

1.0 SCOPE

- 1.1 **Purpose:** This specification covers axis and motion nomenclature for numerically controlled equipment. These requirements are intended to standardize programming and facilitate the interchangeability of programs by prescribing the letter designation of each axis, and the positive direction of each axis.
- 1.2 **Classification:** The specification includes standards for Class III (Positioning), Class IV (Contouring), and Class III/Class IV (Contouring/Positioning Combination Systems) numerically controlled equipment.
- 1.3 Definitions of terms used in this standard are in accordance with the current version of the EIA Automation Bulletin, "Glossary of Terms for Numerically Controlled Machines."
- 1.4 Revisions to these standards will be proposed as technical progress warrants.

2.0 APPLICABLE SPECIFICATIONS

All existing NAS specifications applicable to numerical control.

3.0 REQUIREMENTS

- 3.1 **Coordinate System**
- 3.1.1 The standard right hand coordinate system shall be used and shall give the coordinates of a moving tool with respect to a stationary workpiece. (See Figures 1, 2, & 3).
- 3.1.2 The basic coordinate axes of the system shall be designated by unprimed letters as shown in FIGURE 1. (See paragraph 3.9).
- 3.2 **The z Axis of Motion**
- 3.2.1 The z axis of motion is parallel to the principal spindle axis of the machine.
- 3.2.2 If the spindle can be swiveled or gimbaled, the z axis of motion is parallel to the axis of the spindle when the latter is perpendicular to the work-holding surface.
- 3.2.3 If there are several spindles, one shall be selected as the principal one.
- 3.2.4 If there is no spindle, the z axis is perpendicular to the work-holding surface.
- 3.2.5 Positive z is in the direction from the work-holding means toward the tool-holding means.
- 3.2.5.1 Positive command to moving tool moves tool away from work.
- 3.2.5.2 Positive command to moving work surface moves work away from tool.
- 3.3 **The x Axis of Motion**
- 3.3.1 The x axis of motion is horizontal and perpendicular to z.
- 3.3.2 If z is horizontal, positive x is to the right looking from the spindle toward the workpiece.
- 3.3.3 If z is vertical, positive x is to the right looking from the front of the machine toward the back, or when viewing the workpiece from the machine operator's normal operating position (See Figure 14 & Figure 15).

THIRD ANGLE PROJECTION	
PROCUREMENT SPECIFICATION	NONE

CUSTODIAN	ENGINEERING MANAGEMENT COMMITTEE
TITLE	MACHINE AXIS AND MOTION NOMENCLATURE

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- 3.3.4 On machines generating a surface of revolution, such as lathes, x, u, and p motions (see paragraph 3.7.1) shall be normally in a positive direction radially away from the center of revolution.
- 3.4 The y Axis of Motion
- 3.4.1 The y axis of motion is perpendicular to both x and z.
- 3.4.2 Positive y is in the direction to make a right-handed set of coordinates, (See Figures 1 & 2).
- 3.5 Rotary Motions a, b, and c
- 3.5.1 a, b, and c define rotary motions around the axes x, y, and z respectively.
- 3.5.2 Positive a, b, and c are counter clockwise (CCW) rotations looking from the positive axis toward the origin. (See Figure 1).
- 3.6 The Origin of the Coordinate System
- 3.6.1 The location of the origin ($x=0$, $y=0$, and $z=0$) of the standard right hand coordinate system is arbitrary, and may be located with respect to the workpiece as desired by the programmer on the assumption that it is adjustable on the machine.
- 3.6.2 The angular origins $a=0$, $b=0$, and $c=0$ are likewise arbitrary.
- 3.7 Additional Axes
- 3.7.1 If in addition to the primary linear slide motions x, y, or z, there exist secondary slide motions parallel to these, they shall be designated u, v, and w respectively. If tertiary motions exist, they shall be designated p, q, and r respectively. If linear motions exist which are not or may not be parallel to x, y, or z, they may be designated u, v, w, p, q, or r as is most convenient.
- 3.7.2 If in addition to the primary rotary motions a, b, or c, there exist secondary rotary motions, either parallel to a, b, or c, or compounded or gimbaled to a, b, or c, they shall be designated d or e.
- 3.7.3 The primary linear motions are those nearest the principal spindle; the secondary motions are those next nearest; the tertiary are the farthest. For example, the carriage on a turret lathe is z, while the saddle, being farther from the spindle, is w.
- 3.8 Direction of Spindle Rotation: Spindle clockwise (CW) and counter clockwise (CCW) rotation shall be defined according to paragraph 3.1.1 & 3.5.2.
- 3.9 Reversed Directions for Moving Workpieces
- 3.9.1 If a machine element moves the workpiece instead of the tool, it must respond to the program in the opposite direction from that defined above for moving the tool. In illustrating various machine tools, an arrow with a primed letter, such as $+x'$, is the direction of motion of a moving workpiece, for a command calling for positive motion; while an arrow for an unprimed letter, such as $+x$, is the direction of motion, for the same positive command, of the tool with respect to the workpiece.
- 3.9.2 The programmer, fixturing set-up personnel, and machine loader should think exclusively in terms of the unprimed directions. Only machine tool builders need consider the primed directions.

