

## Vertical Turning Lathe versus Horizontal Turning Lathe A Comparative Analysis

ALI ALYEHYA

### ABSTRACT

The subtractive manufacturing process had been one of the early processes known in the industry field. One of which is turning operation. This type of operation is based on removing or carving-off material from a stock piece with a sharp cutting tool while the stock piece is revolving.

A horizontal turning lathe (HTL) and a vertical turning lathe (VTL) are two types categorized according to the mounting direction of the work piece and the machine's revolving axis. This research will bring up to surface the advantages and disadvantages of these two main processes and their applications in the industry.

Also, whether the mounting direction of the work piece has any effect on the final product geometrical dimensions and finish. This study is a debate discussing where you should use one over the other; keeping in mind the skill level required to operate the machines, the footprint required at the work plant and most important the affordability and mobility of such machines.

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### I. Introduction

Lathes as classic machine tools have evolved. This change is due to rapid technology improvements and changing production demands. This evolution shows human innovation and the necessity to adapt to the changing of industrial world demands. Two types of lathe machines stand out: Vertical (VTL) and horizontal turning lathes (HTL). While they share the fundamental purpose of machining, they differ remarkably in design, operation, and application. This study embarks on a detailed experimental analysis of VTLs and HTLs, focusing on aspects like efficiency, usability, and cost-effectiveness. Such an examination is critical in manufacturing and technical education, where equipment choice intensely impacts outcomes. The study aims to explore the essential differences between VTLs and HTLs using real-world data and experiences. This investigation goes beyond academic interest; it seeks to sort out the complexities and subtleties of these machines. The objective is to offer a thorough comparison that aids decision-making in industrial and educational contexts, examining operational efficiency, versatility in manufacturing tasks and economic outcomes, thereby illuminating the best applications for VTLs and HTLs.

### II. LITERATURE REVIEW

#### 2.1 Historical Development of Lathes

The history of the lathe is intriguing and reflects manufacturing technology evolution and how

this machine has changed over the decades. Lathes were once laborious manual tools. Hand- or foot-driven variation were essential for teaching rotational machining. The hand-operated lathe was first used for woodturning and metal shaping. One hand spun the material while the other chopped it. Although tedious, this method established rotational cutting.

Foot-powered treadle lathes were key lathe innovations. This innovation let operators use the cutting tool with both hands, boosting precision and ease. The treadle lathe was common in carpentry and light metalworking. The use of steam revolutionized lathe operating during the Industrial Revolution (Guergov, 2018). This led to the power lathe, which improved precision and output.

Current lathes were inspired by power lathes, which were capable of handling tougher materials and more sophisticated operations. A variety of lathes performed various machining processes more accurately and quickly in the 20th century thanks to electric motors.

CNC transformed the lathe in the second part of the 20th century. Computer Numeric Controlled Machines, known for their high automation and precision, are governed by complex computer programs. They excel at executing complex cutting and shaping tasks with minimal human input, delivering unparalleled precision, repeatability, and efficiency. This transition marked a move from manual lathe operation to an era of sophisticated manufacturing technology, significantly influencing industries like aerospace and automotive.

## 2.2 Previous Studies on Lathe Machines

The existing body of research on lathe machines, while rich in documenting their historical evolution, shows a less comprehensive exploration in comparing different lathe types, particularly Vertical Turning Lathes (VTLs) and Horizontal Turning Lathes (HTLs). There are not many studies have concentrated on the technical aspects, design improvements, and operational efficiency of lathes in a broader matter. These technical studies dig deeply into the mechanical design and improvements of lathes, aiming to enhance precision, reduce vibrations, and elevate the quality of machined parts. Their contributions are essential in developing lathe designs, making them more efficient and robust. The research focused on operational efficiency to optimizing the lathe performance, tackling aspects like reducing cycle times, extending tool life, and refining surface finishes. These studies hold significant value in manufacturing contexts where efficiency is closely tied to productivity and cost-effectiveness.

However, a clearly visible gap is noticeable in the literature regarding observed comparisons between VTLs and HTLs. Existing research often overlooks a deep dive into the differences in applications, efficiency, and practical use between these two lathe types. This void is particularly noticeable in studies based on observed data and applications in real-world scenarios. For example, comparative studies of VTLs and HTLs in specific manufacturing applications, such as the aerospace or automotive sectors, are not commonly found. Such analyses are crucial to bring up the strengths and weaknesses of each lathe type within different manufacturing settings. They offer key insights into the suitability of each lathe type for specific tasks, considering factors like the type of material, the size of components, and production volumes.

