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Welcome to the world of CNC! This page is dedicated to supporting users who are new to subtractive manufacturing and production techniques using desktop CNC mills like the Carvera and Carvera Air. The following tutorials and guides are designed to introduce key concepts, as well as build good practices for safety and success. In addition to the introductory guides found on this page, more how to's and projects can be found on the Knowledge Sharing page once your ready to put your skills to the test! In this introductory video, we define what CNC Machines are, as well as look at different types of CNC Machines and the different types of projects that can be made with them! As you choose a CNC machine, it is important to consider the types materials you want to work with, as well as the types of design files you are looking to create. CNC Mills like the Carvera and Carvera Air can work with a range of 2D and 3D design files, as well as many different materials to make limitless things with precision and repeatability. In this introductory video, we define what CAM software is, as well as look at different types of CAD and CAM programs available and why you might choose one over the other to create something with a CNC machine! As you choose your CAM software, it is important to pick one that is not only compatible with your available resources, but also one that will support your needs and the types of projects you create. At Makera, we want our users to pick whichever CAM software they would like, but we've also noticed that few CAM programs are intuitive or as versatile as our own desktop CNC machines. Because of this, we've recently launched Makera CAM - our own CAM software solution to support our users! In this introductory video, we are looking at steps and procedures to operation our CNC machines safely! CNC mills and routers like the Carvera and Carvera Air utilize a subtractive manufacturing process and offer laser engraving features which can create limitless projects, but it is crucial that we do this in a safe manner and work to reduce potential hazards. This video overviews general setup and features which allow for us to operate CNC machines in virtually any environment while also covering the basics for beginners and users who are new to CNC machines and subtractive manufacturing. In this video, we look at the different types of bits, also known as cutting tools, that you might consider for your CNC Project. Bits are what perform the cutting operations when manufacturing our projects, and choosing the correct bit to perform the type of cut we want on the material we are using is key. This video overviews the commonly used milling bits that are provided with the Carvera and Carvera Air, as well as some specialty bits for more complex projects too! In addition to this tutorial video, you can also learn more about choosing the right bit in this Instructable too. And if you're looking for more bits to support your CNC projects, check out the bits available in the Makera Store. The term Speeds and Feeds refers to the travel and cutting speed that our CNC machines operate at while manufacturing our projects. Choosing the right speeds and feeds is vital for the success of your project, and failure to do so might damage not only your bit, but your machine as well. This introductory video overviews key terms, as well as general practices for finding success as we prepare our projects for manufacturing! In addition to this tutorial video, you can also learn more about setting the right Speeds and Feeds in this Instructable too. You can learn more about the recommended speeds and feeds for the bits provided with the Carvera and Carvera Air on the Speeds & Feeds page of our Wiki site. Stock is the term used to describe the material we used to manufacture our CNC projects. Versatile desktop CNC machines like the Carvera and Carvera Air can work with a wide range of materials, including woods, acrylic, composites, metals, and even printed circuit boards! As you choose the right stock for your project, there are some key considerations like choosing the right bits and speeds and feeds as well as needs for external cooling that will contribute towards the success of your project. This video also discusses the good practice for performing test cuts as we start a new project. In addition to this tutorial video, you can also learn more about choosing the right stock in this Instructable too. And if you're looking for more stock to support your CNC projects, check out the materials available in the Makera Store. As we prepare our projects for manufacturing, a key step towards creating a safe and successful environment is to properly secure the stock to the bed of our CNC machines. Failure to do this might not only ruin the project, but could also damage your machine and create potential hazards. This introductory video overviews how to use the different types of clamps and corner brackets that are provided with the Carvera and Carvera Air, as well as covers key strategies for successful manufacturing with desktop CNC mills. When you're ready, its time to get hands on with your desktop CNC machine so that you may begin to manufacture incredible things! Visit the Knowledge Sharing page of our Wiki site for fun projects and tutorials. You can also find more resources on the official Makera YouTube Channel, and step by step how to's on the official Makera Instructables page. For machine-specific resources to get started, see below: This instructable is a lesson in my free CNC Class. To enroll, click here.In this lesson, we'll go over how to get started with CNC. We'll get acquainted with the basic concepts of CNC by turning a photograph into a 3D relief sculpture. I'll demonstrate this process using a script with Fusion 360.What You'll NeedFusion 360 (Mac / Windows)What You'll DoDownload and install Fusion 360. Sign up as a Hobbyist / Enthusiast / Startup to get it for free.Get a quick orientation of the user interface.Download and install a script that will let you turn a 2D image into a 3D surface.Use the script to create a 3D surface for CNC milling.Fusion 360 is pretty much all I use nowadays in terms of 3D software. FULL DISCLOSURE: Fusion 360 is an Autodesk product, and Instructables is an Autodesk company, so this might seem like a biased choice. That's not exactly the case, and here's why:It's easy to learn. The UI has been carefully designed from the ground up to be clean, minimal, and simple. You can go from zero knowledge about 3D modeling to making simple objects in an afternoon.It's powerful. Once you get through the basics, there's really no limit to the complexity of the things you can design with it. It's easy to create simple models with it, but there's nothing holding you back from modeling a fully articulated gas engine if you want to.It's cross-platform. It's available on Mac and PC, and it's proven to be very stable on both platforms in my experience.It's great for CNC. Fusion has a super sophisticated CAM environment that lets you create all kinds of tool paths, which we'll get into later. It's really awesome to have the CAD and CAM together in the same program, because when you change your model, the tool paths update automatically.It's free. If you make less than $100K per year using it, you just renew with a startup license every year and keep using it free of charge.It's not a web app. Though all your files are backed up on the cloud and rendering is taken care of there, you don't have to rely on a high-speed internet connection to use the program.I've been 3D modeling for over 13 years, and I can tell you honestly that this program is perfect for the kind of work I do: furniture, toys, machines, household products, etc. It makes digital fabrication a breeze, especially laser cutting.There are a number of other programs out there that could be used to produce the same results, and if you're comfortable with something else (especially if you've already paid for it), there's no reason why you shouldn't stick with it. But if you haven't spent any money or invested time in another program, believe me when I say you won't be sorry you went with Fusion 360.3D modeling can seem intimidating if you've never done it before. Like anything else, though, if you start slow with a simple project and keep practicing, you'll be creating complex designs before you know it. Here are a few pointers to help you along:Be patient: 3D modeling can be frustrating in the beginning because the process is foreign. If you can get in the habit of asking yourself why the program isn't doing what you want instead of getting mad at it, you'll learn faster and enjoy it more.Learn the vocabulary: Like anything else, a quick Instructables or Youtube search will likely answer your questions quickly when you're stuck. Do they call it a "line" or a "curve"? Is it a "surface" or a "face"? The tricky part is knowing what to search for! Pay attention to the terminology, and you'll learn much faster.Think in steps: Everything you create can be broken down into a series of steps. The lessons in this class will lay these out for you with all the example projects, but when you move on to your own work, continuing to think this way will be very useful. How do you eat an elephant? One piece at a time!Solve one problem at a time: The most difficult part of 3D modeling is translating what's in your head to what's on the screen. If you think of your project as a series of connected parts and tackle one of them at a time, you'll save yourself from being overwhelmed.If you practice regularly and challenge yourself, you'll be designing your own work in a matter of weeks. I promise.Follow the link to download Fusion (don't use the App Store on Mac).Enter your email and download the free trial.Install and setup a free Autodesk ID account.When you open Fusion, select the Trial Counter in the upper toolbar.In the next dialog box, select "Register for Free Use".Sign up as a Start-Up or Enthusiast (Free). You can also Sign up as a Student or Educator (Free) if you're a student or educator at a registered institution.Select the "I accept Terms and Conditions" checkbox and click Submit.Fusion 360 has a great Youtube channel with lots of helpful videos. If you're the type of person who likes to learn software by going through every function it can perform, this channel is a good place to start. The overview here should get you pretty well oriented to the interface and give you an idea of how the program works.But before we dive into a full-fledged 3D model, I'll quickly run through the interface.PRO TIP: Use a 3-button mouse! It's so much easier than using a trackpad.Application bar: Access the Data Panel, file operations, save, undo and redo.Profile and help: In Profile, you can control your profile and account settings, or use the help menu to continue your learning or get help in troubleshooting.Toolbar: Use the Toolbar to select the workspace you want to work in, and the tool you want to use in the workspace selected.ViewCube: Use the ViewCube to orbit your design or view the design from standard view positions.Browser: The browser lists objects in your design. Use the browser to make changes to objects and control visibility of objects.Canvas and marking menu: Left click to select objects in the canvas (the space where you make your models). Right-click to access the marking menu. The marking menu contains frequently used commands in the wheel and all commands in the overflow menu.Timeline: The timeline lists operations performed on your design. Right-click operations in the timeline to make changes. Drag operations to change the order they are calculated.Navigation bar and display settings: The navigation bar contains commands used to zoom, pan, and orbit your design. The display settings control the appearance of the interface and how designs are displayed in canvas.There are three ways to manipulate the view of your design:Navigation BarViewCubeWheel button on a mouseNavigation BarThe navigation bar is positioned at the bottom of the canvas. It provides access to navigation commands. The menus on the right end control Display Settings and Layout Grid options.To start a navigation command, click a button on the navigation bar.Navigation CommandsOrbit: A set of commands that rotate the current view.Look At: Views faces of a model from a selected plane.Pan: Moves the view parallel to the screen.Zoom: Increases or decreases the magnification of the current view.Fit: Positions the entire model on the screen.Display SettingsSet of commands that enables you to specify desired visual style, visibility of objects, or camera settings, for example.Grid and SnapsCommands that allow you to specify increments, grid settings, and show / hide the layout grid.ViewportsViewports are windows that display your design. You can show up to four viewports in the canvas at once. Displaying multiple viewports allows you to work in one view and see the changes from other camera positions.ViewCubeUse the ViewCube to rotate the camera. Drag the ViewCube to perform a free orbit. Click faces and corners of the cube to access standard orthographic and isometric views.Mouse: Use mouse shortcuts to zoom in/out, pan the view and orbit the view.Scroll middle mouse button to zoom in or zoom out.Click and hold the middle mouse button to pan the view.Shift Key + middle mouse button to orbit the view.Trackpad: If you have a Mac with a touchpad or an Apple Magic Mouse, you can use multi-touch gestures to navigate the view.Pinch to zoom in.Spread to zoom out.Two finger drag to pan.SHIFT + two finger drag to rotate.For more help with the UI, click here."Script" is shorthand for a bit of code that you can plug into the program to give it a new tool that wasn't included by the software developer. There are dozens of scripts that allow you to do some pretty awesome things.To translate a 2D bitmap image to a 3D surface for CNC milling, we're going to use the Image-2-Surface script written by Hans Kellner.The script is very simple. All it does is translate the value (level of lightness or darkness) of a bitmap image to the height of a point on a mesh surface. The white parts of an image will be the highest points, and the black parts will be the lowest points. This script will work with any photo, but I find it's best to use grayscale images because it's easier to predict what it will look like in 3D.INSTALL THE SCRIPTFirst, download the Zip file attached belo and unzip it in a location of your choice. I would advise keeping it some place other than the Downloads folder, or any other folder that is regularly cleaned out.To load the script in Fusion, follow these steps:Start Fusion 360 and then select the ADD-INS > Scripts and Add-Ins... menu item.The Scripts and Add-Ins dialog will appear and display the My Scripts and Sample Scripts folders.Select one of the My Scripts folders, then click on the + icon near the top of the dialog.Locate the Image2Surface.js file in the folder you copied, select it, and click Open. The script should now be installed and ready to be run.Scripts and Add-Ins MenuFusion360Image2Surface-master.zipAfter opening Fusion, I save the untitled file with a new name.With my file saved, and the Workspace set to MODEL, I go to ADD-INS > Scripts and Add-Ins... I select Image2Surface from the list and click Run.CHOOSE A BITMAP IMAGEThe script opens a window where you can choose a bitmap image. I'm using a topographical map of the Monterey Canyons in Santa Cruz.IMPORTANT: the image should be a small size. The higher the resolution, the more points on the mesh, which means slower performance or crashing. The image I'm using is less than 300 X 300 PX and seems to work fine. Notice also that the image is blurred- this makes for a smoother mesh.To find good images for practice, just do a google search for "depth map image" and you'll see lots of images that are ready for this kind of work.If you want to follow along, you can right-click and download the image below and use it to create your 3D surface.Monterrey Canyon File: 288 X 288 PXSETTINGSWhen you've selected your image, click OK and you'll get the Image2Surface script dialog. Here's a breakdown of the settings and what they mean. There's a lot of technical jargon that we won't get into here, but I find that a good place to start learning about this kind of thing is to just play around with the settings and see what happens. The settings shown in the screenshot below seem to yield the best results. You may want to invert your image depending on what it is. When your settings are dialed in, click OK, and the script will make the surface. IMPORTANT: Export format must be set to OBJ in order for the surface to be usable for CNC work later.Mesh created by the Image-2-Surface script by Hans KellnerTROUBLESHOOTINGIs Fusion freezing or crashing when you try to run the script? Chances are, your image is too large. Keep it under 300 X 300 pixels and it shouldn't be a problem. The smaller the image, the faster the processing.The surface the script creates is a Polygon Mesh surface. This type of surface is made up of facets with edges and points. If you zoom in, you'll see that there are no curved surfaces.This type of geometry can't be used to make g-code toolpaths, so we'll need to convert it to T-Spline geometry. A t-spline is a type of NURBS geometry that works with control points that affect a flexible surface.You're going to need a T-Spline geometry to create your CNC tool path, so click the CREATE > Create Form tool from the menu. This tool takes you into the SCULPT workspace.Next, click UTILITES > Convert and select Mesh Body in the Selection Filter. Now click the mesh surface that the script created and click OK. Now it's time to be patient and let the program do its work converting the surface to a T-Spline body- it might take a couple of minutes.Click FINISH FORM and Fusion will go back to the MODEL workspace.PLACE THE SURFACE WITHIN A BLOCKIn order to better visualize what you're going to cut out on the CNC, it's a good idea to create a solid form. First, select the surface in the Bodies folder in the BROWSER on the left-hand side of the screen. Then Right-Click anywhere on the screen and select Move from the menu.Looking at the surface from the side, rotate it 90 so that the top of the surface is facing up.The size of the surface is based completely on the original bitmap image, so now you'll need to scale it to fit the actual size of the piece you want to cut out. To do this, make sure the body is selected in the BROWSER and go to MODIFY > Scale in the menu. Click Point and select the model origin.NOTE: You may need to turn on Origin in the browser in order to see it.Looking at the surface from the Top view, change the Scale Factor so that the surface fits within the size of the piece you want to cut out. I'm going to use a 3" X 3" piece of wood, so I'm looking for a scale factor that will give me a surface that's just slightly bigger than 3" X 3". I can see how big it is on the layout grid.Now that the surface is in place, create a box to represent the material to be cut out. I'm using a 3" X 3" X .76" square, so I go to CREATE > Box and click the model origin as my starting point. The box command asks for a width, a depth, and a height, which you can enter by typing a number and pressing Tab.I can see that the surface to be cut is actually taller than the material to be cut, so not I need to scale the surface down in the Y dimension. I use the Scale tool again, and change Scale Type to Non Uniform. This option will let you scale in any dimension independently. For Y Distance, Choose a number that gives you some breathing room for the surface to fit within the block.To move the surface closer to the top of the block, Right - Click > Move the surface up in the Y direction so that it's just below the top of the block.CREATE A SOLID SURFACEWith both the block and the surface in place, go to MODIFY > Replace Face. Like every other tool in Fusion, it tells you what it needs to work. First, select the Source Face, which in this case is the top surface of the block. Then, click Select under Target Faces and select the surface you just converted from the original mesh. Click Okay, then turn off the original body in the BROWSER and you'll see the finished surface that you'll be making on the CNC.So far, this is what we've covered:How to download and install Fusion 360 with a free license.A quick orientation of the user interface.How to install a script for extra features.How to generate a 3D surface from a 2D image for CNC milling.In the next lesson, you'll learn how to create a toolpath (cutting instructions the CNC machine can read) in Fusion 360. To get started in CNC, you must understand the CNC Basics. This guide will help you find top CNC tutorials suitable for beginners. We'll guide you on the critical concepts you need to learn and the sequence to follow. An excellent roadmap that segments the CNC Basics into easy-to-understand tutorials is unbeatable, as