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4.0 SCHEMATIC DRAWINGS OF NUMERICALLY CONTROLLED MACHINES

Schematic drawings of typical machines are included to illustrate the intent of this specification. Some machines (such as Figures 10 and 11) may have an alternate operator position, and the axes nomenclature shown will change accordingly, like Figure 14 and 15. (Ref. Para. 3.3.3).

The schematic drawings indicate by letters and arrows the motions normally numerically controlled.

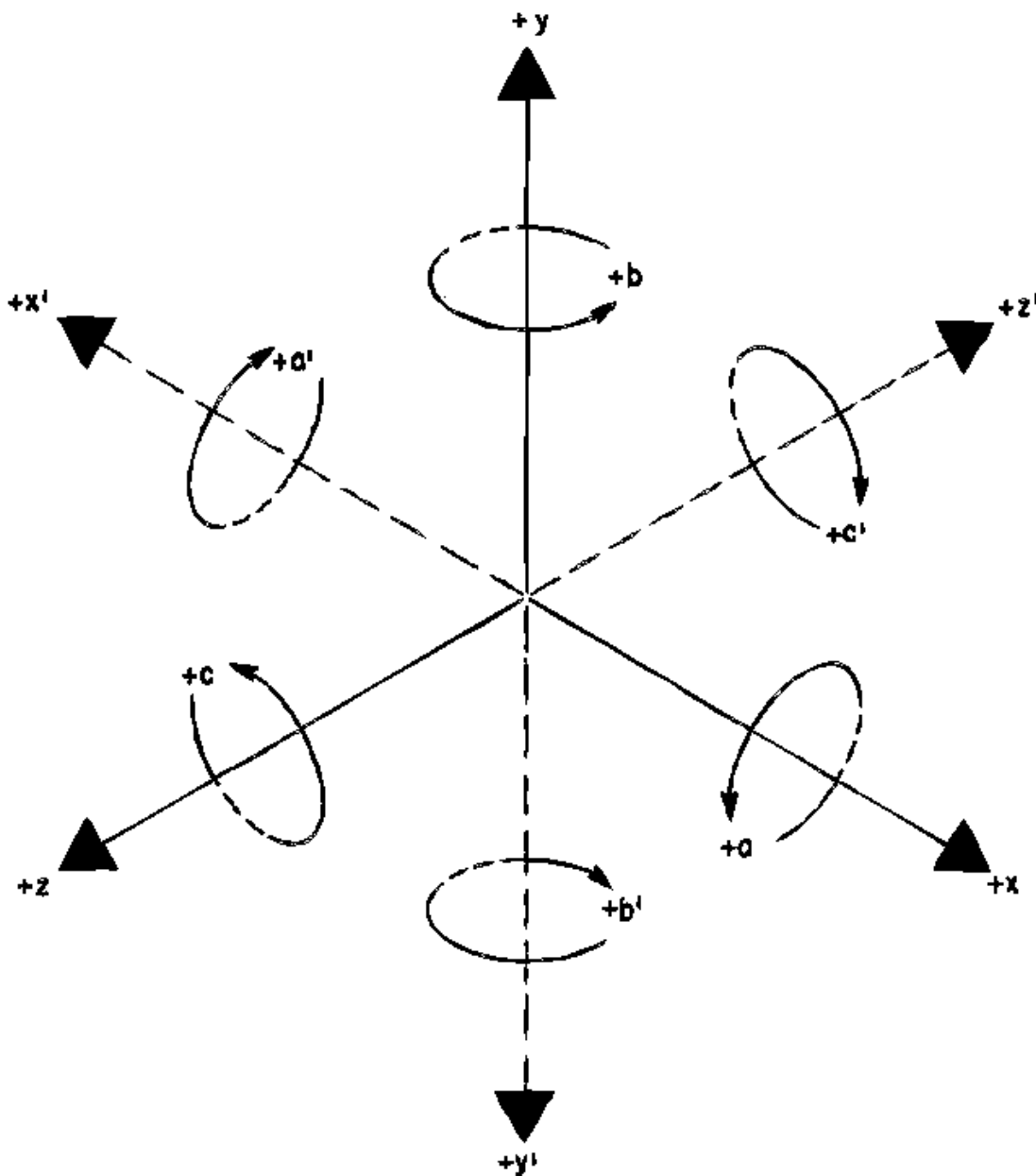


FIGURE 1 – STANDARD RIGHT HAND COORDINATE SYSTEM

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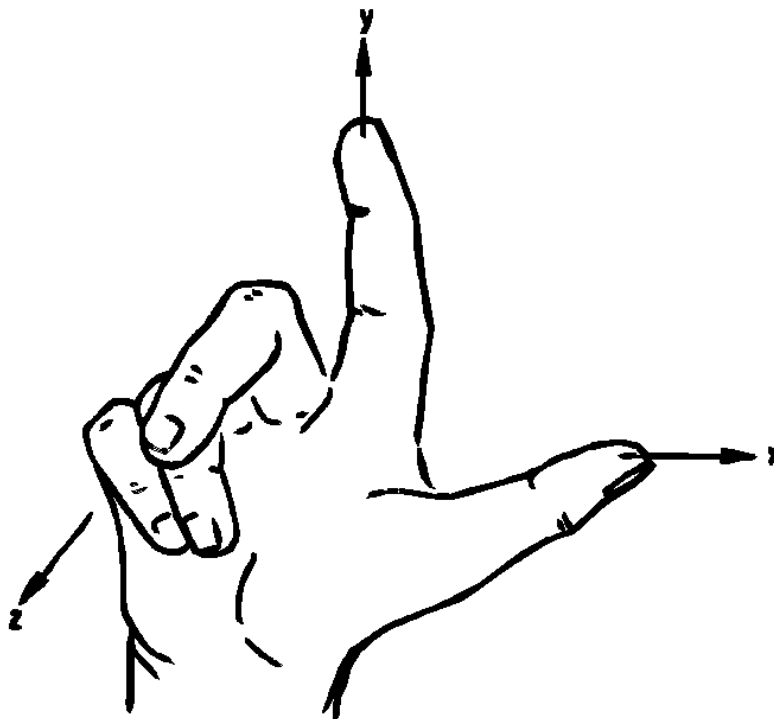