Furthermore, research evaluating the economic aspects, including cost-benefit analyses of VTLs versus HTLs, is sparse. Such insights would be exceedingly valuable, especially for decision-making processes in small to medium-sized enterprises where investment choices significantly influence operational efficiency and profitability. In the world of education and training, where lathes are an integral component in imparting manufacturing principles, there is a lack of comparative studies on VTLs and HTLs to guide curriculum development and equipment selection. This lack of focused research highlights a need for more in-depth study in this area, which is essential for informed decision-making in both industrial and educational fields.

## III. Methodology

This study examines the practical uses, preferences, and performance of VTLs and HTLs using surveys and interviews. The strategy aims to tap into the firsthand experiences of those regularly interacting with these machines. We circulated a structured survey across a varied group of manufacturing sector professionals, targeting machinists, production managers, and maintenance staff. These individuals' daily engagement with lathes provides valuable insights. Our survey seeks detailed feedback on various factors, including usage frequency, efficiency perceptions, ease of operation, and maintenance demands for both VTLs and HTLs. The objective was to collect quantifiable data for statistical analysis, aiming to discover trends and preferences in lathe usage.

Upon the completion of the surveys, we conducted in-depth interviews with select professionals: senior machinists, plant managers, and technical education instructors. These conversations offered qualitative insights, diving into the variation of lathe use that survey alone might not reveal. Discussion points revolving around personal experiences with both types of lathes, specific instances favoring one over the other, and the reliability of performance in diverse manufacturing processes and educational environments. This dual method—survey and interview—was focusing in achieving a balanced understanding of VTLs and HTLs. While surveys sketched a broad industry picture, interviews added depth and context. Thus, our study crafted a comprehensive dataset for comparative analysis. We inspected aspects such as mounting, pricing, workload capacity, and operational efficiency, framing a detailed comparative analytical structure.

## IV. Analysis and Discussion

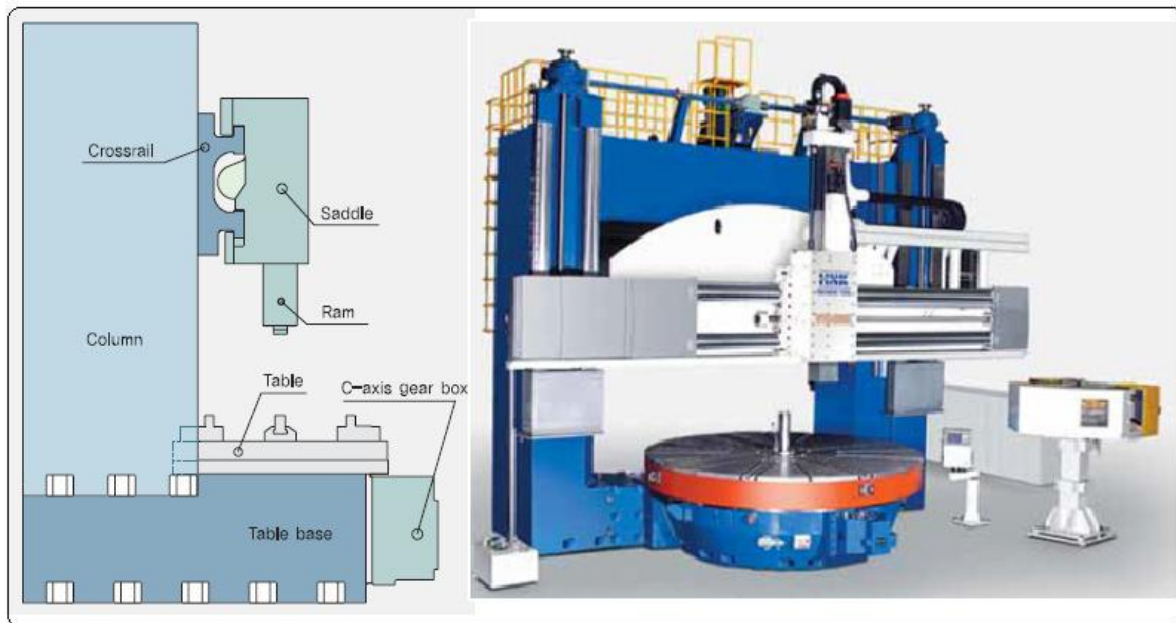
### 4.1 Mounting Differences

The operational capabilities, applications, and suitability for specific tasks of a lathe are intrinsically linked to its mounting orientation, a fact that becomes particularly noticeable when comparing Vertical Turning Lathes (VTLs) and Horizontal Turning Lathes (HTLs). Each type of lathe, with its distinct mounting style, brings unique attributes and preferred use cases to the table.

