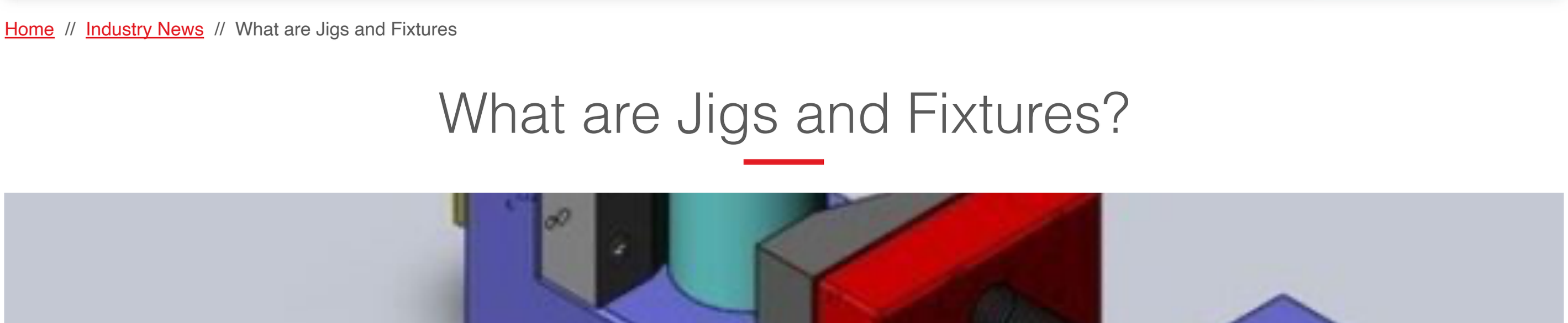
What are Jigs and Fixtures?



What are Jigs and Figures?

What you need to know.

The terms jig and fixture are often confused and used interchangeably, however, despite sharing similar functions, the two are functionally different.

Jigs are tools that hold a cutting tool in place or guide it as it performs a repetitive task like drilling or tapping holes. Fixtures, on the other hand, do not guide a cutting tool, but hold a workpiece steady in a fixed position, orientation, or location.

Our goal in this article is to learn the subtle differences between these manufacturing tools by examining how they are used to improve manufacturing quality, reduce production costs, and automate work.

In this article we will take a closer look at:

Jigs

Jigs are often used in drilling, reaming, counterboring, tapping and other one-dimensional machining operations or applied as guides for tools or templates. Special cramping jigs that ensure squareness are often used as well. Another common application for a jig is a drill bushing that helps guide a drill bit through the surface of the workpiece to ensure correct positioning and angle.

Since the advent of automation and computer numerical controlled (CNC) machines, jigs are often not required because the tool path is digitally programmed and stored in the machine's memory. However, jigs are still used in smaller machine shops to support manual machining of special or custom parts and one-offs.

Fixtures

Fixtures are often used in milling, turning, planning, slotting, grinding, and other multidimensional machining processes, as well as automotive vehicle assembly and optical, laser scanning inspection systems. The material block clamped inside a CNC machine and a vise sitting on a workbench are also fixtures. Fixtures are also essential in an automobile assembly line to secure and guide cars through the welding and assembly processDifferences aside, both jigs and fixtures are tools that make a significant difference. They increase productivity, improve the repeatability of parts, make part assembly and disassembly easier and help create a safer working environment

Nearly all automated industrial manufacturing processes rely on jigs and fixtures to consistently build parts that function properly. Engineers can make sure their jigs and fixtures are strong and well-designed by keeping these key considerations in mind.

There's an old saying among machinists – **fixtures are where you make your mone**y. If you're good at making fixtures that save time, you'll turn a bigger profit. Or so the saying goes.

