Controllers for CNC Routers-Overview of Options
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*Older P2P Machines*

The first CNC Routers were drilling machines used for basic panel processing.

These machines were very well known as “Point to Point Machines” (P2P).

They were very fast and built for speed and production but were not the most accurate machines.
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Main Purpose of P2P Machines

P2P machines were used primarily as drilling machines for cabinet side panels.

They usually had a boring head with line bore drills and a saw for cutting slots.

Some of the later models included a light duty router spindle to cut toe kicks.
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*Older P2P Controls*

The controls for these P2P machines were very basic in design.

They were, however fairly advanced in software as they had the very earliest versions of CAM systems built into the user interface.

They were very easy to program and had powerful parametric capabilities.
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Older FT CNC Routers

The first Flat Table (FT) machines were very large in size and often had multiple spindles.

They seldom had boring heads or drill heads.

Unlike the P2P machines they were slow but very accurate.

These machines are affectionately known as “CNC Tanks”.

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Main Purpose of FT Routers

The early FT machines were used for manufacturing furniture components, MDF doors and many types of solid wood applications requiring special fixtures.
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*Older FT Router Controls*

These early FT machines had what is commonly known as industrialized controllers built for harsh environments and efficient communication to the machines.
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The Evolution of CNC Machines

Over the years many machinery companies entered the marketplace with different types of machines.

During this time two very significant changes were coming about;

1. P2P Machines were getting closer to being able to perform like an FT Machine.
2. FT Machines were getting as fast as P2P machines and most of them now had a Boring Head.
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New Pod and Rail Machines

The term “P2P” was now left behind with the older machines and being replaced with “Pod and Rail” Machines.

These machines are still fast but have greatly improved their accuracy.

They are also capable of performing almost every type of operation.
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Older P2P Controls

The P2P controls cannot handle all the features of the Pod and Rail machines.
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New Pod and Rail Controls

The controls for the Pod and Rail machines are very different from the P2P machines.

They are typically PC based or PC driven controls.

They utilize proprietary software to make programming at the controller very easy and powerful.
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New FT Machines

The new FT style machines come in many more configurations and have many more capabilities.

Speed is no longer an issue as they are as fast as Pod and Rail machines.
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New FT Controls

The new FT controls typically remained “G-Code” controllers.

Most often they require a third party software for advanced programming capabilities.
The Evolution of CNC Machines

So far we have looked at the controllers for Pod and Rail machines and FT machines.

If we stop there you might think it doesn’t matter about controls because you get what you get depending on the type machine you need or want.

The challenge is the two types of machines and manufacturers clash together with Nested Base Manufacturing cells.
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New FT Machines for Nested Base Manufacturing

There is a wide variety of machines available from many different manufacturers.

Most often, clients do not consider the advantages/disadvantages of the CNC controller they get with each model of machine.
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Levels and types of programming

Before we look at the features of the controllers let’s first look at four levels of programming as these programming levels or languages greatly effect how a controller is built;

1. CAD/CAM Programming
2. APT Style or Word Address G-Code Programming
3. G-Code or Letter Address G-Code Programming
4. Motion Control Programming
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**CAD/CAM Programming**

- Graphic Style programming.
- Most often performed in an office away from machine.
- Sometimes installed and utilized at the control.
- Very powerful and automated.
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APT Style Programming

- Sometimes called “Word Address G-Code”.
- Parametric type of G-Code.
- Was predominantly replaced by CAD/CAM

```plaintext
$$\text{PART SHAPE DEFINITION}
\text{STRRT = POINT/ -50,-20,100}
P1 = POINT/0, 0, 0
P2 = POINT/60, 0, 0
P2 = POINT/30, 10, 0
L1 = LINE/P1,P2
L2 = LINE/P2,ATANGL,135
C1 = CIRCLE/CENTER, P2, RADIUS, 60
PL1 = PLANE/P1, P2, P3
PL2 = PLANE/PARLEL, PL1, ZSMALL, 5
PL3 = PLANE/PARLEL, PL1, ZLARGE, 5
```
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**G-Code Style Programming**

