Single Point Cutting Tool Geometry

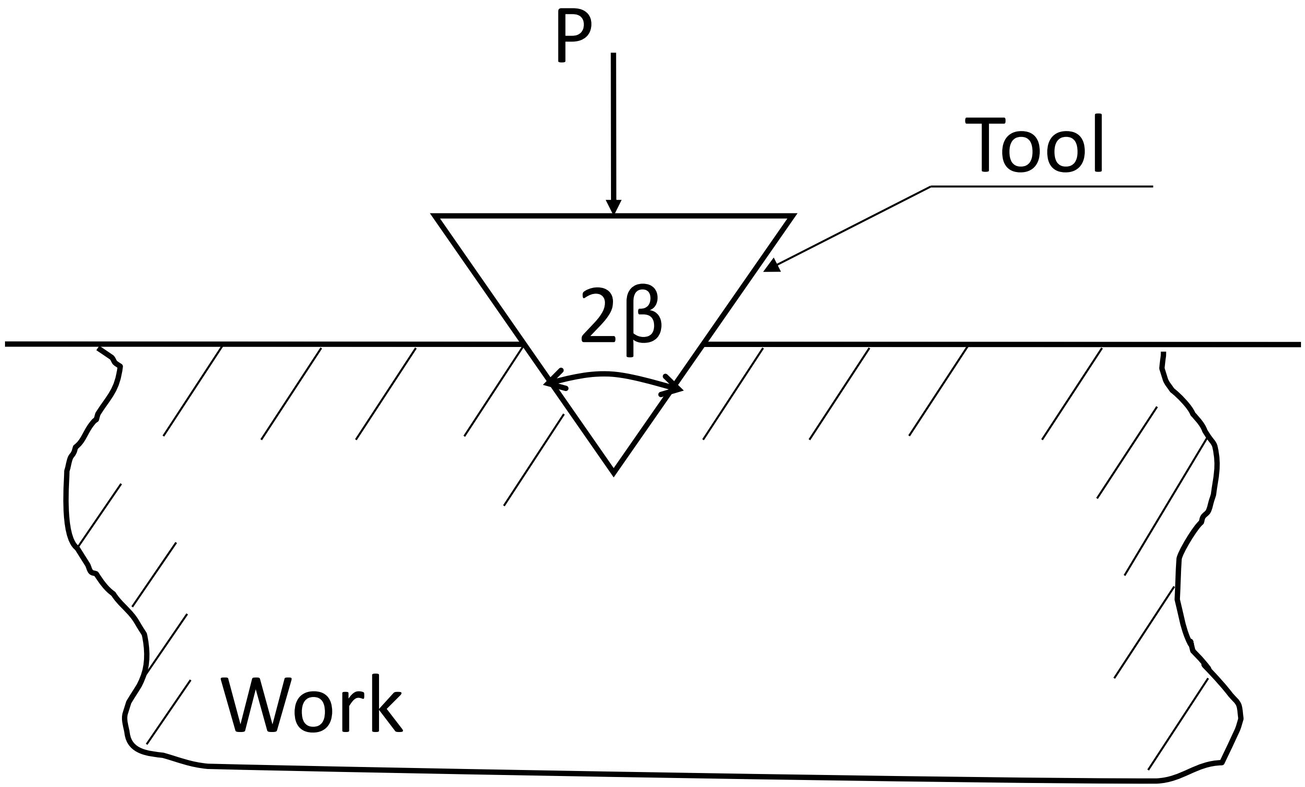
Prof. S. S. Pande

Mechanical Engineering Department
Indian Institute of Technology, Bombay

Outline

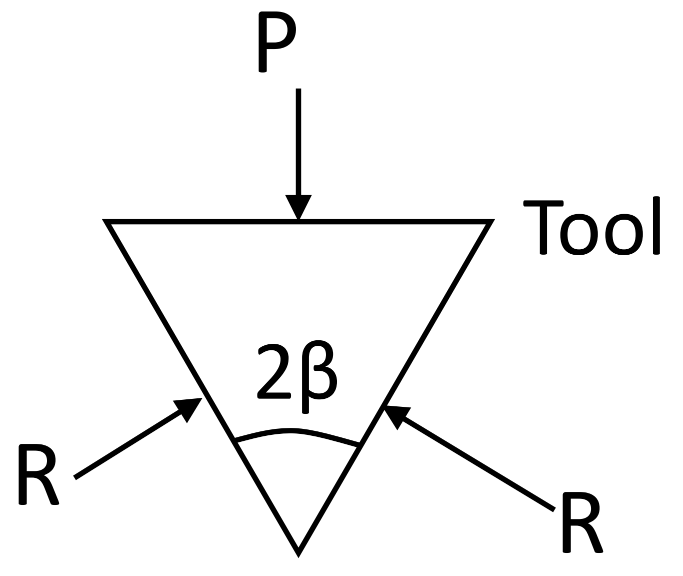
- Tool Geometry, Tool Angles
- Systems for Tool nomenclature
  - ISO System - *ORS/NRS*
  - American Standards System - *ASA*
- Tool Angle Conversion: ISO $\longleftrightarrow$ ASA
  - Mathematical Basis