FIGURE 2 – STANDARD RIGHT HAND RULE FOR LINEAR MOTIONS

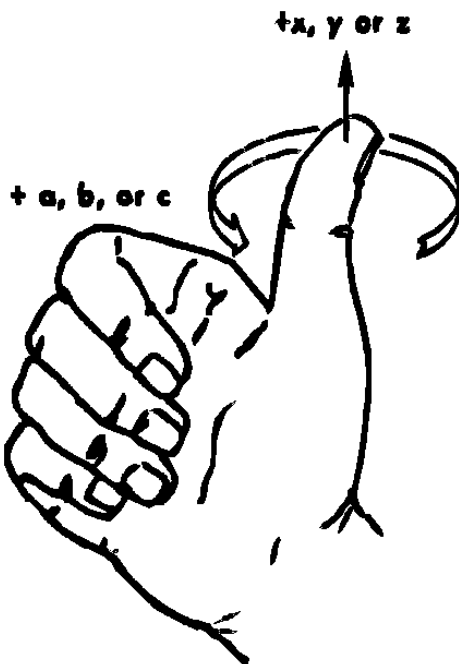


FIGURE 3 – STANDARD RIGHT HAND RULE FOR ROTARY MOTIONS

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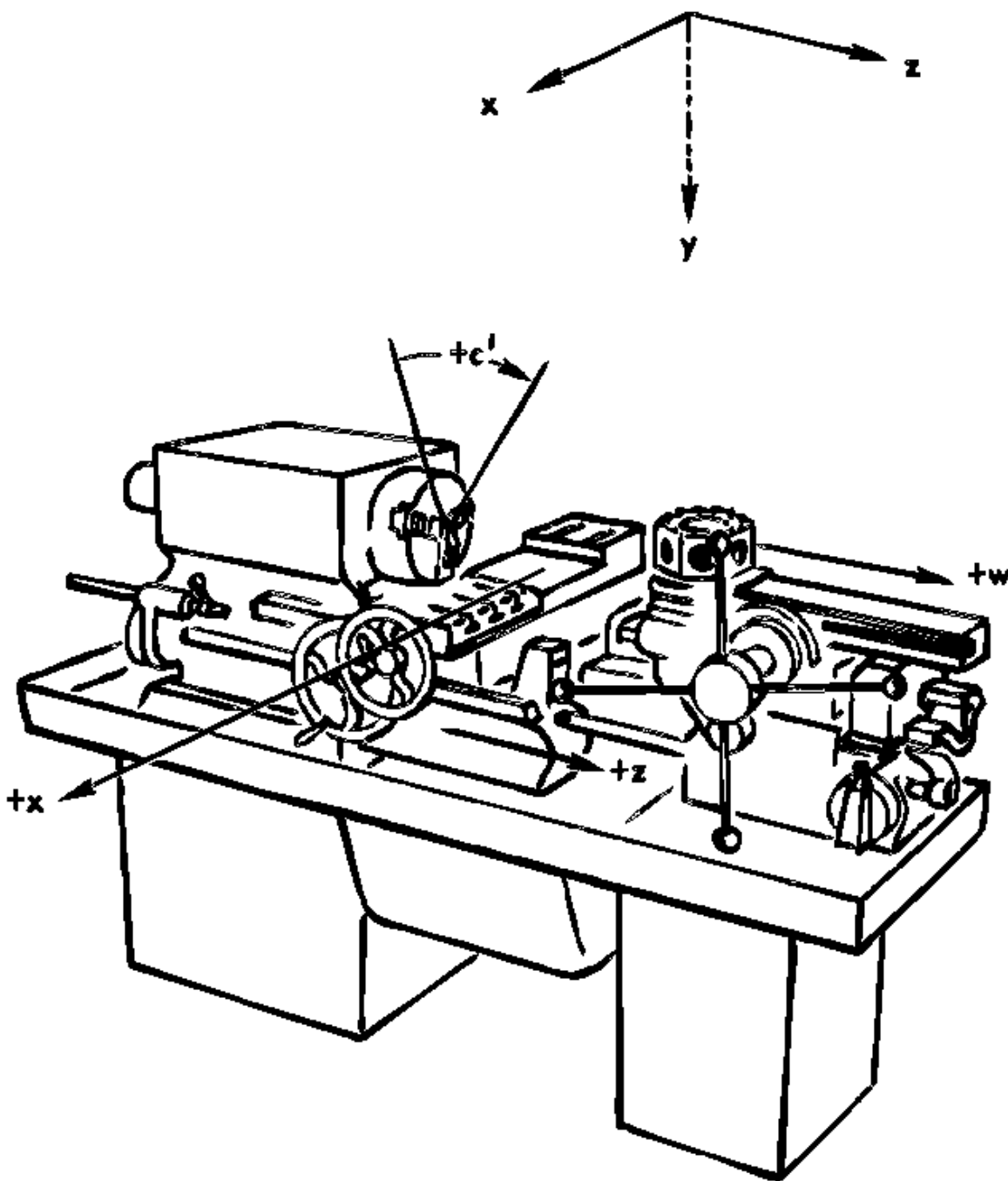