- Widely known as the standard of CNC programming.
- Still very popular in the metal industry.
- Much more powerful than the average CNC programmer/operator commonly knows.

```
G17 G20 G90 G94 G54
G0 Z0.25
X-0.5 Y0.
Z0.1
G01 Z0. F5
G02 X0. Y0.5 I0.5 J0. F2.5
X0.5 Y0.10. J-0.5
X0. Y-0.5 I-0.5 J0.
X-0.5 Y0.10. J0.5
G01 Z0.1 F5
G00 X0. Y0. Z0.25
```
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Motion Control Programming

• Usually a type of “Binary Code” system format.
• Used to send signals or pulses to the drives of a CNC machine.
• The typical CNC programmer/operator has little to no knowledge of this code or it’s existence.

01010100 01101000 01101001 01110011 00100000 01101001 01110010 00100000 01101000 01101001 01110011 00100000 01101000 01101001 01100001 01101100 00100000 01101000 01101001 01110011 00100000 01101000 01101001 01101110 01100000 01100001 01110010 01101110 00100000 01101000 01110010 01111001 00101000 01100000 01101001 01110010 01110011 00100000 01100000 01110001 01101111 01101000 00100000 01101110 00100000 01100001 00100000 01100000 01101111 01101000 01100001 00100000 01101000 00100001 01101000 00100001
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Control communication strength

Let’s take a look at the communication capabilities of PC based and Industrial Controller.
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**Typical PC control**

- CAD/CAM Programming
- APT Programming
- G-Code Programming
- Motion Control Programming

The PC is responsible for handling all of the code conversions.
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Typical Industrial control

- CAD/CAM Programming
- APT Programming
- G-Code Programming
- Motion Control Programming

PC

Machine Controller

To have the Machine’s industrial control handle the G-Code transfer to Motion Control code is vital to the proper operation of the machine’s drive system.
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*G-Code to Motion Control Code*

```
G17 G20 G90 G94 G54
G0 Z0.25
X-0.5 Y0.
Z0.1
G01 Z0. F5;
G02 X0. Y0.5 I0.5 J0. F2.5
X0.5 Y0. I0. J-0.5
X0. Y-0.5 I-0.5 J0.
X-0.5 Y0. I0. J0.5
G01 Z0.1 F5.
G00 X0. Y0. Z0.25
```

```
01010100 01101000 01101001 01110011
00100000 01101001 01110011 00100000
01110100 01101000 01100101 00100000
01110100 01110101 01110100 01101111
01110100 01101001 01100001 01101100
00100000 01101000 01101111 00100000
01101110 01100101 01100001 01110010
01101110 01000000 01100010 01101001
01101110 01000001 01100100 01111001
00101110 00100000 01001001 00100000
01101000 01101111 01110000 01100101
00100000 01111001 01101111 01110101
00100000 01100101 01101110 01101010
1111 01111001 00100000 01101001
0100 00100001
```
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*Ease of programming at the control*

**PC**

PC based controllers most often have very advanced programming capability at the control with great features for locating parts and creating work zones.

**IC**

Industrial controllers use G-Code only at the control.

**CAD/CAM software written by the machine manufacturer is proprietary software that will not be capable of programming a different brand of machinery.**
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Cost of Control

Generally, a less expensive option when building the machine. However, the cost of special software will sometimes even out the cost.

Industrial controls are generally more expensive than PC controls. Some manufacturers build their own unit with industrial components.
Environment Protection

Will not have all the proper industrial components to protect against electromagnetic noise and dust. The best protection is now placing the PC in a closed cabinet with air control.

Industrial components that protect against electromagnetic noise and dust. This type of control has proven to last longer and maintain its performance over many years.
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*Overall Performance*

In closing, Generally speaking, in my opinion, you want your control to send commands to the machine as efficient as possible and last a long time while maintaining this efficiency. The industrial controller will win this battle at all times because it is as rudimentary as it can be.

A PC controller will help you with programming at the control, especially if you want to nest programs at the control.