Basic Tool Shape



Wedge angle : 2β

Cutting Efficiency

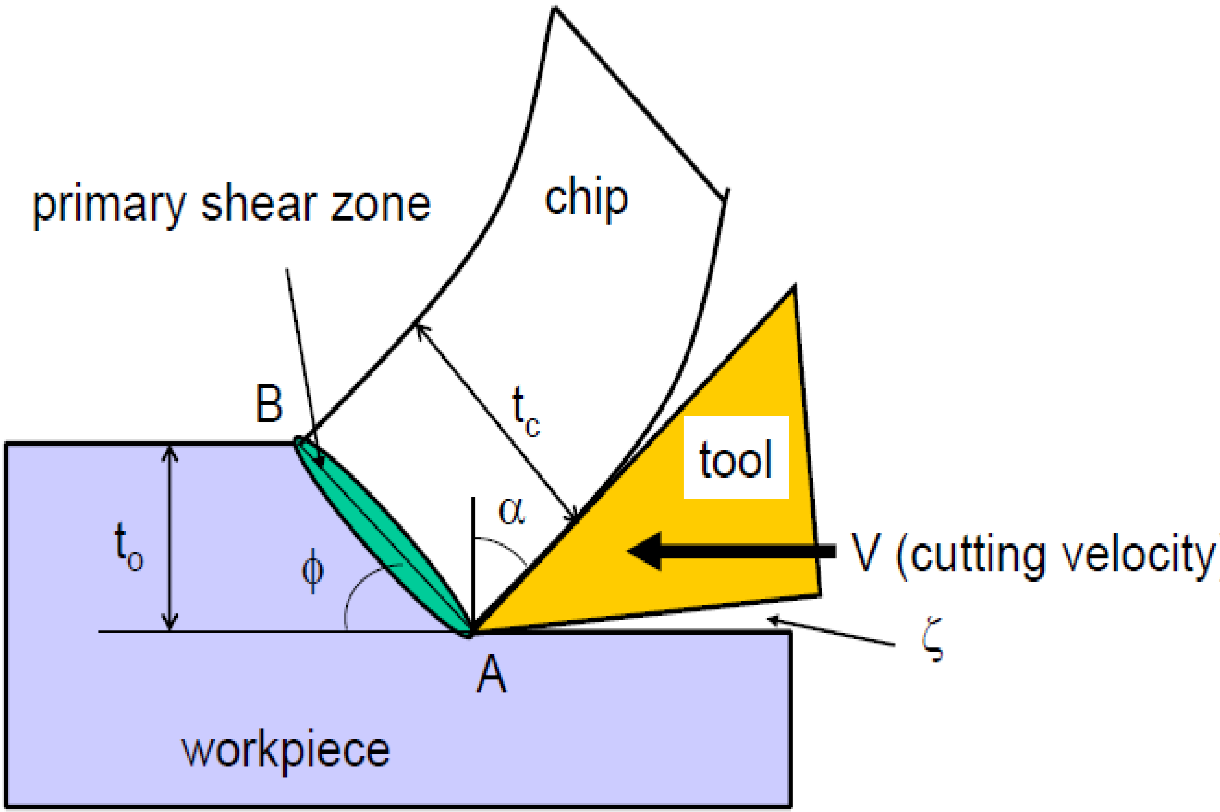


$$P = 2R \sin\beta$$

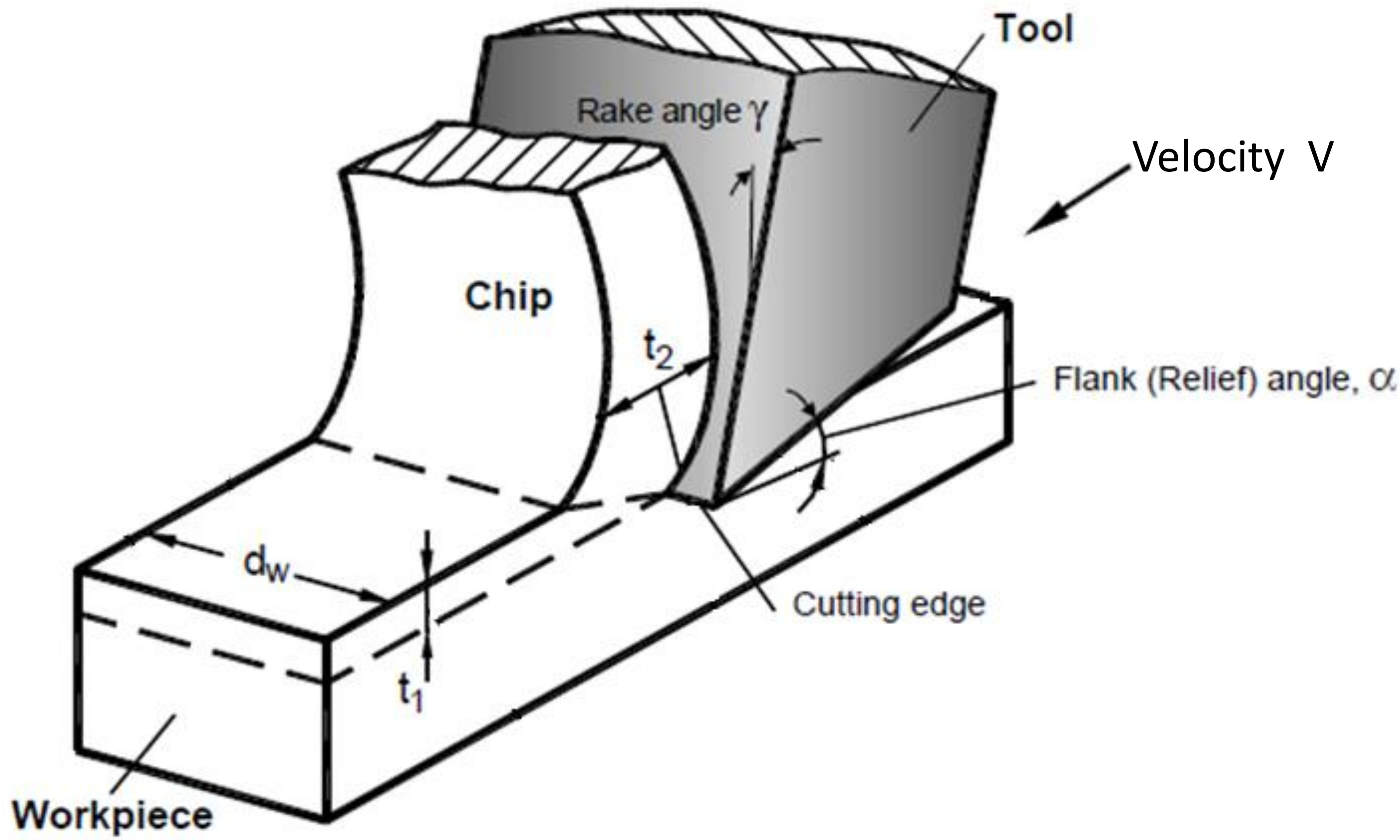
$$\text{Cutting Efficiency} = \frac{R}{P}$$

