous curve into a heavy steel plate, or engraving a thumbnail on the back of a gold watch, CNCs can do it faster and with greater accuracy than any other type of machine. Most CNCs move on a variety of linear and rotating axes, and can perform a variety of complex tasks – the more axes, the more versatile tasks and the more complex shape that it is possible to cut. Ad A CNC in particular, Tormach PCNC 1100 Mill (it's personal computer numerical control), stands as a leader in the field and can be exactly what you need whether you're an engineer, an entrepreneur or a hobbyist. The machine can cut through everything, from wood and plastic to even steel, iron, titanium and chrome alloys – and shape them into the final 3D product you're looking for. PCNC's 1.5 horsepower spindle rotates at speeds between 100 and 5000 RPMs. Do you want the whole package? PCNC and all associated gadgets will set you back about $16,000 [source: Tormach]. But that price includes a long list of accessories; PCNC 1100 Mill itself costs $7,480, and you can mix and match your extras. And it is not as expensive as it can be; During the design process, the people of Tormach worked to keep this personal CNC affordable, as well as easy to use. Read about another type of tool found in the Prototype This toolbox! on the next page. When two metal surfaces need to be folded and they cannot be melted, you will reach for your trusty soldering iron. Solder makes use of the fact that different metals have different melting points - using a metal alloy with a lower melting point than the two you join do the trick. Soldering can be difficult, though. Getting just the right amount of heat and solder on the project can be challenging, especially if you use a solder that needs a lot of heat like some of the unleaded. Then there is humidification and fluxes and the danger that you have not formed a strong enough bond between what you are trying to connect to. There is much to consider in good solder. Ad Because of all this, many companies are developing technologies to make the process run smoother. An example is OK International, a company that develops and sells tools for electronics assembly equipment, like their PS-900 Soldering Station. The PS-900 uses SmartHeat technology to provide extremely stable heat levels through the soldering process – that is, until you put it into the convenient automatic sleep Unleaded alloys work well with the PS-900. Depending on what you use for solder, and what you're betting on, the company offers different tips to get the best match. This soldering system can also be used in conjunction with other OK International products such as their smoke extraction systems, liquid dispensers and other related tools. We've seen what happens when things warm up; Let's cool them off a little on the next page. A cold saw is a special type of circular saw that uses a coolant system during the cutting process. This helps reduce sparks, dust and gravel while cooling the saw, which helps to produce a smoother cut and increase blade life. Powerful stiff appear of various kinds is common, and these holding materials are cut into a vibration-free grip, another major factor that contributes to precision cutting and long-lasting blades. Cold saws are especially suitable for cutting narrow pipes and small bars - and by producing exact miters (cuts at angles - like 45 degree angle cuts on the pieces of a door frame). They use special saw blades, called high-speed steel or HSS blades, that are less heat resistant and can cut at faster speeds. Ad Let's take a closer look at one of these machines made by Kalamazoo Machine Tool. Cast iron Kalamazoo FHC350D cold saw is a manual machine that can make a big cut that is free of degrees. The saw uses circular high-speed steel blades up to 14 inches (about 35 centimeters) in diameter that can be set to spin at either 26 or 52 revolutions per minute - something you want to adjust depending on what you cut. Now that we've cut everything into pieces, let's check out a cool tool on the next page that can help put it all back together. And this next tool is not like the small soldering system we read about on the last page that is perfect for intricate work - this hot air machine is for the big jobs. MIG welding (which stands for metallinated gas) is achieved by feeding a wire through the contact tip of a welding gun. A shield of gas, also delivered through the tip, surrounds the contact area - protects the electrode line and keeps contamination out of the weld so that it looks better. The feed line is melted when it is live with electricity and forms the welding pond. MIG welding is also known as GMAW (gas metal arc welding - today it may actually have some semi-ineted gases like carbon dioxide in it too - although the term MIG is still popular). The advantages of MIG-style welding is that it saves time, there is not much cleanup, there is less waste and, probably most importantly, you get a very good weld. Ad Millermatic 252 MIG Welder is a good example of this technology, selling at a base price of about $2,500 [source: Miller]. Complete with wheels for easier mobility, this Millermatic can be used for lightweight manufacturing, metal and many other workshop applications. Millermatic can weld steel, stainless steel and aluminum at a wire speed between 50 to 700 inches per minute (about 1.3 to 17.8 meters per minute). Different aspects of the welding job can be preset to save time and allow the welder to control each step of the process. For example, you can specify how long the shield gas will flow before the welding arc is live. Millermatic also has certain memory features, such as storing parameters and settings for the different types of welding guns you can attach to it. We have quite a lot of heavy equipment and materials on our hands now that are going to take up some space. Find out about a cool tool that can be used to carry all this around the workshop on the next page. Most forklifts, and vehicles in general, are not the easiest things in the world to maneuver. This is because the wheels just roll forward and backward - there is no side movement. So if your goal is to move somewhere to the right or left - say to the better parking lot a few spaces down that just opened up - and you'll end up pointed in the same direction when you get there, you'll have to turn around, either go forward or backward, and hit again. In a car this is not so big, but when it comes to vehicles like forklifts, it can be a different story. Forklifts often carry large, large and very heavy objects that can be difficult to load and challenging to maneuver (especially through doorways and other narrow places). Anything that turns and maneuvers at safe, but very slow speeds can also soak up a lot of time. And that's what makes this latest tool so cool - the wheels are designed to let it travel in any direction. The special wheel design was invented by Bengt Ilon of Sweden in the 1970s. It works because the wheels consist of a circular set of rollers arranged at angles along the wheel. In practice, this gives the wheels something similar to the functional shape of a sphere (like the ball bearings in wheelchairs) and greatly increases the range of motion available. You want to go sideways? How about diagonally backwards with a twist at the end? Whatever you want, any direction of movement is now possible. These fancy wheels have begun to appear on various commercial products, including the Airtrax Sidewinder ATX-3000. This forklift is powered with two joysticks and can rotate in a full circle while it remains in one place - no donuts here. It can also run anywhere up to 3 inches high. A great advantage of Sidewinder is that a warehouse can be filled with more elements because less space needs to be devoted to driving maneuvers, all of which can also be achieved faster. To find out more about the world of high-tech tools and other interesting facts, follow the links on the next page. Jackhammers offer incredible power when it to break down hard substances. Find out how these demolition wonders work. 7.1.1 Solder Basics. Circuit Technology Center. 7/7/200. (8/7/2008). MSO7104A Oscilloscope Data Sheet. Agilent Technologies. 2/12/2008. (9/22/2008) Technologies InfiniiVision 7000 Series Oscilloscope data sheet. (September 22, 2008) Technologies Corporate website. (04.08.2008) the company's website. (04.08.2008) Cold Saws. Baileigh Industries Inc. (8/8/2008) software - the history of CAD CAM. Cadazz. 7/2004. (8/5/2008) Saw. The Government of South Australia Department of Education and Children's Services. (8/8/2008) Al. ZCorporation Spectrum Z510. 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