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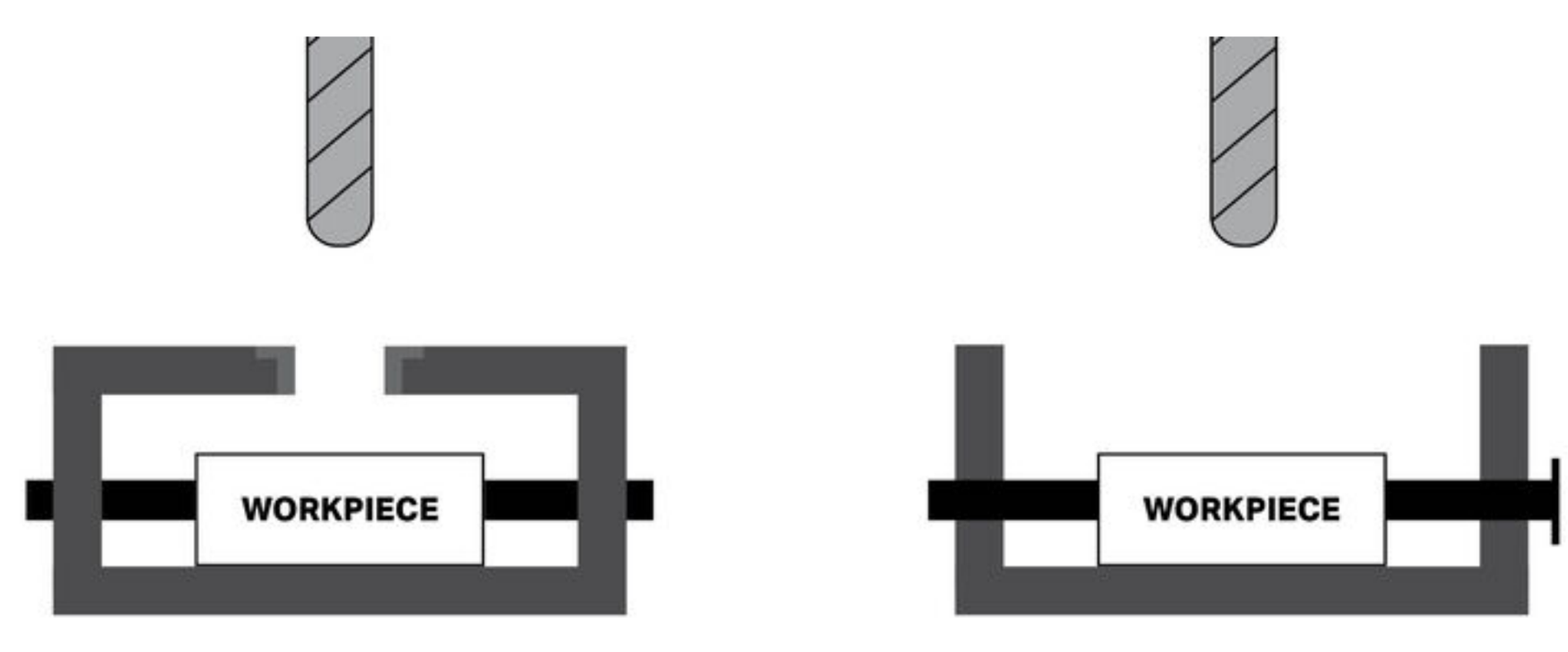


Types of Jigs and Fixtures

There are many different types of jigs and fixtures for machining operations that typically include:

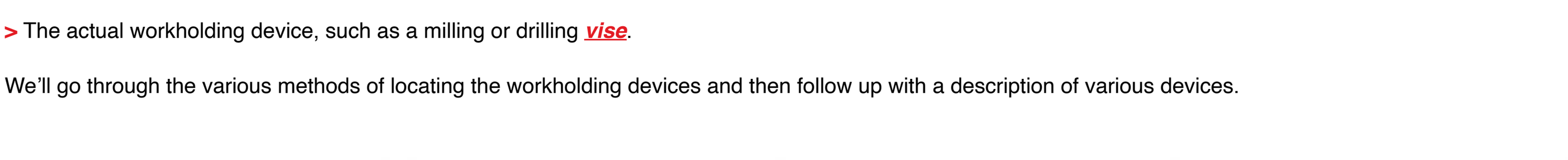
Type of Jigs	Type of Jigs	Type of Fixtures
Closed Jig	Trunnion Jig	Plate Fixture
Plate Jig	Pump Jig	Vise Jaw Fixture
Sandwich Jig	Indexing Jig	Indexing Fixture
Angle Plate Jig	Template Jig	Multi-Station Fixture
Box Jig	Multi-Section Jig	*Chucks*
Channel Jig	Drill Jig	*Collets*

There are two components to workholding with jigs and fixtures:

> The method of locating and securing the workholding device to your machine. This includes T-Slots but goes on to include modular fixture plates, 4th axis solutions, and much more.