it enables any novice to quickly grasp the concepts.That's exactly what this article is: a Beginner's Roadmap for how to Learn CNC!CNC Basics: Big Picture & ConceptsPersonally, I always start with the big picture and basic concepts. They're the foundation for deeper understanding, and the give you that all-important overview of how the big pieces go together in the puzzle. Once you've got the CNC Basics down, you can drill down and learn cnc in bite-sized chunks.This Big Picture View will seem pretty normal if you're planning to make your living in the CNC Manufacturing world. But, for many hobbyists, they want to jump in and buy or build a CNC machine right away.Here's the thing-learn the CNC Basics first before you try to acquire a machine. Understanding these CNC basics will help you understand your potential new machine's specs and documentation. They'll help you understand what people on forums (great learning resources!) are talking about. This can potentially save you money and frustration. Once you've got at least an overview of the basics, move on to researching how much cnc machines cost.Here's the Big Picture to help you get your arms around those CNC basics fast.Big Picture: Step-By-Step Guide to Making CNC PartsThere are 9 steps to make a CNC part described below. Click on the title of any to drill down and see details for each step.1Design Idealized Part Deliverable: Create an Idealized CAD Model of the PartDesign the part in the CAD software based on sketches, photos, specifications, and any other ideas we have for the part. The part is "Idealized" because we haven't done any serious homework yet to evaluate how easy it will be to manufacture the part. Experienced Designers will have avoided many manufacturing problems at this stage while Beginners will discover they need to change quite a bit to make the part easy to manufacture.2Modify Design for Manufacturing Needs Deliverable: Finished CAD Model + Setup Sheet Outline that is a plan for how to manufacture the part80% of the cost to manufacture a product is determined at Design Time...In this step, we will evaluate how easy it is to manufacture our part, change the design as desired to make it easier to manufacture, and arrive at a plan for how to manufacture the part which we'll capture in our Setup Sheet Outline.3CNC Programming Deliverable: G-Code Part Program + Finished Setup SheetUsing MeshCAM to create a G-Code Part Program...Armed with a CAD model and our Setup Sheet Outline, we're ready to dive into CAM, Conversational Programming, Hand Coding, or whatever method we want to use to create a G-Code Part Program.4Machine Setup Deliverable: CNC Machine is Setup to Run the PartSetup is where we get the CNC Machines all ready to run the part. We need to make sure it has all the right tools in the tool changer, the right gcode program loaded, and in general that the machine is ready to go.5Program Proofing Deliverable: Program is Proven, Ready to Run the PartProofing the program is the last step before we actually make real cuts. The goal of proofing is to verify the program is correct and the CNC machine is setup correctly so that there will be no problems when the g-code is run for the first time. Proofing can be done either by Cutting Air (simple but very time consuming) or by using a CNC Simulator (also called a G-Code Simulator).Click the section title to drill down and see which is better.6Machine the Part Deliverable: CNC'd PartsAfter all the preparation, we're finally ready to make some chips and machine a CNC part.7Manufacturer Quality Control and Part Inspection Deliverable: Inspected Parts, Ready for FinishingHaving finished the CNC machining, it's time for Quality Control. We'll inspect the parts to make sure they meet the desired specifications, tolerances, and surface finishes. But first, most parts will need deburring. See our article on Deburring Tools for Metal to learn more.8Finishing Deliverable: Part is Finished!Our last step involves finishing the parts. It's optional, as our parts may not require it. But, there are many forms of finishing possible ranging from paint, to anodizing, to bead blasting, and more.CNC Basics: The CNC Software StackNow you've got the Big Picture for How CNC Parts are Made. Cool beans! That's an awesome framework to help file away future CNC learnings and concepts.Let's get another framework in place: The CNC Software Stack.By "CNC Software Stack" I mean, "What are the different CNC Software packages used and how do they fit together?"Theres a fair amount of different software that is involved when making a part with CNC. At the very least that includes a CAD program with CAM (or perhapsConversational CNCinstead of CADCAM, but lets start with CAM as a newbie) to generate the g-code, and your machine controller, which turns that g-code into machine motions that make your part for you. Theres a lot of other software out there that youll hear about and wonder about. Its helpful to get a mile-wide-but-inch-deep overview of what all that software does and how it fits together. You wont need all of it to get started, but its still worth understanding it because itll help you understand a lot more about the workflows going from a design concept to a finished part at the software level.To help folks understand the CNC Software Stack better, we wrote an article calledCNC Software: Digital Tooling for CNCthat explains all about what kinds of CNC software are available and how it all fits together. Heres a diagram that shows how the most important pieces of software work together:That article gives you the overview and background. Even better is ourBeginners Guide to the Best CAD CAM Software. Its laser-focused on exactly the software Beginners need to get started. Even better, its chock full of buyers guides, evaluation tips, learning help, and even a guide to the secret deals on the Internet that will let you buy the most popular software uber cheap.Check it out!3 Awesome Software Packages to make you a Better CNC'erG-Wizard Calculator MeshCamThe World's Easiest CAM. Easy Point-and-Shoot G-Code Wizards so you can skip CAD/CAM.Conversational is Free with G-Wizard Editor, our g-code editor and simulator. GW Editor can really help beginners get their arms around g-code.Building or Purchasing a CNC MachineYou've got the overall idea of how CNC Parts are made in hand. You know what the CNC Software Stack looks like. By now you're ready to jump in and start choosing your CNC Machine.Hang on a minute, we'll get there soon. Just know two things.First, the learning curve on the CNC Software will take a little while. Don't be afraid to start there and even get the point where you are pretty comfortable with it before you buy a machine. Otherwise, you're going to wind up terribly frustrated because you're unable to run your shiny new machine and make parts.Second, read as much as you can from the rest of this guide. You need these concepts to help you evaluate your machine choices. CNC Machines are pretty expensive, even the hobby-class machines. And building one trades some of that expense for a big investment of your time. Make sure those time and money investments result in the right machine for your needs!Here's a couple of resources to help you choose and get your CNC machine. If you want to buy an industrial machine, skip ahead past the DIY stuff. If you're a DIY'er, just keep reading.CNC Basics:DIY CNC Machine BasicsThose of you who want to build your own CNC machine, or at least jump ahead to buying one, have been chomping at the bit. You didn't want to wade through all those basics to get here. But, you'll find having that knowledge will really help you to make the right decisions when building or buying a CNC Machine.Who would've thought anyone that wanted one could have a CNC machine right in their own home workshop?You can buy completed machines from companies like Tormach or Carbide3D for very reasonable prices or you can build your own machine, either from scratch or as a conversion of an existing manual machine. Once you have your machine and know how to use it, you'll be able to make beautiful parts quickly and easily.But, there is a challenge-knowing how to use CNC to create your parts requires you to pick up a number of different kinds of knowledge. It's not hard, but it's also not very well organized or accessible. Until now.With this page, we're going to bring together links to articles that cover all the basics you'll need to use a CNC machine or to get started with the planning to buy or make a CNC machine. If you go through these articles, you'll wind up with a solid grounding in the basics.You'll know how things fit together and you'll have the basic background you need to dig deeper into other areas of CNC you get interested in. We'll also organize the page so the order the concepts and articles are presented is an ideal order for you to learn things in.But, you don't have to stick to that order if you don't want to. Feel free to jump around and check out whatever interests you.Buying or Building a CNC MachineThis is where you want to start, right? You want to get your hands on that CNC machine. If you're anything like me, you're not thinking about much of anything else. If you're looking to enter the trade, perhaps you're not thinking about Buying a machine right away. That's fine, just skip ahead to the next chapter.Otherwise, I'm going to start here because it's where everyone wants to start. Just be advised, there's a lot you could learn before getting a machine that would help you to select the best machine for your needs. There's also enough to learn before you make your first CNC part that you should start before getting the machine just so you don't have to look at the idle machine while you're learning.I'm not saying CNC is hard, but there's a pretty good breadth of information you'll need. Easy to learn, just a lot of pieces to put together. But hey, that's why we wrote this guide for you.What Kind of a CNC Machine Should You Get?This is an important first question to answer. Most CNC'ers want one of 4 machines:CNC RouterCNC Mill3D PrinterCNC Plasma TableA distant fifth place might be a CNC Lathe, but let's put that on hold for a minute. Thegood news is we've put together a fabulous article that walks you through it. It considers all 4 machines and walks you through what their capabilities are, how hard they are to build, what it will cost, and so on.Grab that article right here:[4 Awesome DIY CNC Machines You Can Build Today]Buy, Build, or Kit?Okay, that article talks about Building, but it also applies to helping you choose what kind of machine to Buy.On the question of Buy or Build, you should boil the decision down to one simple question:Do you want to make parts sooner or will you enjoy the whole process of building your own CNC Machine?Before we go any further, let me give you an important caveat. A lot of would-be machine builders want to build to save money. They look at what finished CNC machines cost and it seems scary.Now here is an ugly little secret-building a machine takes a long time, it's a lot of work, and in the end you won't have saved much money at all.Wait!I can already hear many of you rebelling against the notion that building your machine won't save much money. Sorry to burst bubbles, but I've been there and done that. Not just once, but MANY times across many interests. It always starts out seeming like it will save. Once I got a little wiser about it, I rationalized it more as getting started sooner and paying as I went. That latter is closer to the truth.Take a CNC Milling machine. I converted one from scratch. It took a huge amount of time, and in the end it cost me about $6000 all told. No, I didn't have to pay that all up front, but you can buy a nice little Tormach for that price and be making parts right away.That's me, building CNCCookbook's Shapeoko CNC Router Kit...Kits: Best of Both Worlds?If you really want the best of both worlds, look into kits. The Shapeoko (watch me build one in the video above), for example, is a great CNC Router kit. Having a packaged kit like the Shapeoko that's been well engineered and has good documentation will save you a huge amount of time. Yet, you can still get one relatively cheaply.We built a Shapeoko at CNCCookbook and it has been a lot of fun.Here's the other big advantage to a kit: there will be others with machines just like yours. You can ask them questions for help and you can see what they've built or done with their machines. What an inspiration!Buying an Industrial or "Pro" CNC MachineWhat's the Best Machine for My Needs?Good news!We can figure this out scientifically if you're looking to be a Pro and start a CNC business. If you're only interested as a Hobby, go back up and read that DIY article on which machine types. Choose a type, then look at what you can afford. See also our article below on how to afford a new machine.OK, let's see about choosing a new CNC Machine for a business scientifically. You know, in a way that ensures you don't get too much or too little machine.Which machine is better for your business, Machine A or Machine B?Weve all been therepouring over machine catalogs and specifications. This one is so coolthe spindle goes 86 zillion rpms, the rapids are faster than light speed, and the tool changer, oh my, THE TOOLCHANGER!!!But is the biggest baddest machining center always the right choice for your business? Or maybe you can justify an even more potent machine than the ones you are considering? How would you know? How can you make that decision based on logic and hard facts that will pay off in the long run?These are questions every would-be CNC Business owner faces when they start, and if the business is successful, eventually theyll need to revisit the question again.To see how to figure this out objectively, with an eye towards maximizing your success, check out this article:[Help: I Need to Choose the Best Machine for My CNC Business]What About Used Machines?Cheap? Yes, to get it off their floor and on to yours. But to get it working properly? Maybe not so cheap!Don't get me started here! Oh wait, you already did. So here's the deal:Some large number of you are thinking you can get a more powerful machine at a great price by purchasing a used machine.A used industrial CNC can be a fabulous investment. It can also be your worst nightmare.Parts for them are often very expensive and some of the machines were beat to death by their previous owners. What you have to ask yourself is whether you're qualified to tell which machines are the good deals and which are the nightmares? Also, if you do have a problem with a used machine, are you qualified to diagnose and fix it, or can you afford to call out the service men?I'm not saying it can't be done, but I do wonder whether a CNC Beginner is the best person to try.How Can I Afford a New Pro CNC Machine?Dude, have you seen what these CNC machines cost?CNC is one of my favorite things in the world, and it is amazing that an individual these days can actually have a full-blown CNC machine thatsmore powerful than the machines used to put men on the moon right in their own garage. Heck, theyre capable of generating a decent living for you too, if you are a reasonably clever business person. But, the initial startup costs can seem steep.This article is all about how to approach the affordability issue:[Help: How Can I Afford to Buy a CNC Machine?]CNC Basics: Learn Basic Tooling and WorkholdingHaving gotten a few basics under our belts at the 10,000 foot level, it's time to delve into some of the basic tooling and workholding every machinist should know, CNC or otherwise.Let's start with some basic terminology. All of the things we discuss in the tutorials below are Tooling. Tooling consists of the mechanical things we use with our CNC Machine to make parts. Examples:Cutters: These are the elements of tooling that have the sharp edges that slice chips out of the material we are machining.Workholding: Vises, clamps, and many other kinds of tooling are focused on holding down the workpiece so we can accurately machine it without it moving or flexing.Measuring Tools: Machining is about precision. It can range from 1/10's of inches to ten thousandths (1/10000) or less. We use specialized measuring tools to make such precise measurements. The simple rulers and tape measures from carpentry are no longer enough.Note that the articles in this section are a bit specialized. Choose the ones that are appropriate to the kind of machine you'll actually be using first, then branch out and see how some of the other machines work for comparison.CNC Mill Cutter Types and How to Use ThemLearn the basics of cutters used with CNC Milling Machines.Ultimate Guide to Selecting Toolholders for MillingHey, that cutter has to be held in the spindle somehow-what's the best way?CNC Router Cutter Types and How to Use ThemUpcut, Downcut, Compression Cutters, Straight Flutes, Diamond Cutters: There are quite a few different cutter types in the CNC Router arsenal, and it's important for CNC Router users to have a basic idea of what each one is for.CNC Lathe ToolingThis article on tooling up a CNC lathe will give you a good introduction to the types of cutters you'll be using with a lathe.Complete Guide to Machinist VisesIf you're using a CNC Mill, the most common way to hold the workpiece is a Machinist Vise.CNC Milling Machine WorkholdingWorkholding is all about how to hold your parts down for machining so they can't move or flex...Milling Vises, Step Clamps, Fixture Plates, and all the rest. There's a plethora of workholding solutions available for mills and this article walks through them.CNC Router WorkholdingSpoilboards, Clamps, Vacuum Tables, and more.CNC Lathe WorkholdingWe've categorized the different workholding methods for lathes based on their precision, repeatability, and convenience. This makes it easy to choose the most convenient workholding solution that will work for your application. We have a number of great articles and tutorials about measuring tools:Metrology Guide: This is our giant encyclopedia that talks about all the many different tools. Use it as a reference to look up specific tools you need to learn more about, or to find what tool is best to measure something you're interested in.How to use Calipers: Calipers are the most common measuring tool you'll start to use.How to use a Dial Indicator: Dial indicators are useful for setting up jobs and adjusting your CNC machine.How to use Edge Finders: Edge Finders are also use for setting up jobs on your CNC machine.How to use a Micrometer: Micrometers are one of the first super-precision measuring tools you'll learn to use.Acquire measuring tools as you need them.CNC Basics: CNC History and CNC DictionaryWhoa! Cooking with fire now. You've got a lot of great info that gives you insights into the Big Pictures for:Making a CNC PartCNC SoftwareBuilding or Buying Your First CNC MachineLet's get two more "Big Picture" resources in your hands while we're at this:CNC Machine Overview and Computer Numerical Control HistoryUnderstanding history is another way to get oriented and get perspective. It's amazing that individuals can build or own machines that rival the power of the original CNC machines being created for defense and aerospace applications just a few short years ago. See how that evolution unfolded.CNC DictionaryAs a beginner, you'll come across CNC terms that you don't know. Keep this link handy in case you hit a term you don't know. Our CNC Dictionary makes it easy to find out what all the terms mean.What's Next?I'm going to list a few more resources below, but there's the good news:You're Ready to Acquire a CNC Machine and Get Started Making Parts!If you've kept up with the Firehouse of CNC Beginner Information above, Congratulations! Seriously.You've got the overview on everything. You've got a bunch of pointers to even more articles on CNCCookbook you can drill down on to learn more. It's time to make choices that lead you to the next step:Choose your CAD, CAM, and Feeds Speeds Software. Purchase and start learning it in earnest. Do this BEFORE you buy a machine as you want to get through the learning curve and it takes some time.Choose your CNC Machine and get going on acquisition or a build.Choose your first CNC Project. What do you want to make with your machine?After you do those three, it's all about Git er done!Let your choices of software, machine, and first project guide your learning towards the goal of what you need to finish that first project. A few suggestions:Use an easy-to-machine cheap material. I highly recommend wood for your first project. It does make kind of a mess in machines intended for metal, but it's nothing a Shop Vac won't clean up quick.Keep it simple. Your first project is not the time to build a working scale model of a Ferrari V12 engine. You will get to that later, LOL!Stay focused until it is done. Seriously, I mean DONE. That way, you've covered all the bases and you have something to show for it.Want some project ideas? Here's