$$\eta \propto \frac{1}{\sin\beta}$$

Orthogonal Cutting Geometry



Orthogonal Cutting

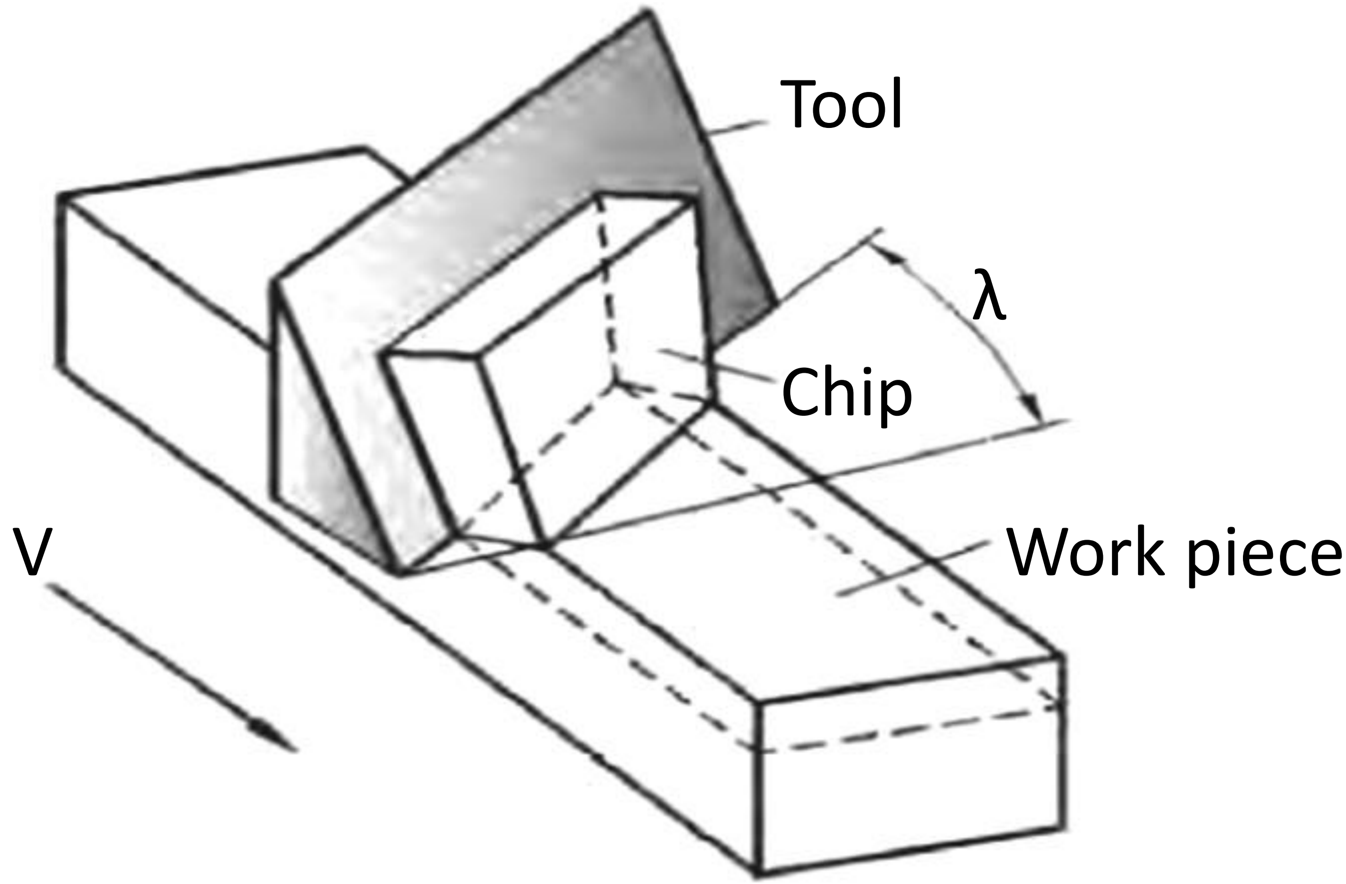


Orthogonal Cutting

<u>Characteristics</u>

- Cutting edge <u>Perpendicular </u>to cutting Velocity Vector
- Plain Strain (2D) phenomenon
- <u>No Spread </u>of material across

Oblique Cutting



Oblique Cutting

Characteristics

- Cutting edge at an angle(λ) to normal to velocity vector in the cutting plane
- Inclination angle λ
  - modifies Tool angles
  - governs Direction of chip flow