> The actual workholding device, such as a milling or drilling *vise*.

We'll go through the various methods of locating the workholding devices and then follow up with a description of various devices.


DRILL JIG | DRILL JIG | CNC MILL MULTI-PART FIXTURE | CNC LATHE CHUCK & WORKPIECE

T Slot Plates

All the workpieces or the workholding tools installed on the milling table are held in position with the help of the table T-slots. It is fundamental to keep the slots clean from chips and any other debris.

Although they are strong and simple to use, one of the biggest disadvantages of T-Slot Plates is that it's hard to get your vise or other workholding fixture back onto the table in exactly the same location and orientation. This can result in extra work every time a machine needs to be set up with new workholding for a new job.

Depending on what you will be attaching to the T-slots, you will have to use T-slot nuts and combine them with other fasteners that fit the nuts.


T Slot Plates


T Slot Nuts

Fixture Plates

The way around the extra setup work is to use a fixture plate. Also called tooling plates**,** they are installed on top of a T-Slot table to provide a new way to position and secure your ***workholding devices***. They typically feature a grid of holes that alternate threaded holes for fasteners and precision dowel pins for positioning.

With T-Slots, the T-Slot nuts slide. A fixture can thus be located anywhere. That sounds great except that the fixtures can be anywhere also. With a Fixture Plate, your fixtures can't be located just anywhere. They must go into the grid of available holes. In other words, with a Fixture Plate, fixtures are always at a well-defined location.

The grid makes workholding positioning significantly easier and repeatable. Tooling Plates are typically made of either Cast Iron or Aluminum, though there are steel ones available too. They can be purchased or made from scratch.

Locating and Positioning Components

The fixture plates are properly positioned and mounted on the T-Slot plates. Then the ***workholding devices***, which include a variety of clamps including jig and fixture clamps are mounted on the fixture plate.

A diverse line of ***locating and positioning components*** for jobs that require precise alignment of the workpiece is available to design your workholding jigs and fixtures.

An extensive range of ***spring plungers*** is available and includes threaded spring plungers, hand-retractable spring plungers, press-fit spring plungers, push-fit spring plungers, pull-pin spring plungers, and index plungers.

Also available are press-fit locating pins and spring locating pins, along with accessories such as pin liners, thread retainers, and lock screws.

Tooling balls are used as reference points for inspection applications. Built to reduce design and detail time, CMM fixture blocks and plates provide a work base with a combination of standard size mounting holes for positioning.

Fixture keys are used to locate jigs and fixtures on slotted machine tool tables.

Alignment pins and bushings are removable locating devices used to precisely align workpieces in jigs and fixtures.

A full range of ***angle plates***, ***gauge stops***, ***locating screws***, and ***stock crowders*** are also available.


SPRING PLUNGERS | TOOLING BALLS | FIXTURE KEYS | ALIGNMENT PINS & BUSHINGS | ANGLE PLATE | LOCATING SCREWS | STOCK CROWDERS

Advantages of Jigs and Fixtures

> Productivity
Jigs and fixtures increase productivity by eliminating frequent repositioning and checking. Operation time is reduced due to an increase in speed, feed and depth of cut because of high clamping rigidity.

> Interchangeability and Quality
Jigs and fixtures enable the production of many workpieces repeatably, accurately and with uniform quality and interchangeability at a competitive cost.

> Skill Reduction
There is no need for the skillful setup of workpieces on a machine. Jigs and fixtures allow unskilled or semi-skilled machine operators to set up the workpieces reducing labor cost.

> Cost Reduction
Higher production, reduced scrap, easy assembly and savings in labor cost result in an ultimate reduction in unit cost.

Jig and Fixture Design Basics

Now that we know the advantages of using jigs and fixtures and how to properly position and mount them in a machine tool, the jig and fixture designer should implement the following principles to ensure easy installation, repeatable location, high quality of workpieces at a competitive cost.