my giant list of CNC Projects.Have fun!More CNC ResourcesWhat About G-Code?Yeah, you know it's out there. You don't strictly need to know it for your first project, but not too long after, you want toLearn Enough G-Code and CNC Machine Basics to Use CNC Like a Manual Machine Tool. We can help, naturally!Full on CNC programs are capable of doing some very complex things. It's almost magical to watch a complex CAD drawing first get converted to g-code by CAM software and then to see the actual 3 dimensional part taking shape (as it were) as all the chips that are not finished part get machined away.Because the process seems complex to the uninitiated, it's very easy for manual machinists to conclude its only good for making really complex parts or large production runs of simple parts. But you can do most anything on a CNC Machine that can be done on the manual tool and often faster and better.Admittedly, most of your CNC Programming will be done using CADCAM software as we talked about just above. But that doesn't mean you should ignore g-code. It's worth learning how to do basic manual-style machining on your CNC if you've ever done any manual machining because your learning curve will be short and you'll suddenly see how a lot of things go together.But even if you've never done any manual machining, it's still worth knowing how to do the simple things easily, without recourse to CAD or CAM, because again, it keeps the learning curve to getting simple things made less daunting.The other reason to learn g-code at least this well is you're going to see it flowing by on your machine controller's screen. You'll understand what the machine is doing a lot better if you can equate them most common g-codes you see coming up with what the machine is likely to do when it executes them. You'll also have a much easier time making simple changes to the g-code programs your CAM software generates, which can save you a lot of time and effort.Lastly, sooner or later you'll need to deal with g-code. Perhaps a cutter will break in mid-program and you want to know how to get the program back on track without starting over.The good news for all this is we have put together one of the best g-code training resources available, and it's completely free:CNC Programming with G-Code: The Definitive Guide6 Best Books for CNC MachinistsDo you like good old fashioned books on paper? Here are the 7 best books for CNC'ers that I know.Feeds and Speeds Master ClassMore killer free training from CNCCookbook. This Master Class is an email course that takes you from Beginner to Expert on Feeds & Speeds. It even includes free Feeds and Speeds Calculators.8 Ways to Locate Part Zero On Your CNC MachineThat fancy gadget is a Haimer 3D Taster. This article walks you through how they're used...Locating Part Zero is an important part of your CNC Basics. It is something you'll do every single time you make a part. Basically, you have to tell the CNC Machine physically where the coordinates 0, 0, 0 (XYZ) are located relative to the part. This article shows you all the best ways to save time and make sure your parts are accurate when locating Part Zero."Beginner" Blog Category: Best Blog posts for beginners.Hey, there's a reason we're the most popular CNC-related blog on the Internet. Check out all the articles we've written to help you learn more about CNC.How About Some Free CAD Files to Play With? Start out with these simple designs you can use to make cool signs and engravings. They're a great way for you to practice your CNC techniques with proven graphical designs. Join our newsletter to get updates on what's next at CNC Cookbook. Share copy and redistribute the material in any medium or format for any purpose, even commercially. Adapt remix, transform, and build upon the material for any purpose, even commercially. The licensor cannot revoke these freedoms as long as you follow the license terms. Attribution You must give appropriate credit , provide a link to the license, and indicate if changes were made . You may do so in any reasonable manner, but not in any way that suggests the licensor endorses you or your use. ShareAlike If you remix, transform, or build upon the material, you must distribute your contributions under the same license as the original. No additional restrictions You may not apply legal terms or technological measures that legally restrict others from doing anything the license permits. You do not have to comply with the license for elements of the material in the public domain or where your use is permitted by an applicable exception or limitation . No warranties are given. The license may not give you all of the permissions necessary for your intended use. For example, other rights such as publicity, privacy, or moral rights may limit how you use the material. Welcome to the final episode of the Tormach Garage Series, where Jeremiah Daws (maker/machinist) kicks off the lesson with a pivotal moment - the actual machining process. If you're new to CNC machining, be sure to view all of the previous episodes of the Tormach Garage Series. This comprehensive guide, created with CNC beginners in mind, will arm you with the basics to get started on your CNC journey. Previous Tormach Garage Series Videos With the workpiece securely clamped in the vise and all necessary offsets and tools in place, the focus shifts to programming a tool path using conversational programming. The steps to employ an end mill in crafting a boss around the part are detailed, specifying dimensions, radii, and depth. A step-by-step walkthrough is provided, ensuring viewers match the screen settings accurately. The subsequent actions involve saving the file in the desired location.Further operations include machining a pocket with specific dimensions and drilling a precise hole in the center of the part. Each step is thoroughly explained, from setting the center point to inputting parameters, culminating in the seamless addition of operations to the existing file.Important safety measuresEmphasizing safety, the importance of cautious practices during CNC milling are underscored. Feed and max velocity sliders are introduced, illustrating their roles in controlling spindle movement. Viewers are advised to start with both sliders at zero percent, gradually increasing the max velocity slider. Daws provides a critical reminder to monitor the Z-axis DTG (distance to go), a crucial distance indicator. This tutorial incorporates an essential safety measure - the feed hold button, akin to a pause button. Operators are urged to trust their instincts and halt the process if any uncertainty arises. Precision over speed is paramount for a measured approach.A pivotal addition to the process is the tool path preview window, allowing a thorough review of intended tool paths before execution. This final checkpoint is presented as a critical step to ensure accuracy and avoid unintended tool paths. With a successful demonstration of the machining process, including verification of desired outcomes, the lesson concludes by measuring the machined part to confirm accuracy. Congratulations! You just machined your first part.Daws then switches gears and briefly introduces Computer-Aided Manufacturing (CAM) software as an alternative for crafting tool paths. He guides viewers through modeling and generating G-code in Fusion 360, seamlessly integrating it into the PathPilot software.Additional ResourcesBe sure to explore additional resources from Tormach, Titans of CNC, and NYC CNC to further enhance your CNC milling expertise. Thank you for joining us for the Tormach Garage Series. We hope this comprehensive guide stands as an invaluable asset for individuals striving to master CNC milling. To get started in CNC, you must understand the CNC Basics. This guide will help you find top CNC tutorials suitable for beginners. We'll guide you on the critical concepts you need to learn and the sequence to follow. An excellent roadmap that segments the CNC Basics into easy-to-understand tutorials is unbeatable, as it enables any novice to quickly grasp the concepts.That's exactly what this article is: a Beginner's Roadmap for how to Learn CNC!CNC Basics: Big Picture & ConceptsPersonally, I always start with the big picture and basic concepts. They're the foundation for deeper understanding, and the give you that all-important overview of how the big pieces go together in the puzzle. Once you've got the CNC Basics down, you can drill down and learn cnc in bite-sized chunks.This Big Picture View will seem pretty normal if you're planning to make your living in the CNC Manufacturing world. But, for many hobbyists, they want to jump in and buy or build a CNC machine right away.Here's the thing-learn the CNC Basics first before you try to acquire a machine. Understanding these CNC basics will help you understand your potential new machine's specs and documentation. They'll help you understand what people on forums (great learning resources!) are talking about. This can potentially save you money and frustration. Once you've got at least an overview of the basics, move on to researching how much cnc machines cost.Here's the Big Picture to help you get your arms around those CNC basics fast.Big Picture: Step-By-Step Guide to Making CNC PartsThere are 9 steps to make a CNC part described below. Click on the title of any to drill down and see details for each step.1Design Idealized Part Deliverable: Create an Idealized CAD Model of the PartDesign the part in the CAD software based on sketches, photos, specifications, and any other ideas we have for the part. The part is "Idealized" because we haven't done any serious homework yet to evaluate how easy it will be to manufacture the part. Experienced Designers will have avoided many manufacturing problems at this stage while Beginners will discover they need to change quite a bit to make the part easy to manufacture.2Modify Design for Manufacturing Needs Deliverable: Finished CAD Model + Setup Sheet Outline that is a plan for how to manufacture the part80% of the cost to manufacture a product is determined at Design Time...In this step, we will evaluate how easy it is to manufacture our part, change the design as desired to make it easier to manufacture, and arrive at a plan for how to manufacture the part which we'll capture in our Setup Sheet Outline.3CNC Programming Deliverable: G-Code Part Program + Finished Setup SheetUsing MeshCAM to create a G-Code Part Program...Armed with a CAD model and our Setup Sheet Outline, we're ready to dive into CAM, Conversational Programming, Hand Coding, or whatever method we want to use to create a G-Code Part Program.4Machine Setup Deliverable: CNC Machine is Setup to Run the PartSetup is where we get the CNC Machines all ready to run the part. We need to make sure it has all the right tools in the tool changer, the right gcode program loaded, and in general that the machine is ready to go.5Program Proofing Deliverable: Program is Proven, Ready to Run the PartProofing the program is the last step before we actually make real cuts. The goal of proofing is to verify the program is correct and the CNC machine is setup correctly so that there will be no problems when the g-code is run for the first time. Proofing can be done either by Cutting Air (simple but very time consuming) or by using a CNC Simulator (also called a G-Code Simulator).Click the section title to drill down and see which is better.6Machine the Part Deliverable: CNC'd PartsAfter all the preparation, we're finally ready to make some chips and machine a CNC part.7Manufacturer Quality Control and Part Inspection Deliverable: Inspected Parts, Ready for FinishingHaving finished the CNC machining, it's time for Quality Control. We'll inspect the parts to make sure they meet the desired specifications, tolerances, and surface finishes. But first, most parts will need deburring. See our article on Deburring Tools for Metal to learn more.8Finishing Deliverable: Part is Finished!Our last step involves finishing the parts. It's optional, as our parts may not require it. But, there are many forms of finishing possible ranging from paint, to anodizing, to bead blasting, and more.CNC Basics: The CNC Software StackNow you've got the Big Picture for How CNC Parts are Made. Cool beans! That's an awesome framework to help file away future CNC learnings and concepts.Let's get another framework in place: The CNC Software Stack.By "CNC Software Stack" I mean, "What are the different CNC Software packages used and how do they fit together?"Theres a fair amount of different software that is involved when making a part with CNC. At the very least that includes a CAD program with CAM (or perhapsConversational CNCinstead of CADCAM, but lets start with CAM as a newbie) to generate the g-code, and your machine controller, which turns that g-code into machine motions that make your part for you. Theres a lot of other software out there that youll hear about and wonder about. Its helpful to get a mile-wide-but-inch-deep overview of what all that software does and how it fits together. You wont need all of it to get started, but its still worth understanding it because itll help you understand a lot more about the workflows going from a design concept to a finished part at the software level.To help folks understand the CNC Software Stack better, we wrote an article calledCNC Software: Digital Tooling for CNCthat explains all about what kinds of CNC software are available and how it all fits together. Heres a diagram that shows how the most important pieces of software work together:That article gives you the overview and background. Even better is ourBeginners Guide to the Best CAD CAM Software. Its laser-focused on exactly the software Beginners need to get started. Even better, its chock full of buyers guides, evaluation tips, learning help, and even a guide to the secret deals on the Internet that will let you buy the most popular software uber cheap.Check it out!3 Awesome Software Packages to make you a Better CNC'erG-Wizard Calculator MeshCamThe World's Easiest CAM. Easy Point-and-Shoot G-Code Wizards so you can skip CAD/CAM.Conversational is Free with G-Wizard Editor, our g-code editor and simulator. GW Editor can really help beginners get their arms around g-code.Building or Purchasing a CNC MachineYou've got the overall idea of how CNC Parts are made in hand. You know what the CNC Software Stack looks like. By now you're ready to jump in and start choosing your CNC Machine.Hang on a minute, we'll get there soon. Just know two things.First, the learning curve on the CNC Software will take a little while. Don't be afraid to start there and even get the point where you are pretty comfortable with it before you buy a machine. Otherwise, you're going to wind up terribly frustrated because you're unable to run your shiny new machine and make parts.Second, read as much as you can from the rest of this guide. You need these concepts to help you evaluate your machine choices. CNC Machines are pretty expensive, even the hobby-class machines. And building one trades some of that expense for a big investment of your time. Make sure those time and money investments result in the right machine for your needs!Here's a couple of resources to help you choose and get your CNC machine. If you want to buy an industrial machine, skip ahead past the DIY stuff. If you're a DIY'er, just keep reading.CNC Basics:DIY CNC Machine BasicsThose of you who want to build your own CNC machine, or at least jump ahead to buying one, have been chomping at the bit. You didn't want to wade through all those basics to get here. But, you'll find having that knowledge will really help you to make the right decisions when building or buying a CNC Machine.Who would've thought anyone that wanted one could have a CNC machine right in their own home workshop?You can buy completed machines from companies like Tormach or Carbide3D for very reasonable prices or you can build your own machine, either from scratch or as a conversion of an existing manual machine. Once you have your machine and know how to use it, you'll be able to make beautiful parts quickly and easily.But, there is a challenge-knowing how to use CNC to create your parts requires you to pick up a number of different kinds of knowledge. It's not hard, but it's also not very well organized or accessible. Until now.With this page, we're going to bring together links to articles that cover all the basics you'll need to use a CNC machine or to get started with the planning to buy or make a CNC machine. If you go through these articles, you'll wind up with a solid grounding in the basics.You'll know how things fit together and you'll have the basic background you need to dig deeper into other areas of CNC you get interested in. We'll also organize the page so the order the concepts and articles are presented is an ideal order for you to learn things in.But, you don't have to stick to that order if you don't want to. Feel free to jump around and check out whatever interests you.Buying or Building a CNC MachineThis is where you want to start, right? You want to get your hands on that CNC machine. If you're anything like me, you're not thinking about much of anything else. If you're looking to enter the trade, perhaps you're not thinking about Buying a machine right away. That's fine, just skip ahead to the next chapter.Otherwise, I'm going to start here because it's where everyone wants to start. Just be advised, there's a lot you could learn before getting a machine that would help you to select the best machine for your needs. There's also enough to learn before you make your first CNC part that you should start before getting the machine just so you don't have to look at the idle machine while you're learning.I'm not saying CNC is hard, but there's a pretty good breadth of information you'll need. Easy to learn, just a lot of pieces to put together. But hey, that's why we wrote this guide for you.What Kind of a CNC Machine Should You Get?This is an important first question to answer. Most CNC'ers want one of 4 machines:CNC RouterCNC Mill3D PrinterCNC Plasma TableA distant fifth place might be a CNC Lathe, but let's put that on hold for a minute. Thegood news is we've put together a fabulous article that walks you through it. It considers all 4 machines and walks you through what their capabilities are, how hard they are to build, what it will cost, and so on.Grab that article right here:[4 Awesome DIY CNC Machines You Can Build Today]Buy, Build, or Kit?Okay, that article talks about Building, but it also applies to helping you choose what kind of machine to Buy.On the question of Buy or Build, you should boil the decision down to one simple question:Do you want to make parts sooner or will you enjoy the whole process of building your own CNC Machine?Before we go any further, let me give you an important caveat. A lot of would-be machine builders want to build to save money. They look at what finished CNC machines cost and it seems scary.Now here is an ugly little secret-building a machine takes a long time, it's a lot of work, and in the end you won't have saved much money at all.Wait!I can already hear many of you rebelling against the notion that building your machine won't save much money. Sorry to burst bubbles, but I've been there and done that. Not just once, but MANY times across many interests. It always starts out seeming like it will save. Once I got a little wiser about it, I rationalized it more as getting started sooner and paying as I went. That latter is closer to the truth.Take a CNC Milling machine. I converted one from scratch. It took a huge amount of time, and in the end it cost me about $6000 all told. No, I didn't have to pay that all up front, but you can buy a nice little Tormach for that price and be making parts right away.That's me, building CNCCookbook's Shapeoko CNC Router Kit...Kits: Best of Both Worlds?If you really want the best of both worlds, look into kits. The Shapeoko (watch me build one in the video above), for example, is a great CNC Router kit. Having a packaged kit like the Shapeoko that's been well engineered and has good documentation will save you a huge amount of time. Yet, you can still get one relatively cheaply.We built a Shapeoko at CNCCookbook and it has been a lot of fun.Here's the other big advantage to a kit: there will be others with machines just like yours. You can ask them questions for help and you can see what they've built or done with their machines. What an inspiration!Buying an Industrial or "Pro" CNC MachineWhat's the Best Machine for My Needs?Good news!We can figure this out scientifically if you're looking to be a Pro and start a CNC business. If you're only interested as a Hobby, go back up and read that DIY article on which machine types. Choose a type, then look at what you can afford. See also our article below on how to afford a new machine.OK, let's see about choosing a new CNC Machine for a business scientifically. You know, in a way that ensures you don't get too