VTLs feature a vertical spindle alignment, where the workpiece is affixed vertically, and the cutting tool moves horizontally. This design offers numerous advantages. Space efficiency is one: VTLs, with their smaller footprint, are particularly suited for workshops where floor space is limited (Absolute Machine Tools, 2023). Despite their compact size, they are made to handle large diameters, making them necessary in industries where machining large,

heavy workpieces is required, such as aerospace and heavy machinery. Gravity reduces fixturing and secures workpieces in vertical mounting (Absolute Machine Tools, 2023). Vertical configuration lets

chips fall away, reducing re-cutting and improving machining visibility. This configuration can make loading and unloading big workpieces difficult, requiring overhead cranes or other lifting solutions.



**Figure1:** vertical turning lathe machine VTL

For instance, HTLs have horizontal spindle alignment. The workpiece is horizontal, and the cutting tool approaches from the side. This orientation gives HTLs different benefits. Their flexibility allows for a variety of workpiece sizes and forms, including longer pieces (Tramar Industries, 2018). HTLs are popular in many manufacturing environments because of their adaptability. Their horizontal orientation makes setup and tool access easier, allowing workpieces to be loaded without special equipment and speeding up operations.

HTLs handle long, slender workpieces well because their horizontal alignment eliminates gravity-induced sagging, improving accuracy and

quality. The trade-off, however, is that HTLs may consume more floor space than VTLs and might not provide the same level of support and stability for extremely large or heavy workpieces as VTLs do. Deciding between a VTL and an HTL hinges on the specific demands of the machining task in hand. This selection depends on workpiece size and shape, workspace limitation, and operating flexibility. VTLs are space-efficient and good for heavy, massive components, whereas HTLs are versatile and easy to set up, especially for extended workpieces. Understanding these distinctions helps choose the best lathe type for an application, assuring optimal machining performance and efficiency.



Figure2: horizontal turning lathe machine HTL

#### 4.2 Pros and Cons Analysis

In manufacturing, selecting either Vertical Turning Lathes (VTLs) or Horizontal Turning Lathes (HTLs) is crucial, as each has pros and cons. This analysis examines the benefits and downsides of both to improve decision-making.

##### 4.2.1 Vertical Turning Lathe (VTL)

VTLs are tailored to manage large, bulky workpieces effortlessly. Their vertical setup eliminates the risk of sagging or wobbling, common in horizontal lathes, making them ideal for sectors like aerospace and heavy machinery where large components are standard. One key advantage of VTLs lies in their compact footprint; they accommodate large workpieces yet consume less space than HTLs, a crucial factor in smaller workshops. Additionally, VTLs utilize gravity for efficient chip removal, preventing debris accumulation that could compromise machining quality and extend tool life (Absolute Machine Tools, 2023). However, VTLs present challenges in accessibility. Their vertical arrangement can obstruct operators from reaching certain parts of the workpiece, particularly in tall or deep components, potentially impacting precision and causing ergonomic concerns. Loading and unloading large or heavy workpieces onto VTLs can also be complex, often requiring additional equipment like cranes, which adds to the setup time.

##### 4.2.2 Horizontal Turning Lathe (HTL)

HTLs, in the contrary, are celebrated for their versatility. They accommodate various sizes and

shapes, including elongated parts, making them suitable for various manufacturing environments. The horizontal orientation simplifies setup, particularly for long parts, expedite the process and enhancing productivity. HTLs also offer better accessibility; the horizontal setup ensures easy reach to the workpiece and cutting tool, allowing for more precise control and monitoring. The primary limitation of HTLs is their larger footprint, demanding more space, which can be restrictive in smaller facilities (Ye, 2020). While this is convenient, HTLs might not be the optimal choice for extremely large or heavy workpieces. Horizontal mounting can create stability and accuracy issues for such components if not properly supported. VTLs and HTLs each have their distinct strengths and weaknesses. VTLs excel with large, heavy workpieces, offering space efficiency and effective chip management, but face challenges in accessibility and setup complexity. HTLs provide versatility, easier setup for elongated parts, and improved operator access, but they require more floor space and may struggle with very large workpieces. The choice between them hinges on the specific requirements of the machining task, including workpiece size, shape, and the production environment's constraints.

#### 4.3 Pricing and Cost-Efficiency

Deciding to invest in a lathe machine, be it a Vertical Turning Lathe (VTL) or a Horizontal Turning Lathe (HTL), demands a thorough evaluation of the machine's capabilities, its cost-effectiveness, and efficiency in handling various workloads. This analysis examines VTLs and HTLs' financial and

operational elements to evaluate their cost-efficiency and workload management capabilities. Compared to HTLs, VTLs cost more upfront. Their design is optimized for heavy workpieces. This design requires stronger frames, bearings, and structural components which increases the initial expenses. In some cases, VTLs are cheaper to operate. VTLs excel in heavy component handling scenarios. Their capacity to handle large workpieces without retooling or setup adjustments which reduces cycle times and personnel costs. VTLs' better chip flow management reduces tool wear and maintenance, lowering the operational costs.