FIGURE 4 – HORIZONTAL SPINDLE LATHES AND RELATED MACHINES

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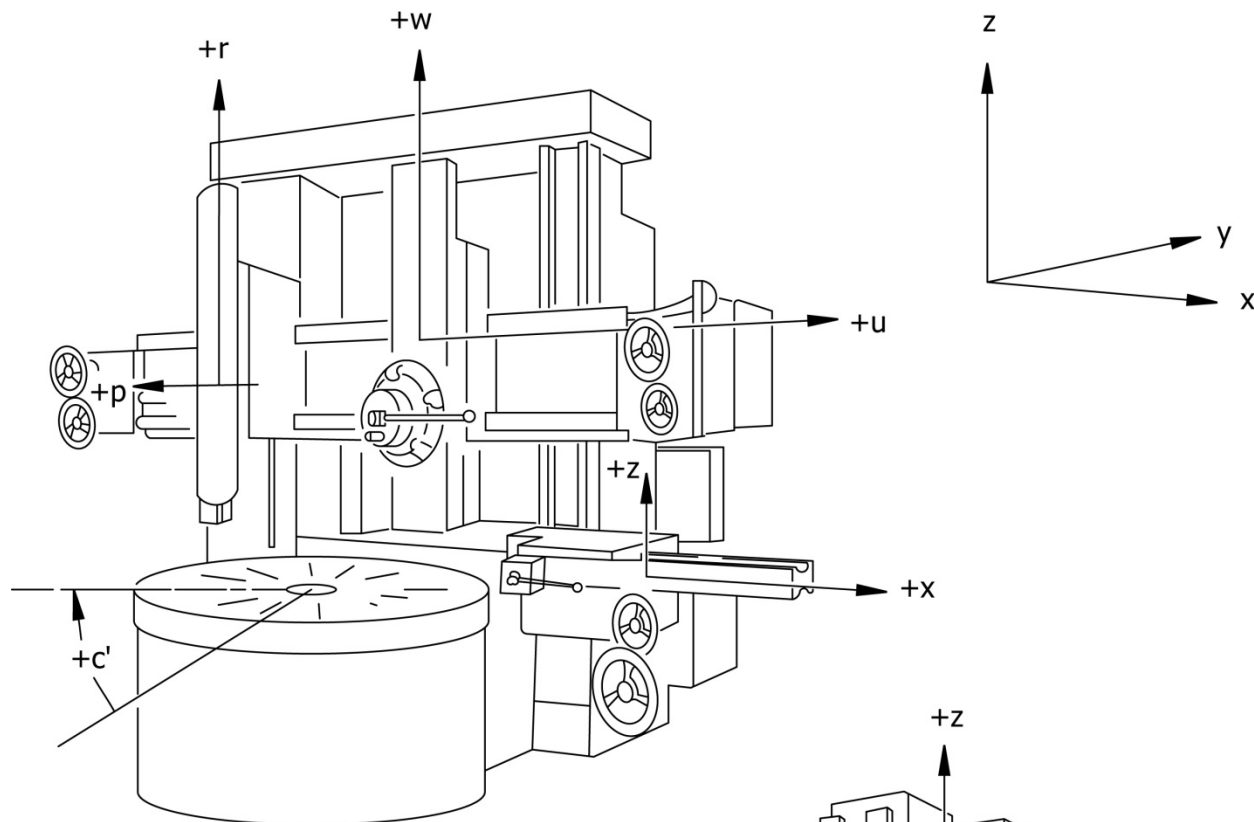