> Locating Points
Provide good for locating points for the workpiece. The workpiece to be machined must be easily inserted and quickly removed from a jig so that no time is wasted in placing the workpiece in position to perform operations. The workpiece location should be accurate to assure the desired cutting tool path.

> Error Proof
The design of jigs and fixtures should not permit the workpiece or the tool to be inserted in any position other than the correct one.

> Idle Time Reduction
Jigs and fixtures should be designed so that processing, loading, clamping and unloading time of the workpiece is minimized.

> Jig and Fixture Weight
Jigs and fixtures should be easy to handle, as light as possible and use minimum material without sacrificing rigidity and stiffness. Lift aids should be incorporated as necessary to prevent operator fatigue.

> Jigs Provided with Feet
Jigs are sometimes provided with feet so that they can be easily placed on the table of the machine.

> Materials for Jigs and Fixtures
Jigs and fixtures are usually made of hardened materials to avoid frequent damage and to resist wear. Examples are mild steel, cast iron, die steel, carbon steel or high-strength steel.

> Clamping Devices
When designing jigs and fixtures, ***clamping devices*** should be as simple as possible without sacrificing effectiveness. The strength of the clamp should hold the workpiece firmly in place, but also take the strain of the cutting tool without moving.
Power-driven clamps are preferred because they are quick-acting, controllable, reliable and can be operated without causing fatigue to machine operators. Movement of clamps should be minimized and clamping pressure should be low enough to prevent workpiece distortion.

Additional, Essential Features of Jigs and Fixtures

In addition to basic jig and fixture design, there are several tool design features the tool designer should address. Among those features are:

> Cleanliness of the Machining Process – designs must minimize time wasted in the cleaning of scarfs, burrs, chips, etc.

> Replaceable Parts and Standardization – the locating and supporting surfaces should be replaceable where possible and should be standardized to allow interchangeable manufacture.

> Coolant Provisions – features should be added to the tool design to allow cooling of the cutting tool and washing away swarf and chips.

> Hardened Surfaces – all locating and supporting surfaces should be hardened materials if possible so that they are not quickly worn out and accuracy is retained for a long time.

> Inserts and Pads – should always be attached to the faces of the clamps which will come in contact with the finished surfaces of the workpiece so that they are not damaged.

> Initial Location – should ensure that the workpiece is not located on more than 3 points in any one plane. Testing should be conducted to verify that there is no rocking. Spring loading should be implemented where possible.

> Clamp Positioning – clamps should be placed directly above the workpiece supports to avoid part distortion and springing and resist cutting tool forces.

> Workpiece Handling and Clearance – sufficient clearance should be provided around the workpiece to allow an operator's hands to easily enter the fixture body for placing the workpiece and to accommodate any part variation. Round all corners and provide handles wherever they will make handling easier.

> Ejecting Devices – proper ejecting devices should be incorporated in the fixture body to push the workpiece out after operation if required.

> Clamping and Binding Devices – should be as quick-acting as possible. Complicated clamping arrangements should be avoided and some locating points should be adjustable.

> Safety – the fixture design should ensure operator and machine safety.

Summary

One of the most common arguments in manufacturing machining processes is jig vs fixture. In this article, we learned about both tools, their types, uses in manufacturing, design principles and essential features.

The primary purpose of a jig or a fixture is to create a secure mounting point for a workpiece, allowing for support during operation and increase accuracy, precision, reliability, and interchangeability in the finished parts.

Jigs are commonly used in drilling, boring, reaming and tapping, while **fixtures** are used for milling, slotting, shaping, turning and planning. Jigs are usually more expensive than fixtures. Jig designs are often more complex than simpler fixture designs.

High-volume machining has different foundational requirements than lower volume production and depends on reliable, repeatable processes that produce parts of consistent quality over extended periods. Typically, specialized workholding solutions like jigs and fixtures are required.

The primary benefits of jigs and fixtures are:

> Accuracy
> Simplicity
> Ease of use
> Repeatability
> Safety

Finally, it should be noted that jigs and fixtures are also used extensively in many industries among which are automotive vehicle welding and assembly, engine and transmission machining and assembly, aerospace manufacturing and the medical and pharma industries.