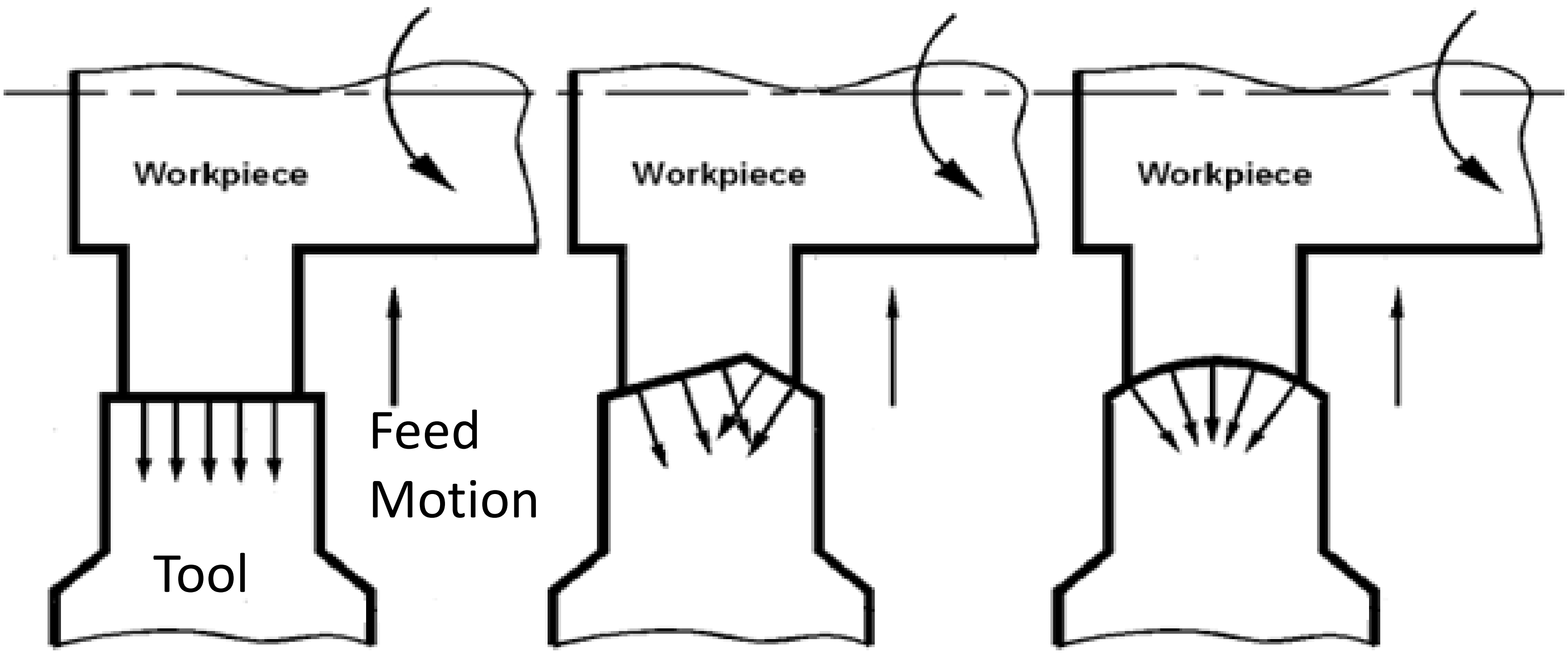
Stabler's Law for Chip flow

$n_c = k. \lambda$

nc = chip flow angle

K = 0.8 – 1.0

Free and Restricted Cutting

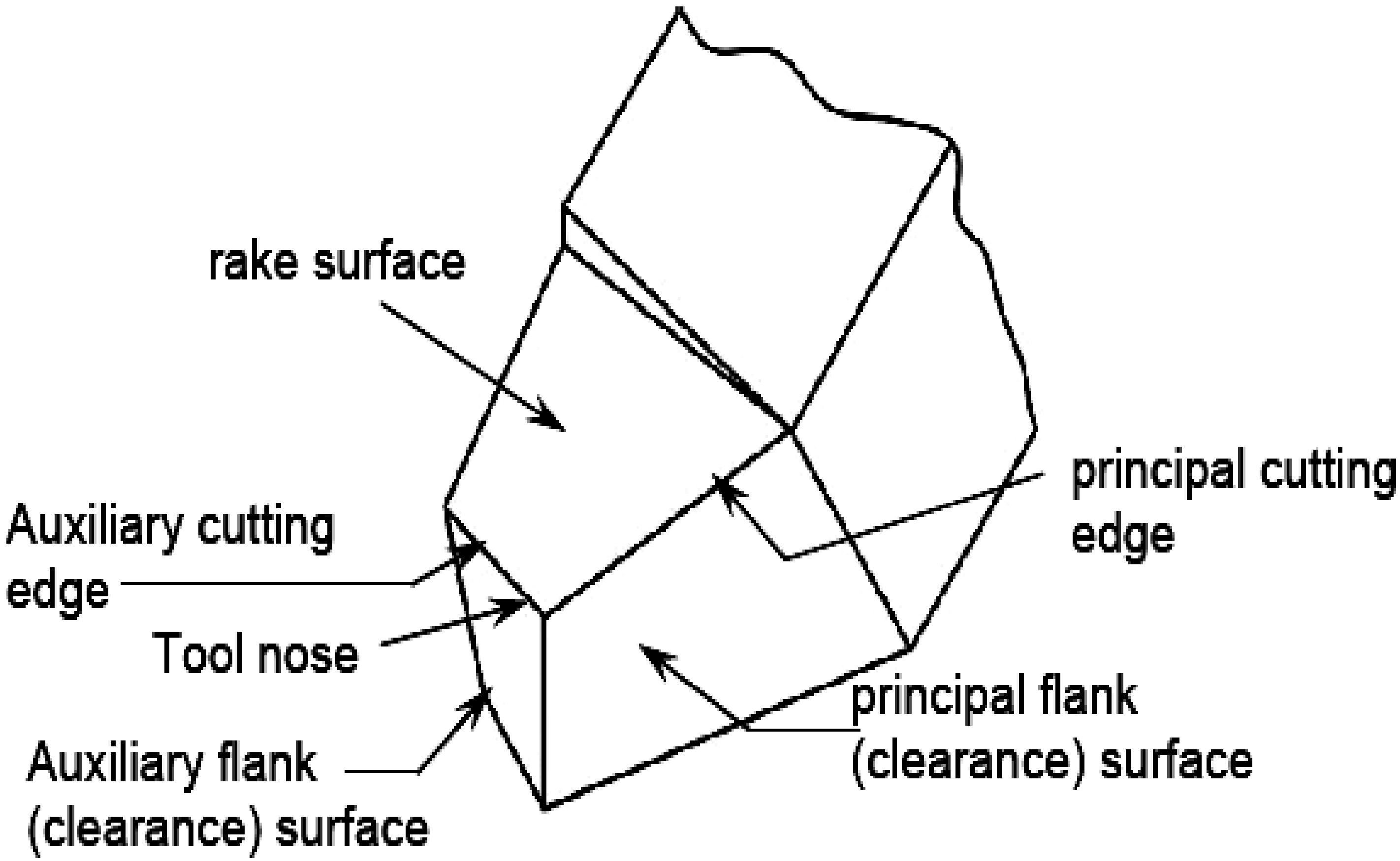


Chip Flow

Free

Restricted

Single Point Tool Geometry



Tool Nomenclature Systems

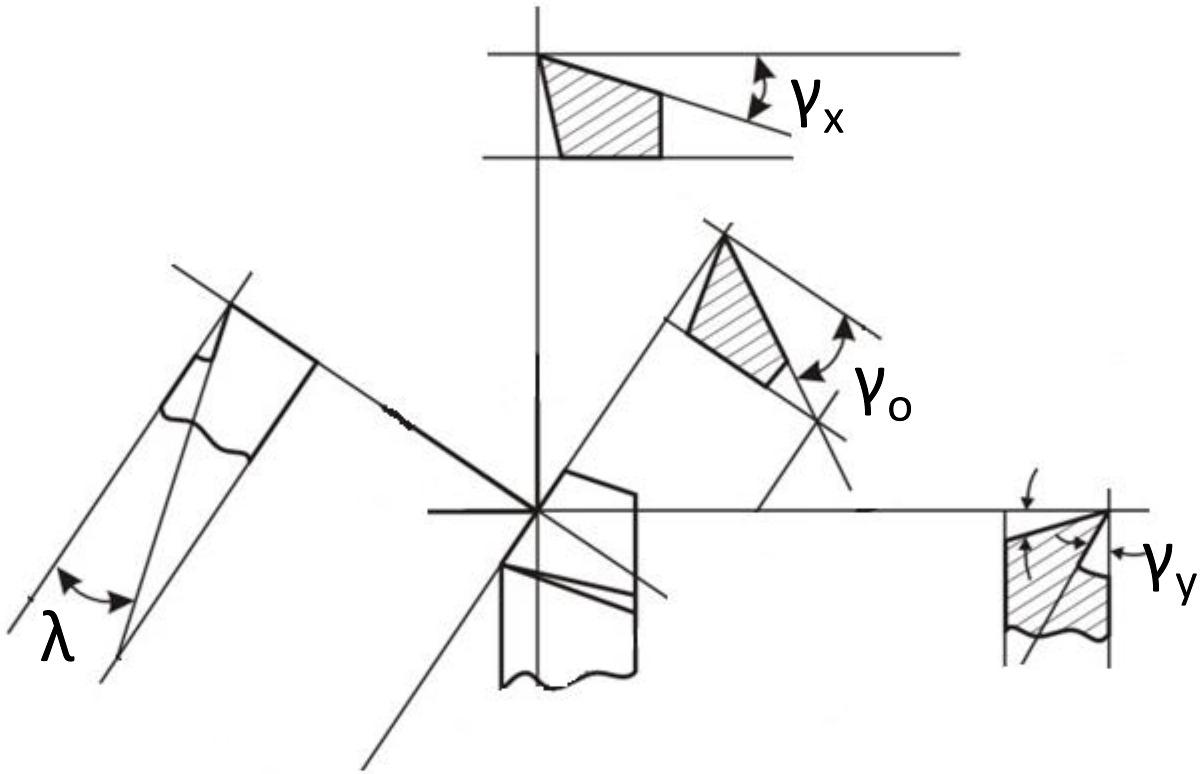
Tool in Hand

- ISO System : *ORS/ NRS*
  - Orthogonal/ Normal Reference System
- American Standards Association (ASA) system