much or too little machine.Which machine is better for your business, Machine A or Machine B?Weve all been therepouring over machine catalogs and specifications. This one is so coolthe spindle goes 86 zillion rpms, the rapids are faster than light speed, and the tool changer, oh my, THE TOOLCHANGER!!!But is the biggest baddest machining center always the right choice for your business? Or maybe you can justify an even more potent machine than the ones you are considering? How would you know? How can you make that decision based on logic and hard facts that will pay off in the long run?These are questions every would-be CNC Business owner faces when they start, and if the business is successful, eventually theyll need to revisit the question again.To see how to figure this out objectively, with an eye towards maximizing your success, check out this article:[Help: I Need to Choose the Best Machine for My CNC Business]What About Used Machines?Cheap? Yes, to get it off their floor and on to yours. But to get it working properly? Maybe not so cheap!Don't get me started here! Oh wait, you already did. So here's the deal:Some large number of you are thinking you can get a more powerful machine at a great price by purchasing a used machine.A used industrial CNC can be a fabulous investment. It can also be your worst nightmare.Parts for them are often very expensive and some of the machines were beat to death by their previous owners. What you have to ask yourself is whether you're qualified to tell which machines are the good deals and which are the nightmares? Also, if you do have a problem with a used machine, are you qualified to diagnose and fix it, or can you afford to call out the service men?I'm not saying it can't be done, but I do wonder whether a CNC Beginner is the best person to try.How Can I Afford a New Pro CNC Machine?Dude, have you seen what these CNC machines cost?CNC is one of my favorite things in the world, and it is amazing that an individual these days can actually have a full-blown CNC machine thatsmore powerful than the machines used to put men on the moon right in their own garage. Heck, theyre capable of generating a decent living for you too, if you are a reasonably clever business person. But, the initial startup costs can seem steep.This article is all about how to approach the affordability issue:[Help: How Can I Afford to Buy a CNC Machine?]CNC Basics: Learn Basic Tooling and WorkholdingHaving gotten a few basics under our belts at the 10,000 foot level, it's time to delve into some of the basic tooling and workholding every machinist should know, CNC or otherwise.Let's start with some basic terminology. All of the things we discuss in the tutorials below are Tooling. Tooling consists of the mechanical things we use with our CNC Machine to make parts. Examples:Cutters: These are the elements of tooling that have the sharp edges that slice chips out of the material we are machining.Workholding: Vises, clamps, and many other kinds of tooling are focused on holding down the workpiece so we can accurately machine it without it moving or flexing.Measuring Tools: Machining is about precision. It can range from 1/10's of inches to ten thousandths (1/10000) or less. We use specialized measuring tools to make such precise measurements. The simple rulers and tape measures from carpentry are no longer enough.Note that the articles in this section are a bit specialized. Choose the ones that are appropriate to the kind of machine you'll actually be using first, then branch out and see how some of the other machines work for comparison.CNC Mill Cutter Types and How to Use ThemLearn the basics of cutters used with CNC Milling Machines.Ultimate Guide to Selecting Toolholders for MillingHey, that cutter has to be held in the spindle somehow-what's the best way?CNC Router Cutter Types and How to Use ThemUpcut, Downcut, Compression Cutters, Straight Flutes, Diamond Cutters: There are quite a few different cutter types in the CNC Router arsenal, and it's important for CNC Router users to have a basic idea of what each one is for.CNC Lathe ToolingThis article on tooling up a CNC lathe will give you a good introduction to the types of cutters you'll be using with a lathe.Complete Guide to Machinist VisesIf you're using a CNC Mill, the most common way to hold the workpiece is a Machinist Vise.CNC Milling Machine WorkholdingWorkholding is all about how to hold your parts down for machining so they can't move or flex...Milling Vises, Step Clamps, Fixture Plates, and all the rest. There's a plethora of workholding solutions available for mills and this article walks through them.CNC Router WorkholdingSpoilboards, Clamps, Vacuum Tables, and more.CNC Lathe WorkholdingWe've categorized the different workholding methods for lathes based on their precision, repeatability, and convenience. This makes it easy to choose the most convenient workholding solution that will work for your application. We have a number of great articles and tutorials about measuring tools:Metrology Guide: This is our giant encyclopedia that talks about all the many different tools. Use it as a reference to look up specific tools you need to learn more about, or to find what tool is best to measure something you're interested in.How to use Calipers: Calipers are the most common measuring tool you'll start to use.How to use a Dial Indicator: Dial indicators are useful for setting up jobs and adjusting your CNC machine.How to use Edge Finders: Edge Finders are also use for setting up jobs on your CNC machine.How to use a Micrometer: Micrometers are one of the first super-precision measuring tools you'll learn to use.Acquire measuring tools as you need them.CNC Basics: CNC History and CNC DictionaryWhoa! Cooking with fire now. You've got a lot of great info that gives you insights into the Big Pictures for:Making a CNC PartCNC SoftwareBuilding or Buying Your First CNC MachineLet's get two more "Big Picture" resources in your hands while we're at this:CNC Machine Overview and Computer Numerical Control HistoryUnderstanding history is another way to get oriented and get perspective. It's amazing that individuals can build or own machines that rival the power of the original CNC machines being created for defense and aerospace applications just a few short years ago. See how that evolution unfolded.CNC DictionaryAs a beginner, you'll come across CNC terms that you don't know. Keep this link handy in case you hit a term you don't know. Our CNC Dictionary makes it easy to find out what all the terms mean.What's Next?I'm going to list a few more resources below, but there's the good news:You're Ready to Acquire a CNC Machine and Get Started Making Parts!If you've kept up with the Firehouse of CNC Beginner Information above, Congratulations! Seriously.You've got the overview on everything. You've got a bunch of pointers to even more articles on CNCCookbook you can drill down on to learn more. It's time to make choices that lead you to the next step:Choose your CAD, CAM, and Feeds Speeds

Software. Purchase and start learning it in earnest. Do this BEFORE you buy a machine as you want to get through the learning curve and it takes some time.Choose your CNC Machine and get going on acquisition or a build.Choose your first CNC Project. What do you want to make with your machine?After you do those three, it's all about Git er done!Let your choices of software, machine, and first project guide your learning towards the goal of what you need to finish that first project. A few suggestions:Use an easy-to-machine cheap material. I highly recommend wood for your first project. It does make kind of a mess in machines intended for metal, but it's nothing a Shop Vac won't clean up quick.Keep it simple. Your first project is not the time to build a working scale model of a Ferrari V12 engine. You will get to that later, LOL!Stay focused until it is done. Seriously, I mean DONE. That way, you've covered all the bases and you have something to show for it.Want some project ideas? Here's my giant list of CNC Projects.Have fun!More CNC ResourcesWhat About G-Code?Yeah, you know it's out there. You don't strictly need to know it for your first project, but not too long after, you want toLearn Enough G-Code and CNC Machine Basics to Use CNC Like a Manual Machine Tool. We can help, naturally!Full on CNC programs are capable of doing some very complex things. It's almost magical to watch a complex CAD drawing first get converted to g-code by CAM software and then to see the actual 3 dimensional part taking shape (as it were) as all the chips that are not finished part get machined away.Because the process seems complex to the uninitiated, it's very easy for manual machinists to conclude its only good for making really complex parts or large production runs of simple parts. But you can do most anything on a CNC Machine that can be done on the manual tool and often faster and better.Admittedly, most of your CNC Programming will be done using CADCAM software as we talked about just above. But that doesn't mean you should ignore g-code. It's worth learning how to do basic manual-style machining on your CNC if you've ever done any manual machining because your learning curve will be short and you'll suddenly see how a lot of things go together.But even if you've never done any manual machining, it's still worth knowing how to do the simple things easily, without recourse to CAD or CAM, because again, it keeps the learning curve to getting simple things made less daunting.The other reason to learn g-code at least this well is you're going to see it flowing by on your machine controller's screen. You'll understand what the machine is doing a lot better if you can equate them most common g-codes you see coming up with what the machine is likely to do when it executes them. You'll also have a much easier time making simple changes to the g-code programs your CAM software generates, which can save you a lot of time and effort.Lastly, sooner or later you'll need to deal with g-code. Perhaps a cutter will break in mid-program and you want to know how to get the program back on track without starting over.The good news for all this is we have put together one of the best g-code training resources available, and it's completely free:CNC Programming with G-Code: The Definitive Guide6 Best Books for CNC MachinistsDo you like good old fashioned books on paper? Here are the 7 best books for CNC'ers that I know.Feeds and Speeds Master ClassMore killer free training from CNCCookbook. This Master Class is an email course that takes you from Beginner to Expert on Feeds & Speeds. It even includes free Feeds and Speeds Calculators.8 Ways to Locate Part Zero On Your CNC MachineThat fancy gadget is a Haimer 3D Taster. This article walks you through how they're used...Locating Part Zero is an important part of your CNC Basics. It is something you'll do every single time you make a part. Basically, you have to tell the CNC Machine physically where the coordinates 0, 0, 0 (XYZ) are located relative to the part. This article shows you all the best ways to save time and make sure your parts are accurate when locating Part Zero."Beginner" Blog Category: Best Blog posts for beginners.Hey, there's a reason we're the most popular CNC-related blog on the Internet. Check out all the articles we've written to help you learn more about CNC.How About Some Free CAD Files to Play With?Start out with these simple designs you can use to make cool signs and engravings. They're a great way for you to practice your CNC techniques with proven graphical designs. Join our newsletter to get updates on what's next at CNC Cookbook. To get started in CNC, you must understand the CNC Basics. This guide will help you find top CNC tutorials suitable for beginners. We'll guide you on the critical concepts you need to learn and the sequence to follow. An excellent roadmap that segments the CNC Basics into easy-to-understand tutorials is unbeatable, as it enables any novice to quickly grasp the concepts.That's exactly what this article is: a Beginner's Roadmap for how to Learn CNC!CNC Basics: Big Picture & ConceptsPersonally, I always start with the big picture and basic concepts. They're the foundation for deeper understanding, and the give you that all-important overview of how the big pieces go together in the puzzle. Once you've got the CNC Basics down, you can drill down and learn cnc in bite-sized chunks.This Big Picture View will seem pretty normal if you're planning to make your living in the CNC Manufacturing world. But, for many hobbyists, they want to jump in and buy or build a CNC machine right away.Here's the thing-learn the CNC Basics first before you try to acquire a machine. Understanding these CNC basics will help you understand your potential new machine's specs and documentation. They'll help you understand what people on forums (great learning resources!) are talking about. This can potentially save you money and frustration. Once you've got at least an overview of the basics, move on to researching how much cnc machines cost.Here's the Big Picture to help you get your arms around those CNC basics fast.Big Picture: Step-By-Step Guide to Making CNC PartsThere are 9 steps to make a CNC part described below. Click on the title of any to drill down and see details for each step.1Design Idealized Part Deliverable: Create an Idealized CAD Model of the PartDesign the part in the CAD software based on sketches, photos, specifications, and any other ideas we have for the part. The part is "Idealized" because we haven't done any serious homework yet to evaluate how easy it will be to manufacture the part. Experienced Designers will have avoided many manufacturing problems at this stage while Beginners will discover they need to change quite a bit to make the part easy to manufacture.2Modify Design for Manufacturing Needs Deliverable: Finished CAD Model + Setup Sheet Outline that is a plan for how to manufacture the part80% of the cost to manufacture a product is determined at Design Time...In this step, we will evaluate how easy it is to manufacture our part, change the design as desired to make it easier to manufacture, and arrive at a plan for how to manufacture the part which we'll capture in our Setup Sheet Outline.3CNC Programming Deliverable: G-Code Part Program + Finished Setup SheetUsing MeshCAM to create a G-Code Part Program...Armed with a CAD model and our Setup Sheet Outline, we're ready to dive into CAM, Conversational Programming, Hand Coding, or whatever method we want to use to create a G-Code Part Program.4Machine Setup Deliverable: CNC Machine is Setup to Run the PartSetup is where we get the CNC Machines all ready to run the part. We need to make sure it has all the right tools in the tool changer, the right gcode program loaded, and in general that the machine is ready to go.5Program Proofing Deliverable: Program is Proven, Ready to Run the PartProofing the program is the last step before we actually make real cuts. The goal of proofing is to verify the program is correct and the CNC machine is setup correctly so that there will be no problems when the g-code is run for the first time. Proofing can be done either by Cutting Air (simple but very time consuming) or by using a CNC Simulator (also called a G-Code Simulator).Click the section title to drill down and see which is better.6Machine the Part Deliverable: CNC'd PartsAfter all the preparation, we're finally ready to make some chips and machine a CNC part.7Manufacturer Quality Control and Part Inspection Deliverable: Inspected Parts, Ready for FinishingHaving finished the CNC machining, it's time for Quality Control. We'll inspect the parts to make sure they meet the desired specifications, tolerances, and surface finishes. But first, most parts will need deburring. See our article on Deburring Tools for Metal to learn more.8Finishing Deliverable: Part is Finished!Our last step involves finishing the parts. It's optional, as our parts may not require it. But, there are many forms of finishing possible ranging from paint, to anodizing, to bead blasting, and more.CNC Basics: The CNC Software StackNow you've got the Big Picture for How CNC Parts are Made. Cool beans! That's an awesome framework to help file away future CNC learnings and concepts.Let's get another framework in place: The CNC Software Stack.By "CNC Software Stack" I mean, "What are the different CNC Software packages used and how do they fit together?"Theres a fair amount of different software that is involved when making a part with CNC. At the very least that includes a CAD program with CAM (or perhapsConversational CNCinstead of CADCAM, but lets start with CAM as a newbie) to generate the g-code, and your machine controller, which turns that g-code into machine motions that make your part for you. Theres a lot of other software out there that youll hear about and wonder about. Its helpful to get a mile-wide-but-inch-deep overview of what all that software does and how it fits together. You wont need all of it to get started, but its still worth understanding it because itll help you understand a lot more about the workflows going from a design concept to a finished part at the software level.To help folks understand the CNC Software Stack better, we wrote an article calledCNC Software: Digital Tooling for CNCthat explains all about what kinds of CNC software are available and how it all fits together. Heres a diagram that shows how the most important pieces of software work together:That article gives you the overview and background. Even better is ourBeginners Guide to the Best CAD CAM Software. Its laser-focused on exactly the software Beginners need to get started. Even better, its chock full of buyers guides, evaluation tips, learning help, and even a guide to the secret deals on the Internet that will let you buy the most popular software uber cheap.Check it out!3 Awesome Software Packages to make you a Better CNC'erG-Wizard Calculator MeshCamThe World's Easiest CAM. Easy Point-and-Shoot G-Code Wizards so you can skip CAD/CAM.Conversational is Free with G-Wizard Editor, our g-code editor and simulator. GW Editor can really help beginners get their arms around g-code.Building or Purchasing a CNC MachineYou've got the overall idea of how CNC Parts are made in hand. You know what the CNC Software Stack looks like. By now you're ready to jump in and start choosing your CNC Machine.Hang on a minute, we'll get there soon. Just know two things.First, the learning curve on the CNC Software will take a little while. Don't be afraid to start there and even get the point where you are pretty comfortable with it before you buy a machine. Otherwise, you're going to wind up terribly frustrated because you're unable to run your shiny new machine and make parts.Second, read as much as you can from the rest of this guide. You need these concepts to help you evaluate your machine choices. CNC Machines are pretty expensive, even the hobby-class machines. And building one trades some of that expense for a big investment of your time. Make sure those time and money investments result in the right machine for your needs!Here's a couple of resources to help you choose and get your CNC machine. If you want to buy an industrial machine, skip ahead past the DIY stuff. If you're a DIY'er, just keep reading.CNC Basics:DIY CNC Machine BasicsThose of you who want to build your own CNC machine, or at least jump ahead to buying one, have been chomping at the bit. You didn't want to wade through all those basics to get here. But, you'll find having that knowledge will really help you to make the right decisions when building or buying a CNC Machine.Who would've thought anyone that wanted one could have a CNC machine right in their own home workshop?You can buy completed machines from companies like Tormach or Carbide3D for very reasonable prices or you can build your own machine, either from scratch or as a conversion of an existing manual machine. Once you have your machine and know how to use it, you'll be able to make beautiful parts quickly and easily.But, there is a challenge-knowing how to use CNC to create your parts requires you to pick up a number of different kinds of knowledge. It's not hard, but it's also not very well organized or accessible. Until now.With this page, we're going to bring together links to articles that cover all the basics you'll need to use a CNC machine or to get started with the planning to buy or make a CNC machine. If you go through these articles, you'll wind up with a solid grounding in the basics.You'll know how things fit together and you'll have the basic background you need to dig deeper into other areas of CNC you get interested in. We'll also organize the page so the order the concepts and articles are presented is an ideal order for you to learn things in.But, you don't have to stick to that order if you don't want to. Feel free to jump around and check out whatever interests you.Buying or Building a CNC MachineThis is where you want to