On the contrary, HTLs generally have a lower initial cost. Their simpler design and lack of the extensive structural reinforcement seen in VTLs usually result in a more modest purchase price. This affordability makes HTLs particularly appealing to smaller workshops or businesses with tight budgets. However, the operational costs for HTLs can vary widely based on their applications. For small to medium-sized workpieces, HTLs operate with high efficiency, keeping operational costs under control. But for larger or more challenging workpieces, the necessity for extra setup, tooling, and potentially extending machining times can increase operational expenses. Moreover, in situations where precision and surface finish are crucial, HTLs might demand more frequent tool changes and maintenance, which could raise their operational costs.

#### 4.4 Workload and Efficiency

HTLs are well-known for their adaptability and wide range applications, handling everything from small, complex parts to moderately large pieces. This versatility ensures HTLs are highly efficient across various tasks, flawlessly adjusting to various production requirements with minimal reconfiguration downtime. Their horizontal setup particularly favors elongated workpieces, a domain where VTLs might struggle. In stark contrast, VTLs showcase their prowess in dealing with large, heavy components. Excelling in tasks involving such bulky items, they offer high efficiency and precision (E.R, 2019). However, VTLs struggle in smaller tasks; their design, while perfect for large-scale work, becomes less effective for minor operations, leading to become unusable in varied workpiece environments. Considering both VTLs and HTLs, each type brings its unique strengths and challenges regarding cost-efficiency and workload handling. VTLs, bearing a higher upfront cost, prove more economical in heavy-duty manufacturing settings, whereas HTLs stand out for their affordability and adaptability, fitting a broad spectrum of applications. The decision between these two lathe machines hinges on a detailed evaluation of specific

manufacturing requirements, budget limitations, and the expected range of workpieces to be produced.

#### 4.5 Case Studies

Understanding the practical applications of Vertical Turning Lathes (VTLs) and Horizontal Turning Lathes (HTLs) becomes clearer through case studies in manufacturing and educational environments, where each lathe type serves specific requirements. In the aerospace industry, where precision and the capacity to handle large, hefty components are crucial, VTLs are the preferred choice. Aerospace manufacturers use VTLs to machine significant parts like fuselage sections and engine casings. The vertical arrangement of VTLs helps manage these large components, providing stability and accuracy. Aerospace components require large floor space. Thus, their space-efficient design helps. The VTL's improved chip flow management ensures neater and improved operations in a precision-critical industry. Automotive manufactures, with its huge and small components, requires versatility in machining. This industry prefers HTLs for their flexibility and setup. Machines are used to machine engine parts, axles, and transmission cases. HTLs' horizontal layout makes setup modifications and part size adaption easier, increasing productivity. Manufacturing automotive drivetrain components benefit from HTLs' precision with extended pieces.

#### 4.6 Educational Field

Technical and vocational training education institutions prioritize equipping students with a broad range of skills and practical experience. Hence, Horizontal Turning Lathes (HTLs) play an essential role in teaching a variety of machining tasks. Ranging from fundamental turning operations to complex procedures, their versatility enables students to handle diverse materials and part sizes, equipping them for various industrial applications. The user-friendly operation and accessibility of HTLs make them particularly appropriate for educational environments, where training in safe environment is highly considerable. In contrast, advanced research facilities and specialized training centers often employ Vertical Turning Lathes (VTLs) for distinctive projects. VTLs are instrumental in machining large-scale components, such as those required in wind turbine construction or in large-scale robotics. Their capability to precisely handle large volume workpieces make them essential for these specialized tasks. Although VTLs are less dominant in educational applications compared to HTLs, they offer precious hands-on experience to students and researchers. Engaging with VTLs allows them to tackle projects that reflect real-life industrial

challenges, especially in sectors like renewable energy and advanced manufacturing, providing a unique perspective beyond conventional educational scopes.

## V. Conclusion

Finally, this study of VTLs and HTLs provides a deeper acknowledgement of these devices. Specific application needs, space limitations, and financial constraints must be considered when choosing a VTL or HTL. Due to their vertical position, VTLs can handle heavy, bulky workpieces and conserve space. Aerospace and heavy machinery require durable machining. Thus, they are crucial. However, HTLs are known for their versatility, ease of use, and adaptability to many machining operations. Their horizontal arrangement simplifies setup and operation, making them excellent for different manufacturing and educational situations that require a variety of machining abilities. Finally, this study helps enterprises and schools to choose one over the other. Decision-makers can maximize efficiency and instructional value by balancing their applications' needs with each lathe type's operational capability and cost. This research provides a complete guide for selecting lathes that meet each environment's needs.

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