FIGURE 5 – VERTICAL TURRET LATHE VERTICAL BORING MILL

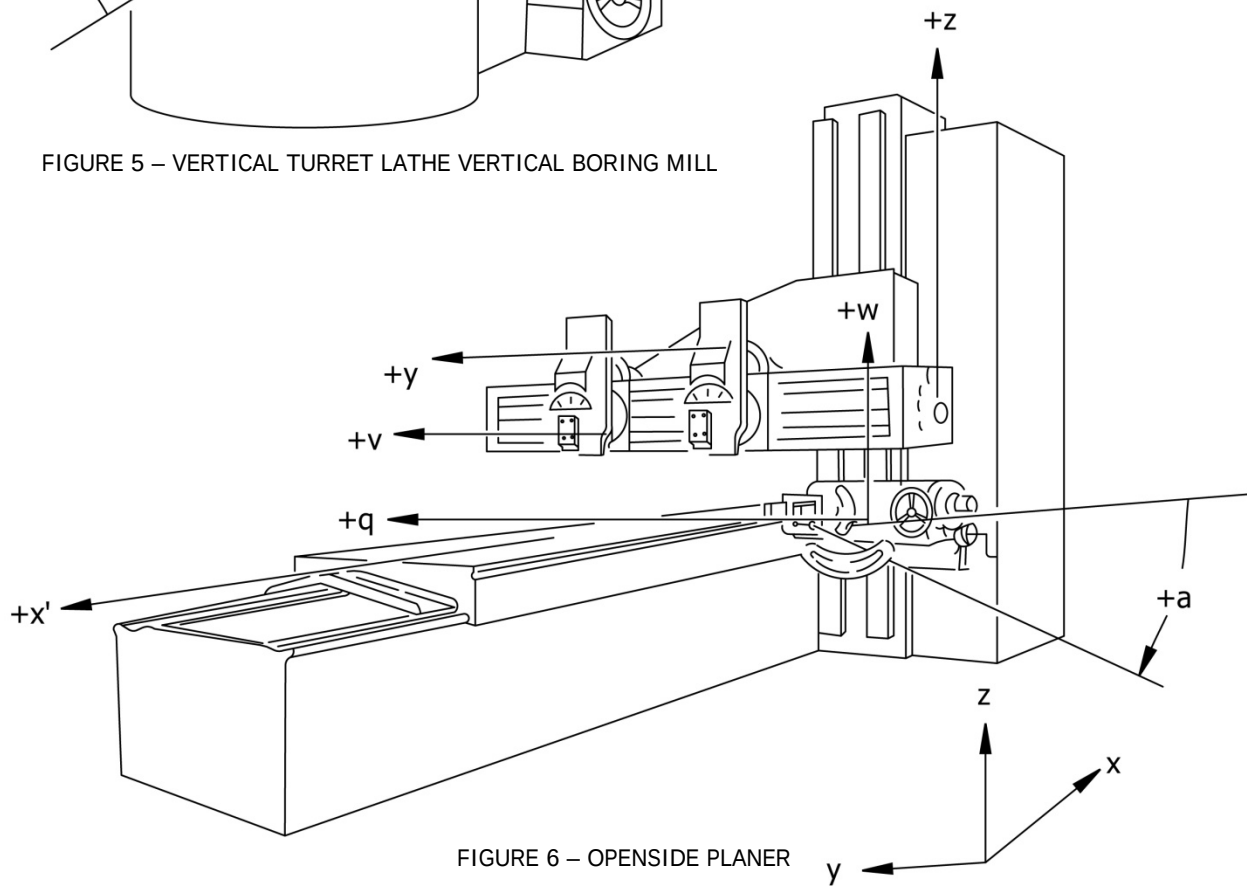


FIGURE 6 – OPENSIDE PLANER

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