start, right? You want to get your hands on that CNC machine. If you're anything like me, you're not thinking about much of anything else. If you're looking to enter the trade, perhaps you're not thinking about Buying a machine right away. That's fine, just skip ahead to the next chapter.Otherwise, I'm going to start here because it's where everyone wants to start. Just be advised, there's a lot you could learn before getting a machine that would help you to select the best machine for your needs. There's also enough to learn before you make your first CNC part that you should start before getting the machine just so you don't have to look at the idle machine while you're learning.I'm not saying CNC is hard, but there's a pretty good breadth of information you'll need. Easy to learn, just a lot of pieces to put together. But hey, that's why we wrote this guide for you.What Kind of a CNC Machine Should You Get?This is an important first question to answer. Most CNC'ers want one of 4 machines:CNC RouterCNC Mill3D PrinterCNC Plasma TableA distant fifth place might be a CNC Lathe, but let's put that on hold for a minute. Thegood news is we've put together a fabulous article that walks you through it. It considers all 4 machines and walks you through what their capabilities are, how hard they are to build, what it will cost, and so on.Grab that article right here:[4 Awesome DIY CNC Machines You Can Build Today]Buy, Build, or Kit?Okay, that article talks about Building, but it also applies to helping you choose what kind of machine to Buy.On the question of Buy or Build, you should boil the decision down to one simple question:Do you want to make parts sooner or will you enjoy the whole process of building your own CNC Machine?Before we go any further, let me give you an important caveat. A lot of would-be machine builders want to build to save money. They look at what finished CNC machines cost and it seems scary.Now here is an ugly little secret-building a machine takes a long time, it's a lot of work, and in the end you won't have saved much money at all.Wait!I can already hear many of you rebelling against the notion that building your machine won't save much money. Sorry to burst bubbles, but I've been there and done that. Not just once, but MANY times across many interests. It always starts out seeming like it will save. Once I got a little wiser about it, I rationalized it more as getting started sooner and paying as I went. That latter is closer to the truth.Take a CNC Milling machine. I converted one from scratch. It took a huge amount of time, and in the end it cost me about $6000 all told. No, I didn't have to pay that all up front, but you can buy a nice little Tormach for that price and be making parts right away.That's me, building CNCCookbook's Shapeoko CNC Router Kit...Kits: Best of Both Worlds?If you really want the best of both worlds, look into kits. The Shapeoko (watch me build one in the video above), for example, is a great CNC Router kit. Having a packaged kit like the Shapeoko that's been well engineered and has good documentation will save you a huge amount of time. Yet, you can still get one relatively cheaply.We built a Shapeoko at CNCCookbook and it has been a lot of fun.Here's the other big advantage to a kit: there will be others with machines just like yours. You can ask them questions for help and you can see what they've built or done with their machines. What an inspiration!Buying an Industrial or "Pro" CNC MachineWhat's the Best Machine for My Needs?Good news!We can figure this out scientifically if you're looking to be a Pro and start a CNC business. If you're only interested as a Hobby, go back up and read that DIY article on which machine types. Choose a type, then look at what you can afford. See also our article below on how to afford a new machine.OK, let's see about choosing a new CNC Machine for a business scientifically. You know, in a way that ensures you don't get too much or too little machine.Which machine is better for your business, Machine A or Machine B?Weve all been therepouring over machine catalogs and specifications. This one is so coolthe spindle goes 86 zillion rpms, the rapids are faster than light speed, and the tool changer, oh my, THE TOOLCHANGER!!!But is the biggest baddest machining center always the right choice for your business? Or maybe you can justify an even more potent machine than the ones you are considering? How would you know? How can you make that decision based on logic and hard facts that will pay off in the long run?These are questions every would-be CNC Business owner faces when they start, and if the business is successful, eventually theyll need to revisit the question again.To see how to figure this out objectively, with an eye towards maximizing your success, check out this article:[Help: I Need to Choose the Best Machine for My CNC Business]What About Used Machines?Cheap? Yes, to get it off their floor and on to yours. But to get it working properly? Maybe not so cheap!Don't get me started here! Oh wait, you already did. So here's the deal:Some large number of you are thinking you can get a more powerful machine at a great price by purchasing a used machine.A used industrial CNC can be a fabulous investment. It can also be your worst nightmare.Parts for them are often very expensive and some of the machines were beat to death by their previous owners. What you have to ask yourself is whether you're qualified to tell which machines are the good deals and which are the nightmares? Also, if you do have a problem with a used machine, are you qualified to diagnose and fix it, or can you afford to call out the service men?I'm not saying it can't be done, but I do wonder whether a CNC Beginner is the best person to try.How Can I Afford a New Pro CNC Machine?Dude, have you seen what these CNC machines cost?CNC is one of my favorite things in the world, and it is amazing that an individual these days can actually have a full-blown CNC machine thatsmore powerful than the machines used to put men on the moon right in their own garage. Heck, theyre capable of generating a decent living for you too, if you are a reasonably clever business person. But, the initial startup costs can seem steep.This article is all about how to approach the affordability issue:[Help: How Can I Afford to Buy a CNC Machine?]CNC Basics: Learn Basic Tooling and WorkholdingHaving gotten a few basics under our belts at the 10,000 foot level, it's time to delve into some of the basic tooling and workholding every machinist should know, CNC or otherwise.Let's start with some basic terminology. All of the things we discuss in the tutorials below are Tooling. Tooling consists of the mechanical things we use with our CNC Machine to make parts. Examples:Cutters: These are the elements of tooling that have the sharp edges that slice chips out of the material we are machining.Workholding: Vises, clamps, and many other kinds of tooling are focused on holding down the workpiece so we can accurately machine it without it moving or flexing.Measuring Tools: Machining is about precision. It can range from 1/10's of inches to ten thousandths (1/10000) or less. We use specialized measuring tools to make such precise measurements. The simple rulers and tape measures from carpentry are no longer enough.Note that the articles in this section are a bit specialized. Choose the ones that are appropriate to the kind of machine you'll actually be using first, then branch out and see how some of the other machines work for comparison.CNC Mill Cutter Types and How to Use ThemLearn the basics of cutters used with CNC Milling Machines.Ultimate Guide to Selecting Toolholders for MillingHey, that cutter has to be held in the spindle somehow-what's the best way?CNC Router Cutter Types and How to Use ThemUpcut, Downcut, Compression Cutters, Straight Flutes, Diamond Cutters: There are quite a few different cutter types in the CNC Router arsenal, and it's important for CNC Router users to have a basic idea of what each one is for.CNC Lathe ToolingThis article on tooling up a CNC lathe will give you a good introduction to the types of cutters you'll be using with a lathe.Complete Guide to Machinist VisesIf you're using a CNC Mill, the most common way to hold the workpiece is a Machinist Vise.CNC Milling Machine WorkholdingWorkholding is all about how to hold your parts down for machining so they can't move or flex...Milling Vises, Step Clamps, Fixture Plates, and all the rest. There's a plethora of workholding solutions available for mills and this article walks through them.CNC Router WorkholdingSpoilboards, Clamps, Vacuum Tables, and more.CNC Lathe WorkholdingWe've categorized the different workholding methods for lathes based on their precision, repeatability, and convenience. This makes it easy to choose the most convenient workholding solution that will work for your application. We have a number of great articles and tutorials about measuring tools:Metrology Guide: This is our giant encyclopedia that talks about all the many different tools. Use it as a reference to look up specific tools you need to learn more about, or to find what tool is best to measure something you're interested in.How to use Calipers: Calipers are the most common measuring tool you'll start to use.How to use a Dial Indicator: Dial indicators are useful for setting up jobs and adjusting your CNC machine.How to use Edge Finders: Edge Finders are also use for setting up jobs on your CNC machine.How to use a Micrometer: Micrometers are one of the first super-precision measuring tools you'll learn to use.Acquire measuring tools as you need them.CNC Basics: CNC History and CNC DictionaryWhoa! Cooking with fire now. You've got a lot of great info that gives you insights into the Big Pictures for:Making a CNC PartCNC SoftwareBuilding or Buying Your First CNC MachineLet's get two more "Big Picture" resources in your hands while we're at this:CNC Machine Overview and Computer Numerical Control HistoryUnderstanding history is another way to get oriented and get perspective. It's amazing that individuals can build or own machines that rival the power of the original CNC machines being created for defense and aerospace applications just a few short years ago. See how that evolution unfolded.CNC DictionaryAs a beginner, you'll come across CNC terms that you don't know. Keep this link handy in case you hit a term you don't know. Our CNC Dictionary makes it easy to find out what all the terms mean.What's Next?I'm going to list a few more resources below, but there's the good news:You're Ready to Acquire a CNC Machine and Get Started Making Parts!If you've kept up with the Firehouse of CNC Beginner Information above, Congratulations! Seriously.You've got the overview on everything. You've got a bunch of pointers to even more articles on CNCCookbook you can drill down on to learn more. It's time to make choices that lead you to the next step:Choose your CAD, CAM, and Feeds Speeds Software. Purchase and start learning it in earnest. Do this BEFORE you buy a machine as you want to get through the learning curve and it takes some time.Choose your CNC Machine and get going on acquisition or a build.Choose your first CNC Project. What do you want to make with your machine?After you do those three, it's all about Git er done!Let your choices of software, machine, and first project guide your learning towards the goal of what you need to finish that first project. A few suggestions:Use an easy-to-machine cheap material. I highly recommend wood for your first project. It does make kind of a mess in machines intended for metal, but it's nothing a Shop Vac won't clean up quick.Keep it simple. Your first project is not the time to build a working scale model of a Ferrari V12 engine. You will get to that later, LOL!Stay focused until it is done. Seriously, I mean DONE. That way, you've covered all the bases and you have something to show for it.Want some project ideas? Here's my giant list of CNC Projects.Have fun!More CNC ResourcesWhat About G-Code?Yeah, you know it's out there. You don't strictly need to know it for your first project, but not too long after, you want toLearn Enough G-Code and CNC Machine Basics to Use CNC Like a Manual Machine Tool. We can help, naturally!Full on CNC programs are capable of doing some very complex things. It's almost magical to watch a complex CAD drawing first get converted to g-code by CAM software and then to see the actual 3 dimensional part taking shape (as it were) as all the chips that are not finished part get machined away.Because the process seems complex to the uninitiated, it's very easy for manual machinists to conclude its only good for making really complex parts or large production runs of simple parts. But you can do most anything on a CNC Machine that can be done on the manual tool and often faster and better.Admittedly, most of your CNC Programming will be done using CADCAM software as we talked about just above. But that doesn't mean you should ignore g-code. 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Perhaps a cutter will break in mid-program and you want to know how to get the program back on track without starting over.The good news for all this is we have put together one of the best g-code training resources available, and it's completely free:CNC Programming with G-Code: The Definitive Guide6 Best Books for CNC MachinistsDo you like good old fashioned books on paper? Here are the 7 best books for CNC'ers that I know.Feeds and Speeds Master ClassMore killer free training from CNCCookbook. This Master Class is an email course that takes you from Beginner to Expert on Feeds & Speeds. It even includes free Feeds and Speeds Calculators.8 Ways to Locate Part Zero On Your CNC MachineThat fancy gadget is a Haimer 3D Taster. This article walks you through how they're used...Locating Part Zero is an important part of your CNC Basics. It is something you'll do every single time you make a part. Basically, you have to tell the CNC Machine physically where the coordinates 0, 0, 0 (XYZ) are located relative to the part. This article shows you all the best ways to save time and make sure your parts are accurate when locating Part Zero."Beginner" Blog Category: Best Blog posts for beginners.Hey, there's a reason we're the most popular CNC-related blog on the Internet. Check out all the articles we've written to help you learn more about CNC.How About Some Free CAD Files to Play With?Start out with these simple designs you can use to make cool signs and engravings. They're a great way for you to practice your CNC techniques with proven graphical designs. Join our newsletter to get updates on what's next at CNC Cookbook. If you have ever thought about owning a CNC machine, but didn't know where to start, this book is for you! Chapter 1: Introduction An overview chapter about the basics of CNC machines and what to expect in the rest of the book. Chapter 2: Mechanical Explore how CNC machines work from a mechanical point of view. This chapter describes the physical components of a CNC machine. Chapter 3: Endmills and Cutting De-mystify endmills and learn what speeds and feeds are, and why you need to know them. Chapter 4: CAD Basics You don't have to know anything about AutoCAD to start making great parts today! Chapter 5: CAM Basics Learn what toolpaths are, and how to use them. Chapter 6: Tutorials Tutorials intended to showcase the workflow of going from idea to part on any CNC machine. Chapter 7: Electro-Mechanical Describes what electronics are required to run a CNC machine, how they work, and what each component is responsible for. Chapter 8: G-Code Learn about the language that drives these machines, how it is structured, and what all of those cryptic codes mean. Chapter 9: Practical Machining A collection of real life scenarios and how-to pointers that will smooth out your path to getting started with CNC. In 2011, Edward designed and released Project Shapeoko via Kickstarter. Shapeoko has become one of the most popular desktop CNC machines on the market and continues to be a market leader and trendsetter. In 2014, Edward co-founded Carbide 3D - a company that specializes in the design and production of desktop manufacturing equipment such as the Shapeoko and Nomad lines of CNC machines. At Carbide 3D, Edward leads the Shapeoko product line and develops other great desktop manufacturing software and equipment. 2016 Edward Ford. All Rights Reserved. If you are new to the world of CNC machining, you might feel overwhelmed by the technology, the tools, and the terminology. Dont worryyou are not alone. This guide to CNC machines for beginners is designed to help you understand the basics, find the right machine, and start creating projects with confidence.What is a CNC Machine?A CNC machine (Computer Numerical Control machine) is an automated tool that reads pre-programmed software commands to control the movement of tools and machinery. These machines are used to perform tasks such as cutting, milling, drilling, engraving, and shaping different materials, including wood, plastic, foam, and metals.The defining characteristic of CNC technology is its ability to eliminate manual control. Unlike traditional machines, CNC machines rely on a computer system to direct operations. This brings a new level of precision, repeatability, and efficiency to various industries like automotive, aerospace, woodworking, and electronics.Even for hobbyists, a CNC machine can bring creative designs to life with incredible accuracy. Whether youre making decorative signs or intricate gears, CNC machines make it possible to manufacture complex parts at home.How Does a CNC Machine Work?Understanding how a CNC machine works starts with recognizing the workflow. First, a design is created using CAD (Computer-Aided Design) software. This design is then converted into machine-readable instructions, typically in the form of G-code, using CAM (Computer-Aided Manufacturing) software.Once the code is ready, it is loaded into the CNC machines controller. The machine then follows the commands, using motors and actuators to control movement along various axestypically X, Y, and Z. Each axis represents a direction (horizontal, vertical, and depth), and the coordination between them allows for intricate shapes and patterns.Modern CNC machines also include sensors, safety systems, and real-time monitoring to ensure precision and reduce the risk of errors. As you continue learning, youll become more familiar with interpreting G-code and optimizing machine settings for different materials and projects.Types of CNC Machines: Choosing the Right Tool for the JobCNC (Computer Numerical Control) machines come in a variety of types, each tailored to specific tasks, materials, and industries. Understanding the different types can help you choose the best one for your needs and avoid costly errors.CNC Milling Machines use rotating multi-point cutting tools to remove material from a workpiece. They are ideal for working with metals, hard plastics, and composite materials. These machines are widely used in manufacturing and prototyping for producing precision components.CNC Routers are typically used for softer materials like wood, foam, and plastic. Theyre a favorite among hobbyists, furniture makers, and sign creators due to their user-friendliness and relatively lower cost.CNC Lathes rotate the material while a stationary cutting tool removes material to create round or cylindrical shapes. Theyre commonly used to make screws, bolts, and other round objects with high accuracy.CNC Plasma Cutters employ a high-speed jet of ionized gas (plasma) to slice through metal sheets. These machines are excellent for fast, efficient cutting of steel and aluminum.CNC Laser Cutters use a highly focused laser beam to cut or engrave materials such as wood, acrylic, and metal. Theyre perfect for detailed designs and fine engraving work.For beginners, CNC routers and milling machines offer the best balance of versatility, accessibility, and ease of use.Best CNC Machines for Beginners:Choosing the best CNC machine as a beginner means finding a balance between affordability, ease of use, software compatibility, and strong community support. Here are some highly recommended beginner-friendly CNC machines:SainSmart Genmitsu 3018-PRO:This compact desktop CNC machine is one of the most popular choices for beginners. Its affordable, easy to set up, and perfect for engraving soft materials like wood, plastic, and PCB boards. Its also widely supported with tutorials and user communities.BobsCNC Evolution 4:Ideal for woodworking enthusiasts, this machine features a sturdy wooden frame and a spacious working area. Its a bit larger than the 3018-PRO and offers more power and stability for slightly bigger projects. Assembly takes time, but its a great learning experience.Shapeoko 4:A step up in terms of build and capabilities, Shapeoko 4 is perfect for beginners who want to grow into more advanced CNC work. It supports a wide range of materials and has a very