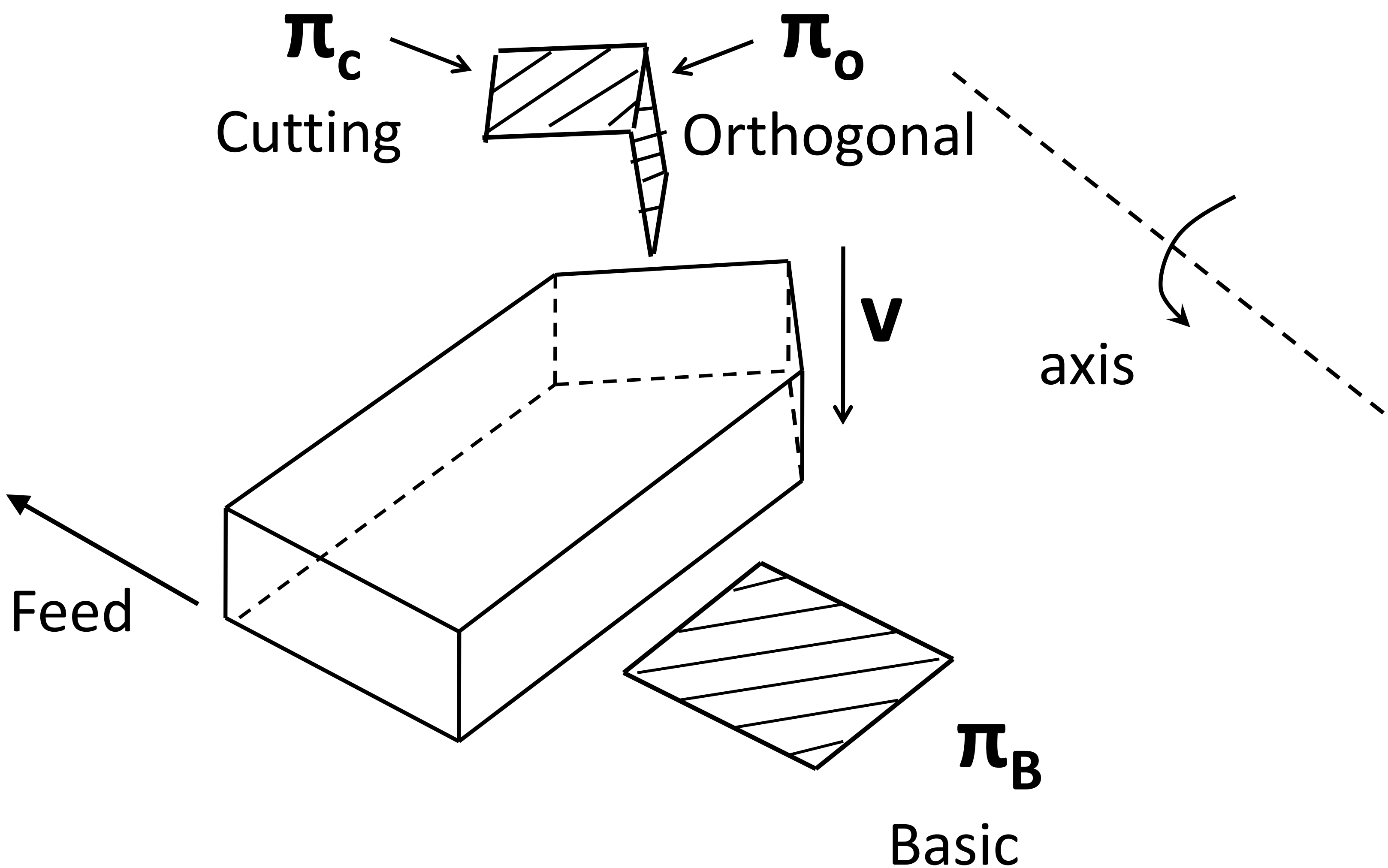
Tool in Machine

- Tool /Insert setting in fixture

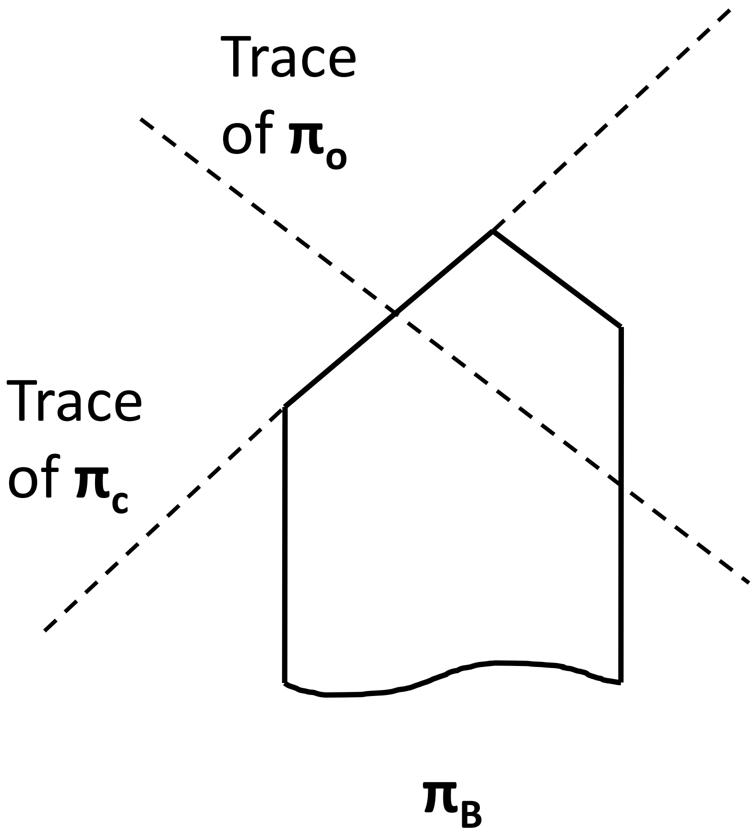
Tool Angle Reference Systems ORS and ASA