active online community for help and inspiration.Snapmaker 2.0:This 3-in-1 modular machine includes CNC carving, 3D printing, and laser engraving. Its ideal for users who want to explore multiple creative avenues with one device.When choosing, prioritize machines with clear instructions, responsive customer service, and active forumsyoull thank yourself when troubleshooting your first projects.CNC Machine BasicsBefore diving into your first project, its crucial to learn CNC machine basics:Axes: Most machines operate in 3-axis (X, Y, Z), but advanced machines can include A, B, and C axes for rotational movement.Spindle: This is the motor that rotates the cutting tool.Toolpath: The programmed path the tool follows during machining.Feed Rate and Speed: Determines how fast the tool moves and spins.Zero Point (Home Position): The reference point from which all movements are measured.Understanding these concepts will help you communicate effectively with the machine and make adjustments for better results. Want to become a CNC expert? Read our complete guide: CNC Machining 101: Beginner-to-Expert Guide to explore everything from basic principles to advanced CNC techniques and boost your real-world skills.Affordable CNC Machine for BeginnersLooking for an affordable CNC machine for beginners doesnt mean sacrificing quality. Many entry-level machines provide great value:Budget: Keep your budget realistic. Entry-level machines typically range from $200 to $1,500.Material Capability: Consider what materials youll be using. Machines vary in strength and rigidity.Ease of Use: Look for machines with user-friendly interfaces and setup guides.Community and Resources: Supportive online communities can help troubleshoot issues and share project ideas.Remember, a well-reviewed affordable machine with great support is often better than a more expensive but complex machine.CNC Machine Uses: Endless Possibilities Across IndustriesOne of the most exciting aspects of CNC (Computer Numerical Control) technology is its incredible versatility. CNC machines are not confined to one specific task or industrytheyre powerful tools used by professionals and hobbyists alike across a wide range of applications. Whether youre carving intricate patterns into wood or creating precision-engineered metal parts, CNC machines offer unmatched flexibility and accuracy. Lets explore the many uses of CNC machines and why theyve become an essential part of modern manufacturing and creative expression.1. Woodworking: From Furniture to Fine ArtCNC machines have revolutionized woodworking. Traditional woodworking requires years of skill and craftsmanship, but CNC allows even beginners to create precise, detailed wood products. Whether youre producing custom furniture parts, cabinetry, wooden signage, or decorative carvings, CNC routers make the job faster and more accurate. Intricate patterns, consistent replication, and reduced waste make CNC an ideal choice for both large-scale manufacturing and small-scale artisans.Hobbyists use CNC routers to personalize home dcor, while professionals rely on them for mass production. With the right design software and a quality CNC wood router, the possibilities are virtually limitless.2. Metal Fabrication: Precision in Every CutMetalworking is another field where CNC machines truly shine. CNC milling machines and lathes are commonly used to fabricate gears, brackets, enclosures, and prototypes. In industries like aerospace,

automotive, and construction, precision is criticaland CNC ensures each component meets tight tolerances.Engineers and designers use CNC machines to create complex metal parts quickly and accurately. Prototyping becomes easier, allowing for faster product development and testing. Whether you need a single custom bracket or a batch of engine components, CNC technology ensures reliability and repeatability in every piece.3. Arts and Crafts: Turning Imagination Into RealityFor artists and crafters, CNC machines are a powerful tool for creativity. You can create intricate jewelry designs, ornaments, sculptures, and even architectural models with stunning detail. Laser engravers and CNC cutters are often used to craft unique pieces out of wood, acrylic, plastic, and soft metals.CNC tools allow creators to experiment with different materials and complex designs that would be difficult or impossible to achieve by hand. For personalized gifts, decorative art, or custom branding materials, CNC brings professional-grade capabilities to your home or small business.4. Electronics: Custom Parts and PCBsIn the electronics field, CNC machines play a significant role in building custom printed circuit boards (PCBs), enclosures, and housings for devices. Makers and engineers often use CNC mills or laser cutters to design functional and visually appealing cases for gadgets and DIY electronics projects.CNC technology enables precise drilling and cutting for circuit layouts and panel designs, helping bring electronic innovations to life quickly and affordably. This is especially useful for startups and prototypers who need custom solutions on demand.5. Automotive: Customization and RetrofitsCNC machines are heavily used in the automotive industry for creating custom parts, engine components, and performance modifications. Whether its fabricating a unique car bracket, a gear shifter knob, or a retrofit kit, CNC technology makes it easy to build parts that match exact specifications.Restorers and car enthusiasts also use CNC to replace unavailable or obsolete parts, giving classic vehicles a new lease on life. With the right machine and software, users can turn ideas into road-ready parts in a matter of hours.You are truly only limited by your imagination when it comes to CNC machine uses. From practical manufacturing to artistic expression, CNC machines empower creators and professionals across various fields. Once youve mastered the basics, youll find yourself producing everything from functional parts to decorative masterpieces with ease.Whether youre a hobbyist, artist, entrepreneur, or engineer, CNC opens the door to creativity, precision, and innovation. The investment in learning and setup pays off in the form of limitless potential and unmatched satisfaction from making something truly your own.Beginner CNC Machine Projects: Start Simple, Learn FastIf you are new to the world of CNC, starting with small, manageable projects is the best way to learn. Beginner CNC machine projects not only help you understand the basics of design and machining but also boost your confidence as you see your ideas come to life.Here are a few beginner-friendly CNC project ideas:Engraved Nameplates: Personalize nameplates for desks, doors, or gifts. These projects are great for learning engraving techniques and experimenting with fonts and materials like wood, plastic, or metal.Customized Coasters: Simple square or round coasters let you practice basic cutting and engraving. Add custom designs or initials to make them unique.Phone Stands or Holders: Functional and easy to design, these stands give you practice with measurements, angles, and tool paths while producing something useful.Tool Holders or Racks: Organize your workspace with CNC-made holders for screwdrivers, bits, or pens. These projects teach practical material handling and layout skills.Wooden Puzzles or Keychains: Great for learning precision and intricate cuts, small puzzles and personalized keychains are fun to make and easy to share.These projects introduce essential CNC skills, including file preparation, tool changes, and safe material handling, all in a low-pressure learning environment. Theyre simple, but each teaches valuable techniques youll use in more advanced work later.Start with one, experiment, and enjoy the process of growing your CNC abilities!CNC Programming for Beginners: Simple Tools to Get StartedGetting started with CNC programming is no longer intimidating, especially with the help of beginner-friendly software. You dont need to be an expert or memorize complex G-code to begin creating your first projects. Modern CNC design software makes it easy to turn your ideas into machine-ready instructions.Here are three popular CNC programming tools perfect for beginners:Easel by Inventables: This web-based software is ideal for 2D carving and light 3D work. It features an easy drag-and-drop interface and is perfect for learning the basics without feeling overwhelmed.Carbide Create: Designed for Shapeoko CNC machines, this software is intuitive and helps you create simple to moderately complex designs. Its great for hobbyists looking to grow their skills.Fusion 360: While more advanced, Fusion 360 offers powerful 3D design and CAM (Computer-Aided Manufacturing) tools. Its free for personal or startup use and widely used in both hobby and professional settings.As you progress, learning to read and write G-code manually can give you more control. It helps fine-tune movements, reduce errors, and unlock advanced CNC capabilities. But to begin, these beginner tools are more than enough to launch your CNC journey with confidence.CNC Machine Safety TipsSafety should never be overlooked. Here are some essential CNC machine safety tips for beginners:Wear Safety Gear: Always wear protective goggles and ear protection.Secure the Workpiece: Loose materials can shift and damage the machine or injure you.Keep Hands Clear: Never touch the tool while its spinning or the machine is operating.Unplug Before Maintenance: Always cut power before changing tools or cleaning.Avoid Distractions: Stay focused and dont leave the machine running unattended.Following these tips helps create a safe and productive working environment.Learning CNC Machining: A Step-by-Step JourneyLearning CNC machining is a rewarding journey that combines creativity, technical skills, and hands-on practice. Whether youre aiming for a hobby or a professional path, the key is to take it step by step and enjoy the process.Online Courses are a great place to begin. Platforms like Coursera, Udemy, and YouTube offer beginner-friendly tutorials covering everything from machine setup to design software. Many courses also include downloadable resources and project-based learning.Books and Manuals are equally valuable, especially those written specifically for your type or brand of CNC machine. They help reinforce fundamental concepts like tool selection, material types, and machine maintenance.Community Groups offer real-world insight. Forums like CNCZone, Reddits r/CNC, and Facebook groups allow you to ask questions, share projects, and learn from experienced users around the world. These communities are especially helpful when troubleshooting or seeking feedback.Most importantly, consistent practice makes a difference. Start with simple projects and gradually challenge yourself as your confidence grows. Dont worry about making mistakesthey are part of the learning process.Everyone progresses at their own pace. Be patient, stay curious, and focus on understanding the principles. Over time, CNC machining becomes not just a skill, but a powerful creative outlet.CNC Machine Setup Guide: Step-by-Step for First-Time UsersSetting up your CNC machine correctly is crucial for a successful first project. Whether youre using a desktop router or a full-sized mill, following a structured process helps you avoid errors and build confidence. Heres a simplified CNC machine setup guide to get you started:1. Unbox and Organize: Carefully unbox your CNC machine and lay out all components. Cross-check with the manual to ensure everything is included. Follow the instructions step by step to assemble the frame, gantry, and moving parts.2. Install Software: Download and install the required drivers for your machine. Then, install your preferred CAM (Computer-Aided Manufacturing) software such as Easel, Carbide Create, or Fusion 360. These programs help convert your design into a toolpath.3. Connect the Machine: Use a USB cable or Wi-Fi connection to link your machine with your computer. Make sure the connection is stable and that your software recognizes the machine.4. Secure Material: Firmly clamp your material (wood, plastic, or metal) to the machines worktable to prevent shifting during cutting.5. Set Zero Position: Use your software or move the spindle manually to define the home or origin pointthis tells the machine where to start cutting.6. Load the Tool: Insert the correct cutting bit, then tighten it securely. Always double-check alignment.7. Run Simulation: Preview your project in the software to catch any design or toolpath errors.8. Start Cutting: Begin your cut at a slow feed rate, especially on the first try. Adjust as needed once you feel confident.By following these steps, youll reduce mistakes and create a solid foundation for future CNC success.DIY CNC Machine KitA DIY CNC machine kit offers a deeper understanding of machine mechanics. Building your own CNC machine can save money and give you hands-on experience.Popular kits include:Genmitsu CNC 3018-PRO Kit: Great for learning electronics and mechanics.OpenBuilds LEAD Machine: More robust and scalable.Makermade Maslow: Wall-mounted for large format woodworking.Be prepared to invest time in assembly and troubleshooting. The learning curve can be steeper, but the rewards are greater.CNC Machine MaintenanceRoutine CNC machine maintenance ensures optimal performance and extends the life of your equipment:Daily: Wipe down surfaces, vacuum debris, check for loose screws.Weekly: Lubricate moving parts and clean tool holders.Monthly: Check belt tension, inspect wiring, update software.Keeping a maintenance log can help you identify patterns and address issues before they become major problems.CNC Machine Tools for BeginnersEquipping your machine with the right CNC machine tools for beginners is essential. Here are a few to get started:End Mills: 2-flute or 4-flute for general cutting.V-bits: For engraving and decorative designs.Ball Nose Bits: Ideal for 3D carving.Clamps and Fixtures: To hold your material securely.Spoilboard: Protects the machines surface during cuts.Start with a basic set and expand as you tackle more complex projects.Final ThoughtsStarting with a CNC machine for beginners may seem like a huge undertaking, but the combination of available technology, online support, and affordable equipment makes it more accessible than ever. Whether you want to pursue a hobby, launch a side business, or explore manufacturing, CNC machining offers countless opportunities.With the right mindset, steady practice, and a solid understanding of the basics, youll soon be creating high-quality parts and beautiful designs from your own home. Now is the perfect time to get startedyour CNC journey awaits!The best CNC machine for beginners is one thats easy to set up, user-friendly, and budget-friendly. Popular choices include the Genmitsu 3018-PRO or BobsCNC Evolution series. These machines come with basic software, simple controls, and helpful community support. Beginners should look for machines that allow learning without complex setup and are suitable for small wood, plastic, or soft metal projects.You can learn CNC machining through online tutorials, free YouTube videos, and beginner-friendly courses on platforms like Coursera or Udemy. Start by understanding how CNC machines work, learn basic G-code, and practice with simulation software. Many starter machines come with guides and manuals. Joining CNC forums or communities also helps you troubleshoot issues and get advice from experienced hobbyists and professionals.You dont need advanced coding knowledge to start using a CNC machine. Beginners can rely on CAD/CAM software like Easel, Fusion 360, or Carbide Create to design and convert files into tool paths automatically. However, learning basic G-code can be helpful over time to troubleshoot issues and fine-tune your projects. Most beginner-friendly machines simplify this process with easy-to-use interfaces.Beginner CNC machines are ideal for working with soft materials like wood, plastic (such as acrylic), foam, and some light metals like aluminum. These materials dont require high-speed spindles or industrial-grade torque, making them perfect for entry-level users. As you gain experience, you can upgrade your machine or bits to handle tougher materials like brass or harder woods.Yes, CNC machining is an excellent hobby that combines creativity, engineering, and hands-on skills. It allows beginners to design and create custom parts, art, signs, furniture, and more. With affordable desktop machines available, its easier than ever to get started. Learning CNC also opens doors to future careers in manufacturing, product design, or prototyping if you decide to go professional. To get started in CNC, you must understand the CNC Basics. This guide will help you find top CNC tutorials suitable for beginners. We'll guide you on the critical concepts you need to learn and the sequence to follow. An excellent roadmap that segments the CNC Basics into easy-to-understand tutorials is unbeatable, as it enables any novice to quickly grasp the concepts.That's exactly what this article is: a Beginner's Roadmap for how to Learn CNC!CNC Basics: Big Picture & ConceptsPersonally, I always start with the big picture and basic concepts. They're the foundation for deeper understanding, and the give you that all-important overview of how the big pieces go together in the puzzle. Once you've got the CNC Basics down, you can drill down and learn cnc in bite-sized chunks.This Big Picture View will seem pretty normal if you're planning to make your living in the CNC Manufacturing world. But, for many hobbyists, they want to jump in and buy or build a CNC machine right away.Here's the thing-learn the CNC Basics first before you try to acquire a machine. Understanding these CNC basics will help you understand your potential new machine's specs and documentation. They'll help you understand what people on forums (great learning resources!) are talking about. This can potentially save you money and frustration. Once you've got at least an overview of the basics, move on to researching how much cnc machines cost.Here's the Big Picture to help you get your arms around those CNC basics fast.Big Picture: Step-By-Step Guide to Making CNC PartsThere are 9 steps to make a CNC part described below. Click on the title of any to drill down and see details for each step.1Design Idealized Part Deliverable: Create an Idealized CAD Model of the PartDesign the part in the CAD software based on sketches, photos, specifications, and any other ideas we have for the part. The part is "Idealized" because we haven't done any serious homework yet to evaluate how easy it will be to manufacture the part. Experienced Designers will have avoided many manufacturing problems at this stage while Beginners will discover they need to change quite a bit to make the part easy to manufacture.2Modify Design for Manufacturing Needs Deliverable: Finished CAD Model + Setup Sheet Outline that is a plan for how to manufacture the part80% of the cost to manufacture a product is determined at Design Time...In this step, we will evaluate how easy it is to manufacture our part, change the design as desired to make it easier to manufacture, and arrive at a plan for how to manufacture the part which we'll capture in our Setup Sheet Outline.3CNC Programming Deliverable: G-Code Part Program + Finished Setup SheetUsing MeshCAM to create a G-Code Part Program...Armed with a CAD model and our Setup Sheet Outline, we're ready to dive into CAM, Conversational Programming, Hand Coding, or whatever method we want to use to create a G-Code Part Program.4Machine Setup Deliverable: CNC Machine is Setup to Run the PartSetup is where we get the CNC Machines all ready to run the part. We need to make sure it has all the right tools in the tool changer, the right gcode program loaded, and in general that the machine is ready to go.5Program Proofing Deliverable: Program is Proven, Ready to Run the PartProofing the program is the last step before we actually make real cuts. The goal of proofing is to verify the program is correct and the CNC machine is setup correctly so that there will be no problems when the g-code is run for the first time. Proofing can be done either by Cutting Air (simple but very time consuming) or by using a CNC Simulator (also called a G-Code Simulator).Click the section title to drill down and see which is better.6Machine the Part Deliverable: CNC'd PartsAfter all the preparation, we're finally ready to make some chips and machine a CNC part.7Manufacturer Quality Control and Part Inspection Deliverable: Inspected Parts, Ready for FinishingHaving finished the CNC machining, it's time for Quality Control. We'll inspect the parts to make sure they meet the desired specifications, tolerances, and surface finishes. But first, most parts will need deburring. See our article on Deburring Tools for Metal to learn more.8Finishing Deliverable: Part is Finished!Our last step involves finishing the parts. It's optional, as our parts may not require it. But, there are many forms of finishing possible ranging from paint, to anodizing, to bead blasting, and more.CNC Basics: The CNC Software StackNow you've got the Big Picture for How CNC Parts are Made. Cool beans! That's an awesome framework to help file away future CNC learnings and concepts.Let's get another framework in place: The CNC Software Stack.By "CNC Software Stack" I mean, "What are the different CNC Software packages used and how do they fit together?"Theres a fair amount of different software that is involved when making a part with CNC. At the very least that includes a CAD program with CAM (or perhapsConversational CNCinstead of CADCAM, but lets start with CAM as a newbie) to generate the g-code, and your machine controller, which turns that g-code into machine motions that make your part for you. Theres a lot of other software out there that youll hear about and wonder about. Its helpful to get a mile-wide-but-inch-deep overview of what all that software does and how it fits together. You wont need all of it to get started, but its still worth understanding it because itll help you understand a lot more about the workflows going from a design concept to a finished part at the software level.To help folks understand the CNC Software Stack better, we wrote an article calledCNC Software: Digital Tooling for CNCthat explains all about what kinds of CNC software are available and how it all fits together. Heres a diagram that shows how the most important pieces of software work together:That article gives you the overview and background. Even better is ourBeginners Guide to the Best CAD CAM Software. Its laser-focused on exactly the software Beginners need to get started. Even better, its chock full of buyers guides, evaluation tips, learning help, and even a guide to the secret deals on the Internet that will let you buy the most popular software uber cheap.Check it out!3 Awesome Software Packages to make you a Better CNC'erG-Wizard Calculator MeshCamThe World's Easiest CAM. Easy Point-and-Shoot G-Code Wizards so you can skip CAD/CAM.Conversational is Free with G-Wizard Editor, our g-code editor and simulator. GW Editor can really help beginners get their arms around g-code.Building or Purchasing a CNC MachineYou've got the overall idea of how CNC Parts are made in hand. You know what the CNC Software Stack looks like. By now you're ready to jump in and start choosing your CNC Machine.Hang on a minute, we'll get there soon. Just know two things.First, the learning curve on the CNC Software will take a little while. Don't be afraid to start there and even get the point where you are pretty comfortable with it before you buy a machine. Otherwise, you're going to wind up terribly frustrated because you're unable to run your shiny new machine and make parts.Second, read as much as you can from the rest of this guide. You need these concepts to help you evaluate your machine choices. CNC Machines are pretty expensive, even the hobby-class machines. And building one trades some of that expense for a big investment of your time. Make sure those time and money investments result in the right machine for your needs!Here's a couple of resources to help you choose and get your CNC machine. If you want to buy an industrial machine, skip ahead past the DIY stuff. If you're a DIY'er, just keep reading.CNC Basics:DIY CNC Machine BasicsThose of you who want to build your own CNC machine, or at least jump ahead to buying one, have been chomping at the bit. You didn't want to wade through all those basics to get here. But, you'll find having that knowledge will really help you to make the right decisions when building or buying a CNC Machine.Who would've thought anyone that wanted one could have a CNC machine right in their own home workshop?You can buy completed machines from companies like Tormach or Carbide3D for very reasonable prices or you can build your own machine, either from scratch or as a conversion of an existing manual machine. Once you have your machine and know how to use it, you'll be able to make beautiful parts quickly and easily.But, there is a challenge-knowing how to use CNC to create your parts requires you to pick up a number of different kinds of knowledge. It's not hard, but it's also not very well organized or accessible. Until now.With this page, we're going to bring together links to articles that cover all the basics you'll need to use a CNC machine or to get started with the planning to buy or make a CNC machine. If you go through these articles, you'll wind up with a solid grounding in the basics.You'll know how things fit together and you'll have the basic background you need to dig deeper into other areas of CNC you get interested in. We'll also organize the page so the order the concepts and articles are presented is an ideal order for you to learn things in.But, you don't have to stick to that order if you don't want to. Feel free to jump around and check out whatever interests you.Buying or Building a CNC MachineThis is where you want to start, right? You want to get your hands on that CNC machine. If you're anything like me, you're not thinking about much of anything else. If you're looking to enter the trade, perhaps you're not thinking about Buying a machine right away. That's fine, just skip ahead to the next chapter.Otherwise, I'm going to start here because it's where everyone wants to start. Just be advised, there's a lot you could learn before getting a machine that would help you to select the best machine for your needs. There's also enough to learn before you make your first CNC part that you should start before getting the machine just so you don't have to look at the idle machine while you're learning.I'm not saying CNC is hard, but there's a pretty good breadth of information you'll need. Easy to learn, just a lot of pieces to put together. But hey, that's why we wrote this guide for you.What Kind of a CNC Machine Should You Get?This is an important first question to answer. Most CNC'ers want one of 4 machines:CNC RouterCNC Mill3D PrinterCNC Plasma TableA distant fifth place might be a CNC Lathe, but let's put that on hold for a minute. Thegood news is we've put together a fabulous article that walks you through it. It considers all 4 machines and walks you through what their capabilities are, how hard they are to build, what it will cost, and so on.Grab that article right here:[4 Awesome DIY CNC Machines You Can Build Today]Buy, Build, or Kit?Okay, that article talks about Building, but it also applies to helping you choose what kind of machine to Buy.On the question of Buy or Build, you should boil the decision down to one simple question:Do you want to make parts sooner or will you enjoy the whole process of building your own CNC Machine?Before we go any further, let me give you an important caveat. A lot of would-be machine builders want to build to save money. They look at what finished CNC machines cost and it seems scary.Now here is an ugly little secret-building a machine takes a long time, it's a lot of work, and in the end you won't have saved much money at all.Wait!I can already hear many of you rebelling against the notion that building your machine won't save much money. Sorry to burst bubbles, but I've been there and done that. Not just once, but MANY times across many interests. It always starts out seeming like it will save. Once I got a little wiser about it, I rationalized it more as getting started sooner and paying as I went. That latter is closer to the truth.Take a CNC Milling machine. I converted one from scratch. It took a huge amount of time, and in the end it cost me about $6000 all told. No, I didn't have to pay that all up front, but you can buy a nice little Tormach for that price and be making parts right away.That's me, building CNCCookbook's Shapeoko CNC Router Kit...Kits: Best of Both Worlds?If you really want the best of both worlds, look into kits. The Shapeoko (watch me build one in the video above), for example, is a great CNC Router kit. Having a packaged kit like the Shapeoko that's been well engineered and has good documentation will save you a huge amount of time. Yet, you can still get one relatively cheaply.We built a Shapeoko at CNCCookbook and it has been a lot of fun.Here's the other big advantage to a kit: there will be others with machines just like yours. You can ask them questions for help and you can see what they've built or done with their machines. What an inspiration!Buying an Industrial or "Pro" CNC MachineWhat's the Best Machine for My Needs?Good news!We can figure this out scientifically if you're looking to be a Pro and start a CNC business. If you're only interested as a Hobby, go back up and read that DIY article on which machine types. Choose a type, then look at what you can afford. See also our article below on how to afford a new machine.OK, let's see about choosing a new CNC Machine for a business scientifically. You know, in a way that ensures you don't get too much or too little machine.Which machine is better for your business, Machine A or Machine B?Weve all been therepouring over machine catalogs and specifications. This one is so coolthe spindle goes 86 zillion rpms, the rapids are faster than light speed, and the tool changer, oh my, THE TOOLCHANGER!!!But is the biggest baddest machining center always the right choice for your business? Or maybe you can justify an even more potent machine than the ones you are considering? How would you know? How can you make that decision based on logic and hard facts that will pay off in the long run?These are questions every would-be CNC Business owner faces when they start, and if the business is successful, eventually theyll need to revisit the question again.To see how to figure this out objectively, with an eye towards maximizing your success, check out this article:[Help: I Need to Choose the Best Machine for My CNC Business]What About Used Machines?Cheap? Yes, to get it off their floor and on to yours. But to get it working properly? Maybe not so cheap!Don't get me started here! Oh wait, you already did. So here's the deal:Some large number of you are thinking you can get a more powerful machine at a great price by purchasing a used machine.A used industrial CNC can be a fabulous investment. It can also be your worst nightmare.Parts for them are often very expensive and some of the machines were beat to death by their previous owners. What you have to ask yourself is whether you're qualified to tell which machines are the good deals and which are the nightmares? Also, if you do have a problem with a used machine, are you qualified to diagnose and fix it, or can you afford to call out the service men?I'm not saying it can't be done, but I do wonder whether a CNC Beginner is the best person to try.How Can I Afford a New Pro CNC Machine?Dude, have you seen what these CNC machines cost?CNC is one of my favorite things in the world, and it is amazing that an individual these days can actually have a full-blown CNC machine thatsmore powerful than the machines used to put men on the moon right in their own garage. Heck, theyre capable of generating a decent living for you too, if you are a reasonably clever business person. But, the initial startup costs can seem steep.This article is all about how to approach the affordability issue:[Help: How Can I Afford to Buy a CNC Machine?]CNC Basics: Learn Basic Tooling and WorkholdingHaving gotten a few basics under our belts at the 10,000 foot level, it's time to delve into some of the basic tooling and workholding every machinist should know, CNC or otherwise.Let's start with some basic terminology. All of the things we discuss in the tutorials below are Tooling. Tooling consists of the mechanical things we use with our CNC Machine to make parts. Examples:Cutters: These are the elements of tooling that have the sharp edges that slice chips out of the material we are machining.Workholding: Vises, clamps, and many other kinds of tooling are focused on holding down the workpiece so we can accurately machine it without it moving or flexing.Measuring Tools: Machining is about precision. It can range from 1/10's of inches to ten thousandths (1/10000) or less. We use specialized measuring tools to make such precise measurements. The simple rulers and tape measures from carpentry are no longer enough.Note that the articles in this section are a bit specialized. Choose the ones that are appropriate to the kind of machine you'll actually be using first, then branch out and see how some of the other machines work for comparison.CNC Mill Cutter Types and How to Use ThemLearn the basics of cutters used with CNC Milling Machines.Ultimate Guide to Selecting Toolholders for MillingHey, that cutter has to be held in the spindle somehow-what's the best way?CNC Router Cutter Types and How to Use ThemUpcut, Downcut, Compression Cutters, Straight Flutes, Diamond Cutters: There are quite a few different cutter types in the CNC Router arsenal, and it's important for CNC Router users to have a basic idea of what each one is for.CNC Lathe ToolingThis article on tooling up a CNC lathe will give you a good introduction to the types of cutters you'll be using with a lathe.Complete Guide to Machinist VisesIf you're using a CNC Mill, the most common way to hold the workpiece is a Machinist Vise.CNC Milling Machine WorkholdingWorkholding is all about how to hold your parts down for machining so they can't move or flex...Milling Vises, Step Clamps, Fixture Plates, and all the rest. There's a plethora of workholding solutions available for mills and this article walks through them.CNC Router WorkholdingSpoilboards, Clamps, Vacuum Tables, and more.CNC Lathe WorkholdingWe've categorized the different workholding methods for lathes based on their precision, repeatability, and convenience. This makes it easy to choose the most convenient workholding solution that will work for your application. We have a number of great articles and tutorials about measuring tools:Metrology Guide: This is our giant encyclopedia that talks about all the many different tools. Use it as a reference to look up specific tools you need to learn more about, or to find what tool is best to measure something you're interested in.How to use Calipers: Calipers are the most common measuring tool you'll start to use.How to use a Dial Indicator: Dial indicators are useful for setting up jobs and adjusting your CNC machine.How to use Edge Finders: Edge Finders are also use for setting up jobs on your CNC machine.How to use a Micrometer: Micrometers are one of the first super-precision measuring tools you'll learn to use.Acquire measuring tools as you need them.CNC Basics: CNC History and CNC DictionaryWhoa! Cooking with fire now. You've got a lot of great info that gives you insights into the Big Pictures for:Making a CNC PartCNC SoftwareBuilding or Buying Your First CNC MachineLet's get two more "Big Picture" resources in your hands while we're at this:CNC Machine Overview and Computer Numerical Control HistoryUnderstanding history is another way to get oriented and get perspective. It's amazing that individuals can build or own machines that rival the power of the original CNC machines being created for defense and aerospace applications just a few short years ago. See how that evolution unfolded.CNC DictionaryAs a beginner, you'll come across CNC terms that you don't know. Keep this link handy in case you hit a term you don't know. Our CNC Dictionary makes it easy to find out what all the terms mean.What's Next?I'm going to list a few more resources below, but there's the good news:You're Ready to Acquire a CNC Machine and Get Started Making Parts!If you've kept up with the Firehouse of CNC Beginner Information above, Congratulations! Seriously.You've got the overview on everything. You've got a bunch of pointers to even more articles on CNCCookbook you can drill down on to learn more. It's time to make choices that lead you to the next step:Choose your CAD, CAM, and Feeds Speeds Software. Purchase and start learning it in earnest. Do this BEFORE you buy a machine as you want to get through the learning curve and it takes some time.Choose your CNC Machine and get going on acquisition or a build.Choose your first CNC Project. What do you want to make with your machine?After you do those three, it's all about Git er done!Let your choices of software, machine, and first project guide your learning towards the goal of what you need to finish that first project. A few suggestions:Use an easy-to-machine cheap material. I highly recommend wood for your first project. It does make kind of a mess in machines intended for metal, but it's nothing a Shop Vac won't clean up quick.Keep it simple. Your first project is not the time to build a working scale model of a Ferrari V12 engine. You will get to that later, LOL!Stay focused until it is done. Seriously, I mean DONE. That way, you've covered all the bases and you have something to show for it.Want some project ideas? Here's my giant list of CNC Projects.Have fun!More CNC ResourcesWhat About G-Code?Yeah, you know it's out there. You don't strictly need to know it for your first project, but not too long after, you want toLearn Enough G-Code and CNC Machine Basics to Use CNC Like a Manual Machine Tool. We can help, naturally!Full on CNC programs are capable of doing some very complex things. It's almost magical to watch a complex CAD drawing first get converted to g-code by CAM software and then to see the actual 3 dimensional part taking shape (as it were) as all the chips that are not finished part get machined away.Because the process seems complex to the uninitiated, it's very easy for manual machinists to conclude its only good for making really complex parts or large production runs of simple parts. But you can do most anything on a CNC Machine that can be done on the manual tool and often faster and better.Admittedly, most of your CNC Programming will be done using CADCAM software as we talked about just above. But that doesn't mean you should ignore g-code. It's worth learning how to do basic manual-style machining on your CNC if you've ever done any manual machining because your learning curve will be short and you'll suddenly see how a lot of things go together.But even if you've never done any manual machining, it's still worth knowing how to do the simple things easily, without recourse to CAD or CAM, because again, it keeps the learning curve to getting simple things made less daunting.The other reason to learn g-code at least this well is you're going to see it flowing by on your machine controller's screen. You'll understand what the machine is doing a lot better if you can equate them most common g-codes you see coming up with what the machine is likely to do when it executes them. You'll also have a much easier time making simple changes to the g-code programs your CAM software generates, which can save you a lot of time and effort.Lastly, sooner or later you'll need to deal with g-code. Perhaps a cutter will break in mid-program and you want to know how to get the program back on track without starting over.The good news for all this is we have put together one of the best g-code training resources available, and it's completely free:CNC Programming with G-Code: The Definitive Guide6 Best Books for CNC MachinistsDo you like good old fashioned books on paper? Here are the 7 best books for CNC'ers that I know.Feeds and Speeds Master ClassMore killer free training from CNCCookbook. This Master Class is an email course that takes you from Beginner to Expert on Feeds & Speeds. It even includes free Feeds and Speeds Calculators.8 Ways to Locate Part Zero On Your CNC MachineThat fancy gadget is a Haimer 3D Taster. This article walks you through how they're used...Locating Part Zero is an important part of your CNC Basics. It is something you'll do every single time you make a part. Basically, you have to tell the CNC Machine physically where the coordinates 0, 0, 0 (XYZ) are located relative to the part. This article shows you all the best ways to save time and make sure your parts are accurate when locating Part Zero."Beginner" Blog Category: Best Blog posts for beginners.Hey, there's a reason we're the most popular CNC-related blog on the Internet. Check out all the articles we've written to help you learn more about CNC.How About Some Free CAD Files to Play With? Start out with these simple designs you can use to make cool signs and engravings. They're a great way for you to practice your CNC techniques with proven graphical designs. Join our newsletter to get updates on what's next at CNC Cookbook. To get started in CNC, you must understand the CNC Basics. This guide will help you find top CNC tutorials suitable for beginners. We'll guide you on the critical concepts you need to learn and the sequence to follow. An excellent roadmap that segments the CNC Basics into easy-to-understand tutorials is unbeatable, as it enables any novice to quickly grasp the concepts.That's exactly