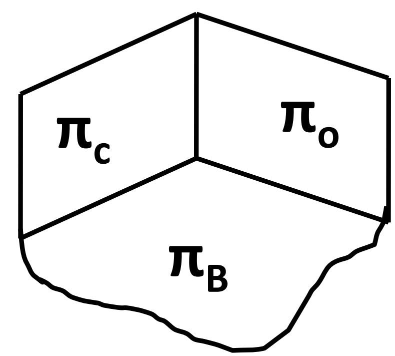


Tool Reference Planes

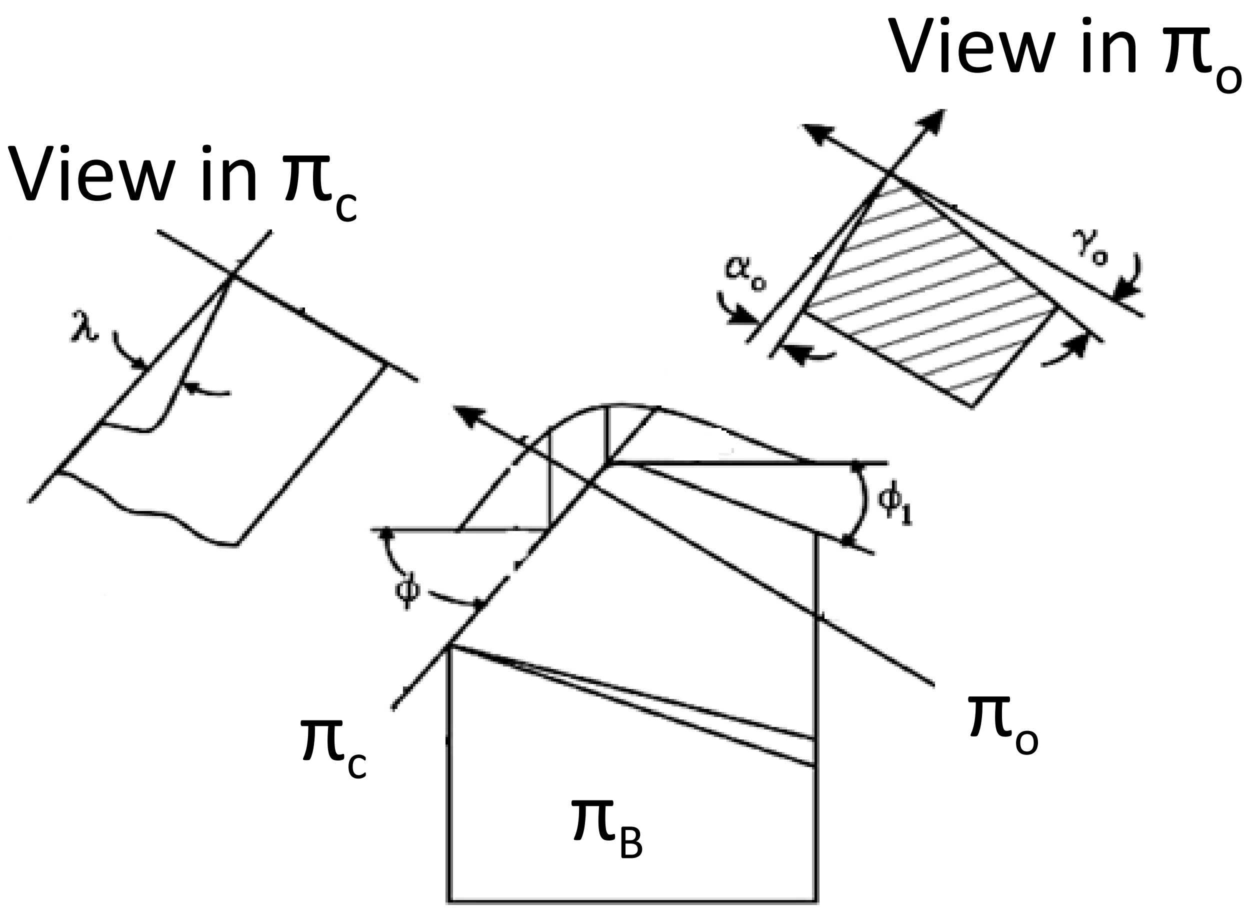


Orthogonal (ORS) Reference Planes

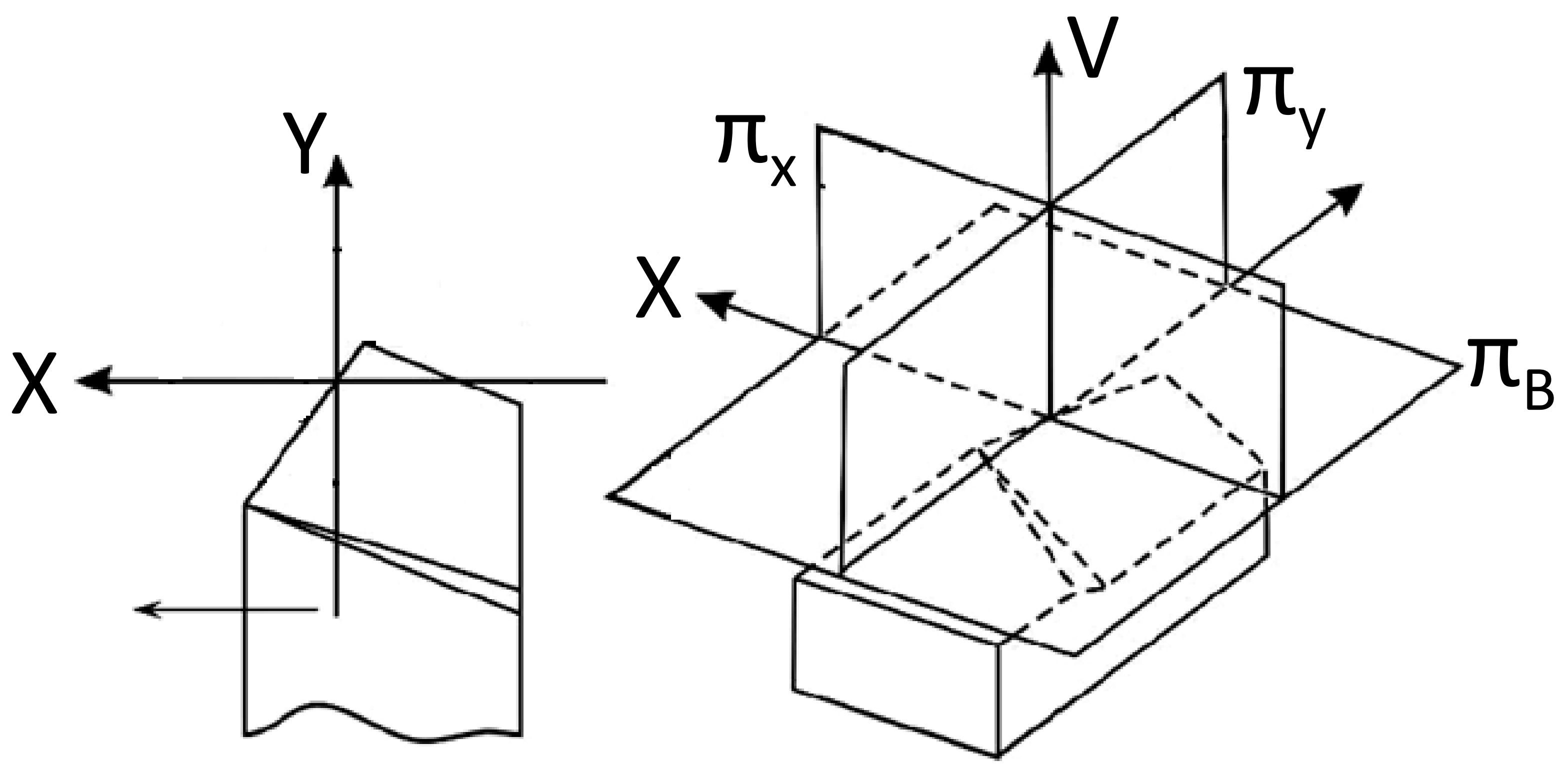




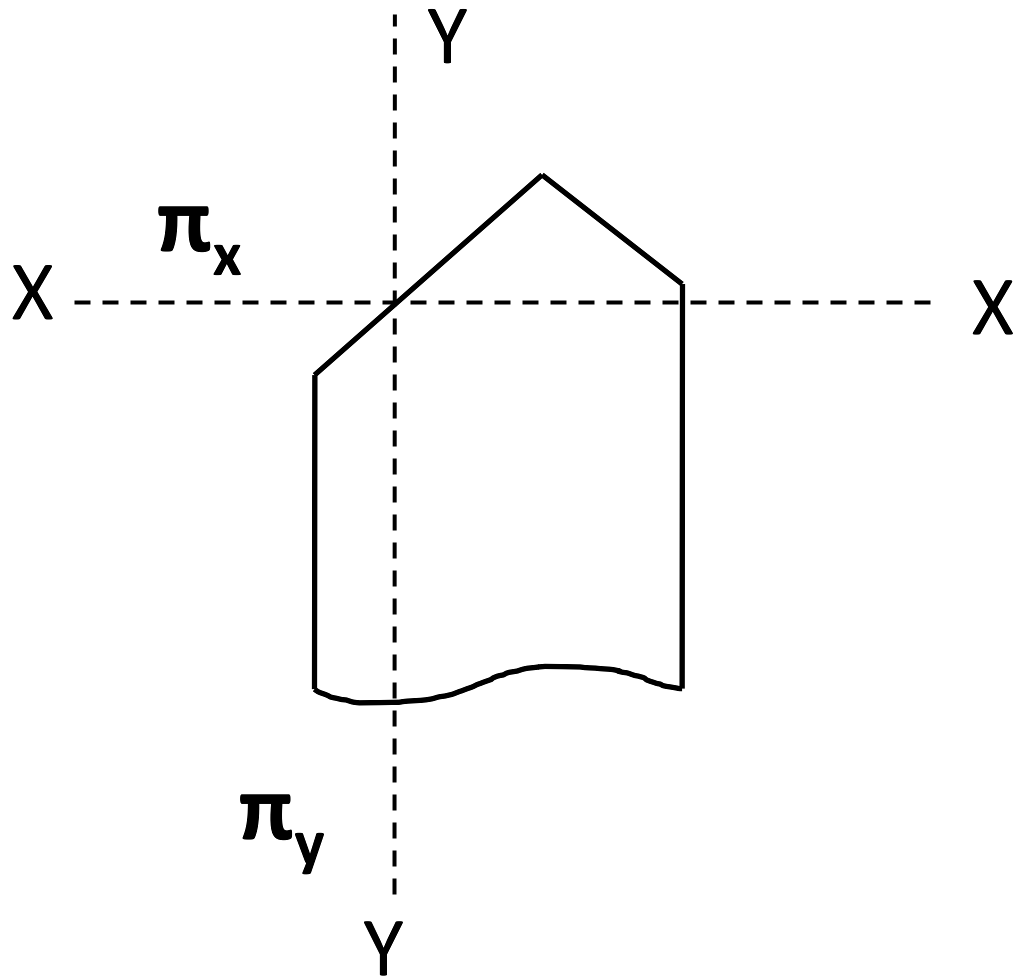
Reference Planes - ORS



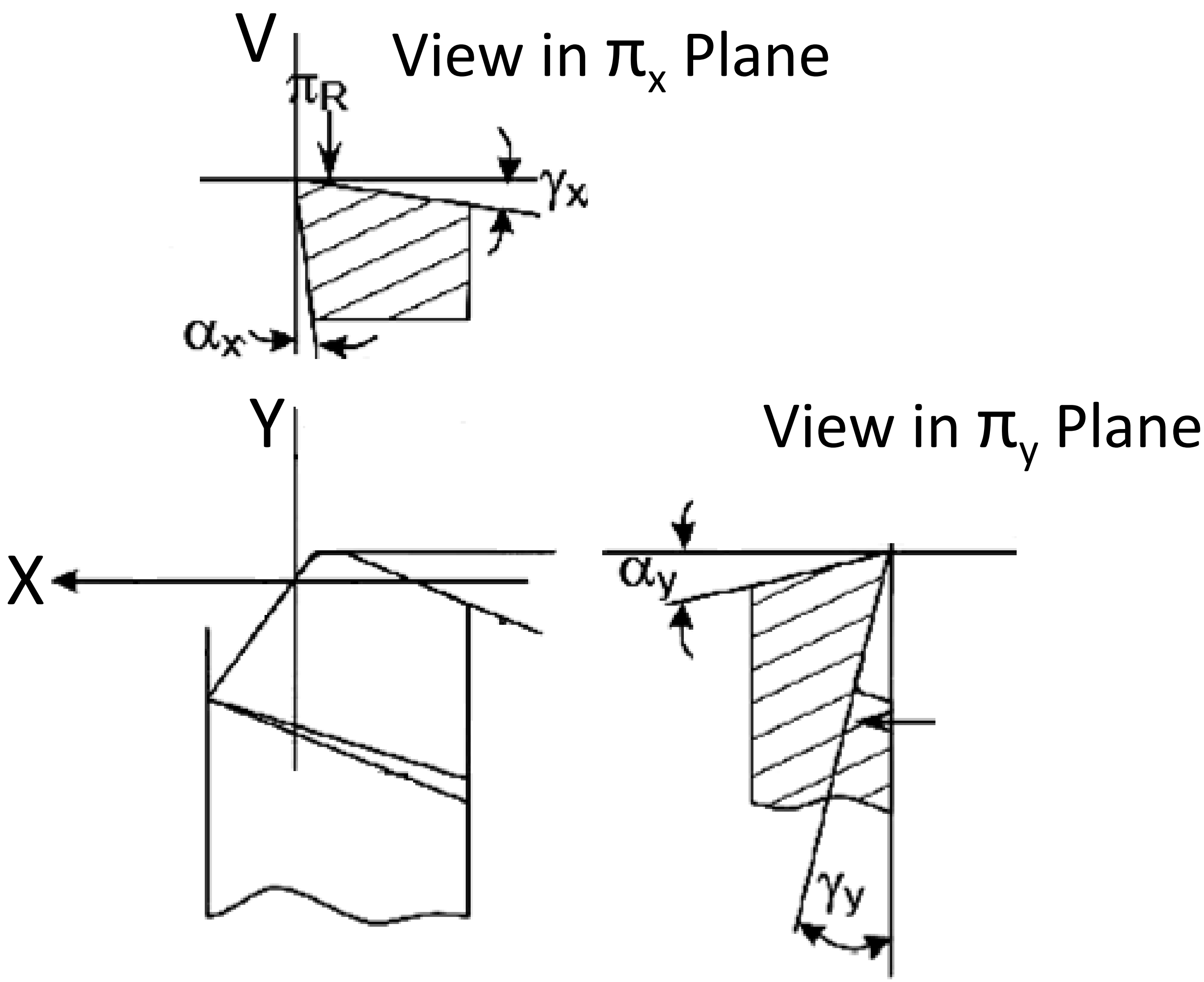
Reference Planes – ASA system



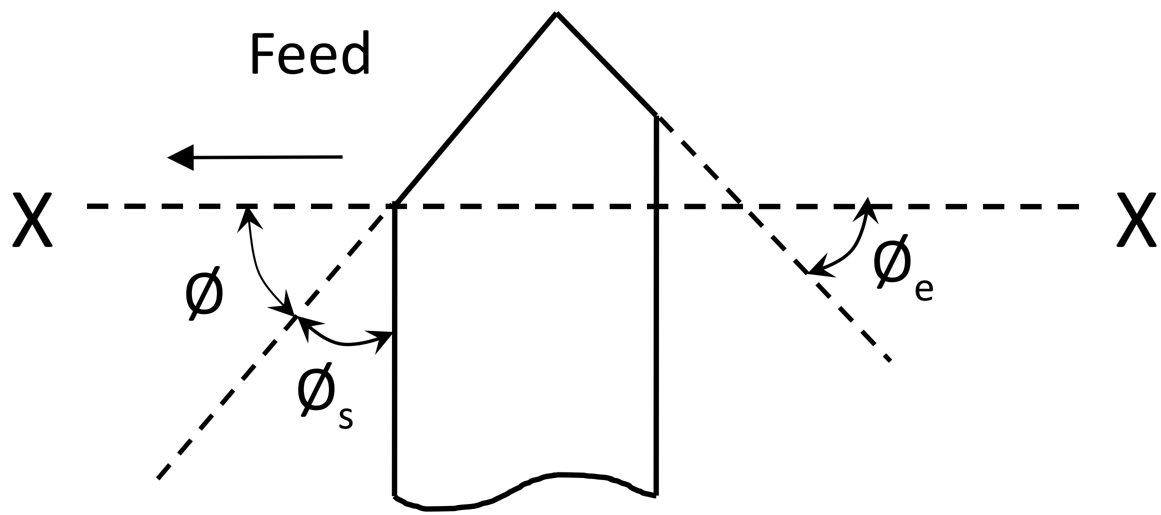
ASA Reference Planes



Tool Angles – ASA System



Tool Angles



$\varnothing$ = Plan Approach angle

$\varnothing_s$ = Side cutting Edge angle

$\varnothing_e$ = End cutting Edge angle

$$\boldsymbol{\varnothing = 90 - \varnothing_s}$$

Tool Designation

ASA System

γ_y , γ_x , α_y , α_x , $\varnothing_e$, $\varnothing_s$, r

γ_y	:	Back rake angle
γ_x	:	Side rake angle
α_y	:	Front clearance angle
α_x	:	Side clearance angle
$\varnothing_e$	:	End cutting Edge angle
$\varnothing_s$	:	Side cutting Edge angle
r	:	Nose radius (mm)

Tool Angle Conversion

ORS $\longrightarrow$ **ASA**

(γ_o, λ) (γ_x , γ_y)

$$\begin{bmatrix} tan\gamma_x \\ \\ tan\gamma_y \end{bmatrix} = \begin{bmatrix} sin\emptyset & -cos\emptyset \\ \\ cos\emptyset & sin\emptyset \end{bmatrix} \begin{bmatrix} tan\gamma_o \\ \\ tan\lambda \end{bmatrix}$$