what this article is: a Beginner's Roadmap for how to Learn CNC!CNC Basics: Big Picture & ConceptsPersonally, I always start with the big picture and basic concepts. They're the foundation for deeper understanding, and the give you that all-important overview of how the big pieces go together in the puzzle. Once you've got the CNC Basics down, you can drill down and learn cnc in bite-sized chunks.This Big Picture View will seem pretty normal if you're planning to make your living in the CNC Manufacturing world. But, for many hobbyists, they want to jump in and buy or build a CNC machine right away.Here's the thing-learn the CNC Basics first before you try to acquire a machine. Understanding these CNC basics will help you understand your potential new machine's specs and documentation. They'll help you understand what people on forums (great learning resources!) are talking about. This can potentially save you money and frustration. Once you've got at least an overview of the basics, move on to researching how much cnc machines cost.Here's the Big Picture to help you get your arms around those CNC basics fast.Big Picture: Step-By-Step Guide to Making CNC PartsThere are 9 steps to make a CNC part described below. Click on the title of any to drill down and see details for each step.1Design Idealized Part Deliverable: Create an Idealized CAD Model of the PartDesign the part in the CAD software based on sketches, photos, specifications, and any other ideas we have for the part. The part is "Idealized" because we haven't done any serious homework yet to evaluate how easy it will be to manufacture the part. Experienced Designers will have avoided many manufacturing problems at this stage while Beginners will discover they need to change quite a bit to make the part easy to manufacture.2Modify Design for Manufacturing Needs Deliverable: Finished CAD Model + Setup Sheet Outline that is a plan for how to manufacture the part80% of the cost to manufacture a product is determined at Design Time...In this step, we will evaluate how easy it is to manufacture our part, change the design as desired to make it easier to manufacture, and arrive at a plan for how to manufacture the part which we'll capture in our Setup Sheet Outline.3CNC Programming Deliverable: G-Code Part Program + Finished Setup SheetUsing MeshCAM to create a G-Code Part Program...Armed with a CAD model and our Setup Sheet Outline, we're ready to dive into CAM, Conversational Programming, Hand Coding, or whatever method we want to use to create a G-Code Part Program.4Machine Setup Deliverable: CNC Machine is Setup to Run the PartSetup is where we get the CNC Machines all ready to run the part. We need to make sure it has all the right tools in the tool changer, the right gcode program loaded, and in general that the machine is ready to go.5Program Proofing Deliverable: Program is Proven, Ready to Run the PartProofing the program is the last step before we actually make real cuts. The goal of proofing is to verify the program is correct and the CNC machine is setup correctly so that there will be no problems when the g-code is run for the first time. Proofing can be done either by Cutting Air (simple but very time consuming) or by using a CNC Simulator (also called a G-Code Simulator).Click the section title to drill down and see which is better.6Machine the Part Deliverable: CNC'd PartsAfter all the preparation, we're finally ready to make some chips and machine a CNC part.7Manufacturer Quality Control and Part Inspection Deliverable: Inspected Parts, Ready for FinishingHaving finished the CNC machining, it's time for Quality Control. We'll inspect the parts to make sure they meet the desired specifications, tolerances, and surface finishes. But first, most parts will need deburring. See our article on Deburring Tools for Metal to learn more.8Finishing Deliverable: Part is Finished!Our last step involves finishing the parts. It's optional, as our parts may not require it. But, there are many forms of finishing possible ranging from paint, to anodizing, to bead blasting, and more.CNC Basics: The CNC Software StackNow you've got the Big Picture for How CNC Parts are Made. Cool beans! That's an awesome framework to help file away future CNC learnings and concepts.Let's get another framework in place: The CNC Software Stack.By "CNC Software Stack" I mean, "What are the different CNC Software packages used and how do they fit together?"Theres a fair amount of different software that is involved when making a part with CNC. At the very least that includes a CAD program with CAM (or perhapsConversational CNCinstead of CADCAM, but lets start with CAM as a newbie) to generate the g-code, and your machine controller, which turns that g-code into machine motions that make your part for you. Theres a lot of other software out there that youll hear about and wonder about. Its helpful to get a mile-wide-but-inch-deep overview of what all that software does and how it fits together. You wont need all of it to get started, but its still worth understanding it because itll help you understand a lot more about the workflows going from a design concept to a finished part at the software level.To help folks understand the CNC Software Stack better, we wrote an article calledCNC Software: Digital Tooling for CNCthat explains all about what kinds of CNC software are available and how it all fits together. Heres a diagram that shows how the most important pieces of software work together:That article gives you the overview and background. Even better is ourBeginners Guide to the Best CAD CAM Software. Its laser-focused on exactly the software Beginners need to get started. Even better, its chock full of buyers guides, evaluation tips, learning help, and even a guide to the secret deals on the Internet that will let you buy the most popular software uber cheap.Check it out!3 Awesome Software Packages to make you a Better CNC'erG-Wizard Calculator MeshCamThe World's Easiest CAM. Easy Point-and-Shoot G-Code Wizards so you can skip CAD/CAM.Conversational is Free with G-Wizard Editor, our g-code editor and simulator. GW Editor can really help beginners get their arms around g-code.Building or Purchasing a CNC MachineYou've got the overall idea of how CNC Parts are made in hand. You know what the CNC Software Stack looks like. By now you're ready to jump in and start choosing your CNC Machine.Hang on a minute, we'll get there soon. Just know two things.First, the learning curve on the CNC Software will take a little while. Don't be afraid to start there and even get the point where you are pretty comfortable with it before you buy a machine. Otherwise, you're going to wind up terribly frustrated because you're unable to run your shiny new machine and make parts.Second, read as much as you can from the rest of this guide. You need these concepts to help you evaluate your machine choices. CNC Machines are pretty expensive, even the hobby-class machines. And building one trades some of that expense for a big investment of your time. Make sure those time and money investments result in the right machine for your needs!Here's a couple of resources to help you choose and get your CNC machine. If you want to buy an industrial machine, skip ahead past the DIY stuff. If you're a DIY'er, just keep reading.CNC Basics:DIY CNC Machine BasicsThose of you who want to build your own CNC machine, or at least jump ahead to buying one, have been chomping at the bit. You didn't want to wade through all those basics to get here. But, you'll find having that knowledge will really help you to make the right decisions when building or buying a CNC Machine.Who would've thought anyone that wanted one could have a CNC machine right in their own home workshop?You can buy completed machines from companies like Tormach or Carbide3D for very reasonable prices or you can build your own machine, either from scratch or as a conversion of an existing manual machine. Once you have your machine and know how to use it, you'll be able to make beautiful parts quickly and easily.But, there is a challenge-knowing how to use CNC to create your parts requires you to pick up a number of different kinds of knowledge. It's not hard, but it's also not very well organized or accessible. Until now.With this page, we're going to bring together links to articles that cover all the basics you'll need to use a CNC machine or to get started with the planning to buy or make a CNC machine. If you go through these articles, you'll wind up with a solid grounding in the basics.You'll know how things fit together and you'll have the basic background you need to dig deeper into other areas of CNC you get interested in. We'll also organize the page so the order the concepts and articles are presented is an ideal order for you to learn things in.But, you don't have to stick to that order if you don't want to. Feel free to jump around and check out whatever interests you.Buying or Building a CNC MachineThis is where you want to start, right? You want to get your hands on that CNC machine. If you're anything like me, you're not thinking about much of anything else. If you're looking to enter the trade, perhaps you're not thinking about Buying a machine right away. That's fine, just skip ahead to the next chapter.Otherwise, I'm going to start here because it's where everyone wants to start. Just be advised, there's a lot you could learn before getting a machine that would help you to select the best machine for your needs. There's also enough to learn before you make your first CNC part that you should start before getting the machine just so you don't have to look at the idle machine while you're learning.I'm not saying CNC is hard, but there's a pretty good breadth of information you'll need. Easy to learn, just a lot of pieces to put together. But hey, that's why we wrote this guide for you.What Kind of a CNC Machine Should You Get?This is an important first question to answer. Most CNC'ers want one of 4 machines:CNC RouterCNC Mill3D PrinterCNC Plasma TableA distant fifth place might be a CNC Lathe, but let's put that on hold for a minute. Thegood news is we've put together a fabulous article that walks you through it. It considers all 4 machines and walks you through what their capabilities are, how hard they are to build, what it will cost, and so on.Grab that article right here:[4 Awesome DIY CNC Machines You Can Build Today]Buy, Build, or Kit?Okay, that article talks about Building, but it also applies to helping you choose what kind of machine to Buy.On the question of Buy or Build, you should boil the decision down to one simple question:Do you want to make parts sooner or will you enjoy the whole process of building your own CNC Machine?Before we go any further, let me give you an important caveat. A lot of would-be machine builders want to build to save money. They look at what finished CNC machines cost and it seems scary.Now here is an ugly little secret-building a machine takes a long time, it's a lot of work, and in the end you won't have saved much money at all.Wait!I can already hear many of you rebelling against the notion that building your machine won't save much money. Sorry to burst bubbles, but I've been there and done that. Not just once, but MANY times across many interests. It always starts out seeming like it will save. Once I got a little wiser about it, I rationalized it more as getting started sooner and paying as I went. That latter is closer to the truth.Take a CNC Milling machine. I converted one from scratch. It took a huge amount of time, and in the end it cost me about $6000 all told. No, I didn't have to pay that all up front, but you can buy a nice little Tormach for that price and be making parts right away.That's me, building CNCCookbook's Shapeoko CNC Router Kit...Kits: Best of Both Worlds?If you really want the best of both worlds, look into kits. The Shapeoko (watch me build one in the video above), for example, is a great CNC Router kit. Having a packaged kit like the Shapeoko that's been well engineered and has good documentation will save you a huge amount of time. Yet, you can still get one relatively cheaply.We built a Shapeoko at CNCCookbook and it has been a lot of fun.Here's the other big advantage to a kit: there will be others with machines just like yours. You can ask them questions for help and you can see what they've built or done with their machines. What an inspiration!Buying an Industrial or "Pro" CNC MachineWhat's the Best Machine for My Needs?Good news!We can figure this out scientifically if you're looking to be a Pro and start a CNC business. If you're only interested as a Hobby, go back up and read that DIY article on which machine types. Choose a type, then look at what you can afford. See also our article below on how to afford a new machine.OK, let's see about choosing a new CNC Machine for a business scientifically. You know, in a way that ensures you don't get too much or too little machine.Which machine is better for your business, Machine A or Machine B?Weve all been therepouring over machine catalogs and specifications. This one is so coolthe spindle goes 86 zillion rpms, the rapids are faster than light speed, and the tool changer, oh my, THE TOOLCHANGER!!!But is the biggest baddest machining center always the right choice for your business? Or maybe you can justify an even more potent machine than the ones you are considering? How would you know? How can you make that decision based on logic and hard facts that will pay off in the long run?These are questions every would-be CNC Business owner faces when they start, and if the business is successful, eventually theyll need to revisit the question again.To see how to figure this out objectively, with an eye towards maximizing your success, check out this article:[Help: I Need to Choose the Best Machine for My CNC Business]What About Used Machines?Cheap? Yes, to get it off their floor and on to yours. But to get it working properly? Maybe not so cheap!Don't get me started here! Oh wait, you already did. So here's the deal:Some large number of you are thinking you can get a more powerful machine at a great price by purchasing a used machine.A used industrial CNC can be a fabulous investment. It can also be your worst nightmare.Parts for them are often very expensive and some of the machines were beat to death by their previous owners. 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Use it as a reference to look up specific tools you need to learn more about, or to find what tool is best to measure something you're interested in.How to use Calipers: Calipers are the most common measuring tool you'll start to use.How to use a Dial Indicator: Dial indicators are useful for setting up jobs and adjusting your CNC machine.How to use Edge Finders: Edge Finders are also use for setting up jobs on your CNC machine.How to use a Micrometer: Micrometers are one of the first super-precision measuring tools you'll learn to use.Acquire measuring tools as you need them.CNC Basics: CNC History and CNC DictionaryWhoa! Cooking with fire now. You've got a lot of great info that gives you insights into the Big Pictures for:Making a CNC PartCNC SoftwareBuilding or Buying Your First CNC MachineLet's get two more "Big Picture" resources in your hands while we're at this:CNC Machine Overview and Computer Numerical Control HistoryUnderstanding history is another way to get oriented and get perspective. It's amazing that individuals can build or own machines that rival the power of the original CNC machines being created for defense and aerospace applications just a few short years ago. See how that evolution unfolded.CNC DictionaryAs a beginner, you'll come across CNC terms that you don't know. Keep this link handy in case you hit a term you don't know. Our CNC Dictionary makes it easy to find out what all the terms mean.What's Next?I'm going to list a few more resources below, but there's the good news:You're Ready to Acquire a CNC Machine and Get Started Making Parts!If you've kept up with the Firehouse of CNC Beginner Information above, Congratulations! Seriously.You've got the overview on everything. You've got a bunch of pointers to even more articles on CNCCookbook you can drill down on to learn more. It's time to make choices that lead you to the next step:Choose your CAD, CAM, and Feeds Speeds Software. Purchase and start learning it in earnest. Do this BEFORE you buy a machine as you want to get through the learning curve and it takes some time.Choose your CNC Machine and get going on acquisition or a build.Choose your first CNC Project. What do you want to make with your machine?After you do those three, it's all about Git er done!Let your choices of software, machine, and first project guide your learning towards the goal of what you need to finish that first project. A few suggestions:Use an easy-to-machine cheap material. I highly recommend wood for your first project. It does make kind of a mess in machines intended for metal, but it's nothing a Shop Vac won't clean up quick.Keep it simple. Your first project is not the time to build a working scale model of a Ferrari V12 engine. You will get to that later, LOL!Stay focused until it is done. Seriously, I mean DONE. That way, you've covered all the bases and you have something to show for it.Want some project ideas? Here's my giant list of CNC Projects.Have fun!More CNC ResourcesWhat About G-Code?Yeah, you know it's out there. You don't strictly need to know it for your first project, but not too long after, you want toLearn Enough G-Code and CNC Machine Basics to Use CNC Like a Manual Machine Tool. We can help, naturally!Full on CNC programs are capable of doing some very complex things. It's almost magical to watch a complex CAD drawing first get converted to g-code by CAM software and then to see the actual 3 dimensional part taking shape (as it were) as all the chips that are not finished part get machined away.Because the process seems complex to the uninitiated, it's very easy for manual machinists to conclude its only good for making really complex parts or large production runs of simple parts. But you can do most anything on a CNC Machine that can be done on the manual tool and often faster and better.Admittedly, most of your CNC Programming will be done using CADCAM software as we talked about just above. But that doesn't mean you should ignore g-code. It's worth learning how to do basic manual-style machining on your CNC if you've ever done any manual machining because your learning curve will be short and you'll suddenly see how a lot of things go together.But even if you've never done any manual machining, it's still worth knowing how to do the simple things easily, without recourse to CAD or CAM, because again, it keeps the learning curve to getting simple things made less daunting.The other reason to learn g-code at least this well is you're going to see it flowing by on your machine controller's screen. You'll understand what the machine is doing a lot better if you can equate them most common g-codes you see coming up with what the machine is likely to do when it executes them. You'll also have a much easier time making simple changes to the g-code programs your CAM software generates, which can save you a lot of time and effort.Lastly, sooner or later you'll need to deal with g-code. Perhaps a cutter will break in mid-program and you want to know how to get the program back on track without starting over.The good news for all this is we have put together one of the best g-code training resources available, and it's completely free:CNC Programming with G-Code: The Definitive Guide6 Best Books for CNC MachinistsDo you like good old fashioned books on paper? Here are the 7 best books for CNC'ers that I know.Feeds and Speeds Master ClassMore killer free training from CNCCookbook. This Master Class is an email course that takes you from Beginner to Expert on Feeds & Speeds. It even includes free Feeds and Speeds Calculators.8 Ways to Locate Part Zero On Your CNC MachineThat fancy gadget is a Haimer 3D Taster. This article walks you through how they're used...Locating Part Zero is an important part of your CNC Basics. It is something you'll do every single time you make a part. Basically, you have to tell the CNC Machine physically where the coordinates 0, 0, 0 (XYZ) are located relative to the part. This article shows you all the best ways to save time and make sure your parts are accurate when locating Part Zero."Beginner" Blog Category: Best Blog posts for beginners.Hey, there's a reason we're the most popular CNC-related blog on the Internet. Check out all the articles we've written to help you learn more about CNC.How About Some Free CAD Files to Play With? Start out with these simple designs you can use to make cool signs and engravings. They're a great way for you to practice your CNC techniques with proven graphical designs. Join our newsletter to get updates on what's next at CNC Cookbook.

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