$\emptyset$ = Plan Approach angle

Tool Angle Conversion

ASA $\longrightarrow$ **ORS**

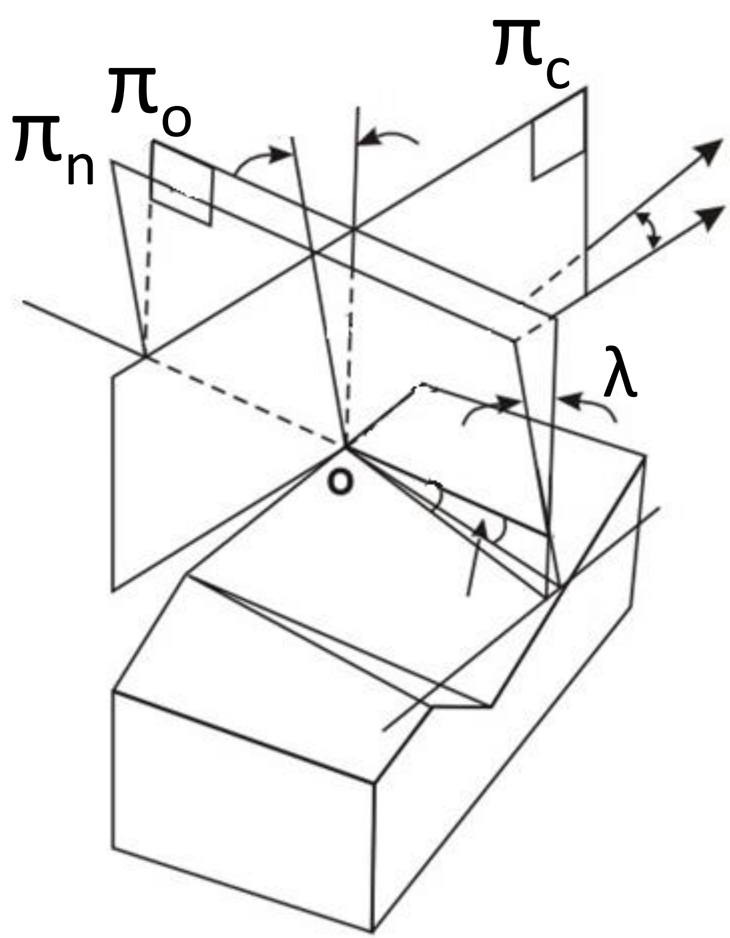
(γ_x , γ_y) (γ_o, λ)

$$\begin{bmatrix} tan\gamma_o \\ \\ tan\lambda \end{bmatrix} = \begin{bmatrix} sin\emptyset & cos\emptyset \\ \\ -cos\emptyset & sin\emptyset \end{bmatrix} \begin{bmatrix} tan\gamma_x \\ \\ tan\gamma_y \end{bmatrix}$$

$\emptyset$ = Plan Approach angle

Does Orthogonal Plane $\boldsymbol{\pi_o}$ represent <u>True</u> rake angle?

Orthogonal and Normal Reference Planes



Tool Angle Conversion

ORS $\longrightarrow$ NRS

$\boldsymbol{\gamma}_{\mathbf{o}}$ $\boldsymbol{\gamma}_{\mathbf{n}}$

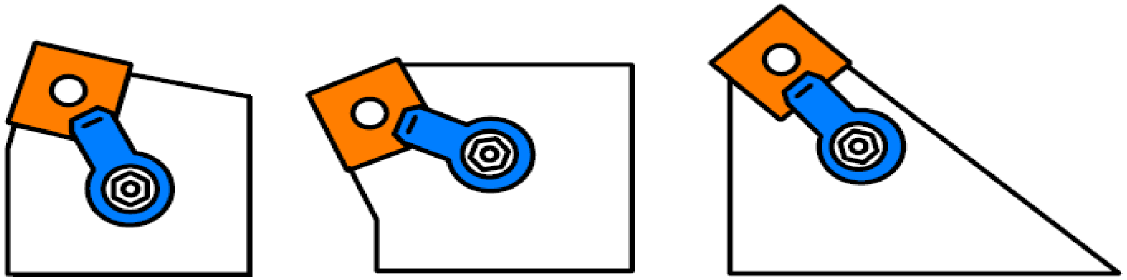
$$tan\gamma_n = tan\gamma_o \,.\, Cos\lambda$$

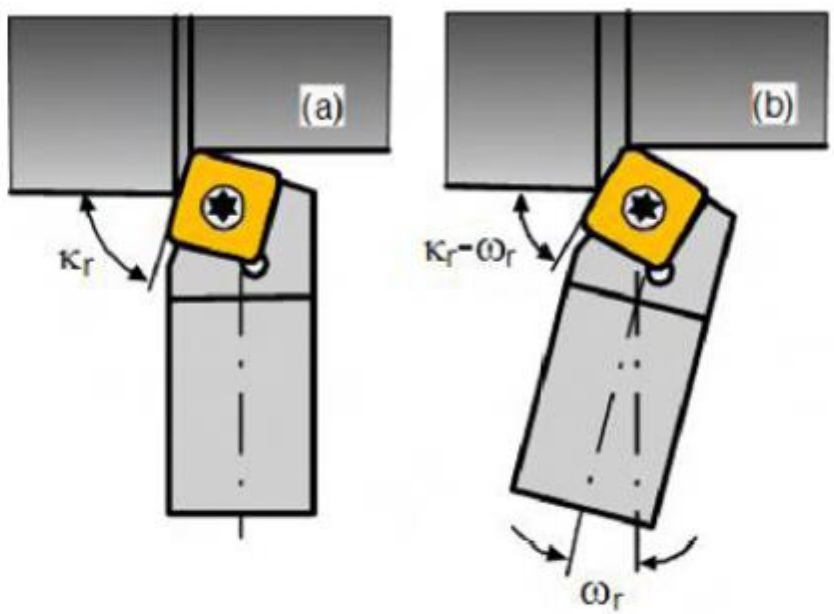
Tool in Machine System

Static angles on Tool/Insert change due to

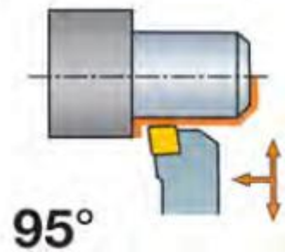
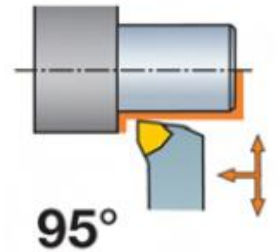
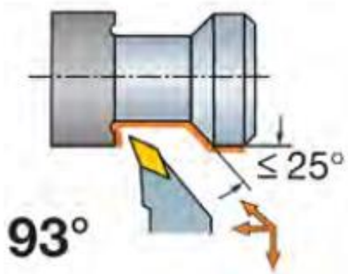
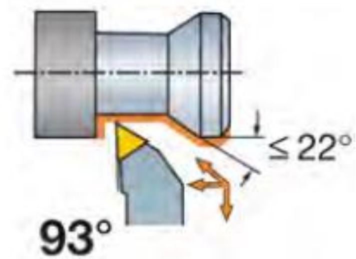
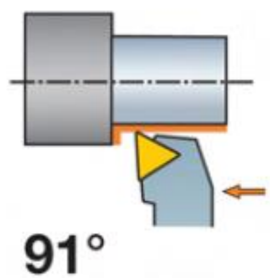
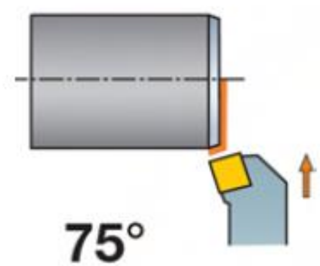
- Setting in tool Holders/ Fixtures
- Tool/ Work relative motion.

Inserts in Tool Holder





Inserts and Tool Angles

Insert	Tool cutting edge angle	Insert	Tool cutting edge angle
C 		W 	
V 		T 	
T 		S 	

Tool Setup on Machine