ADVANCED MACHINING
BETP 3584
INTRODUCTION TO ADVANCED MACHINING
5-AXIS CNC MACHINING CONCEPT

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Learning Outcomes

At the end of this course, students should be able to:

✓**Explain** the basic operation principles and control systems of CNC machine.

✓**Construct** Five-Axis CNC Programming for Milling operations.

✓**Analyze** problem related with CNC Program using linear moves, circular moves and canned cycles.

✓**Use** Five-Axis CNC Milling Machine.

✓**Demonstrate** positive team working attributes by contributing actively in group projects.

Practical Application

The practical application consists of Five-Axis CNC Machining applications such as:

1. Facing and Roughing
2. Multiple Hole Drilling Operations – Machining Pattern.
3. Five-Axis Pocketing Operation.
4. Five-Axis Profile Contouring Operation.
5. Multi-Axis Flank Contouring Operation.
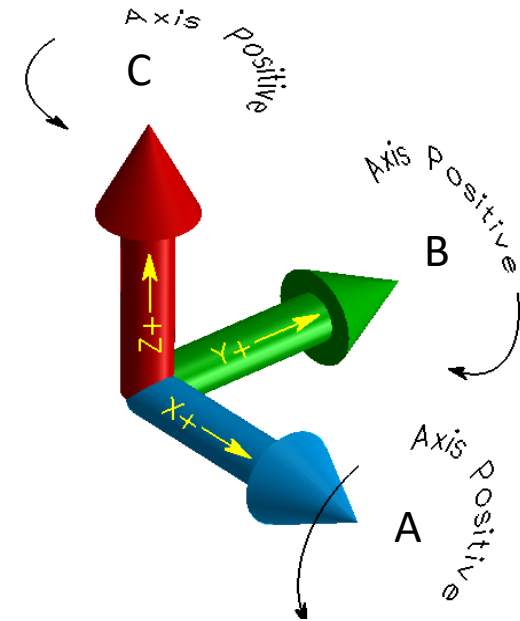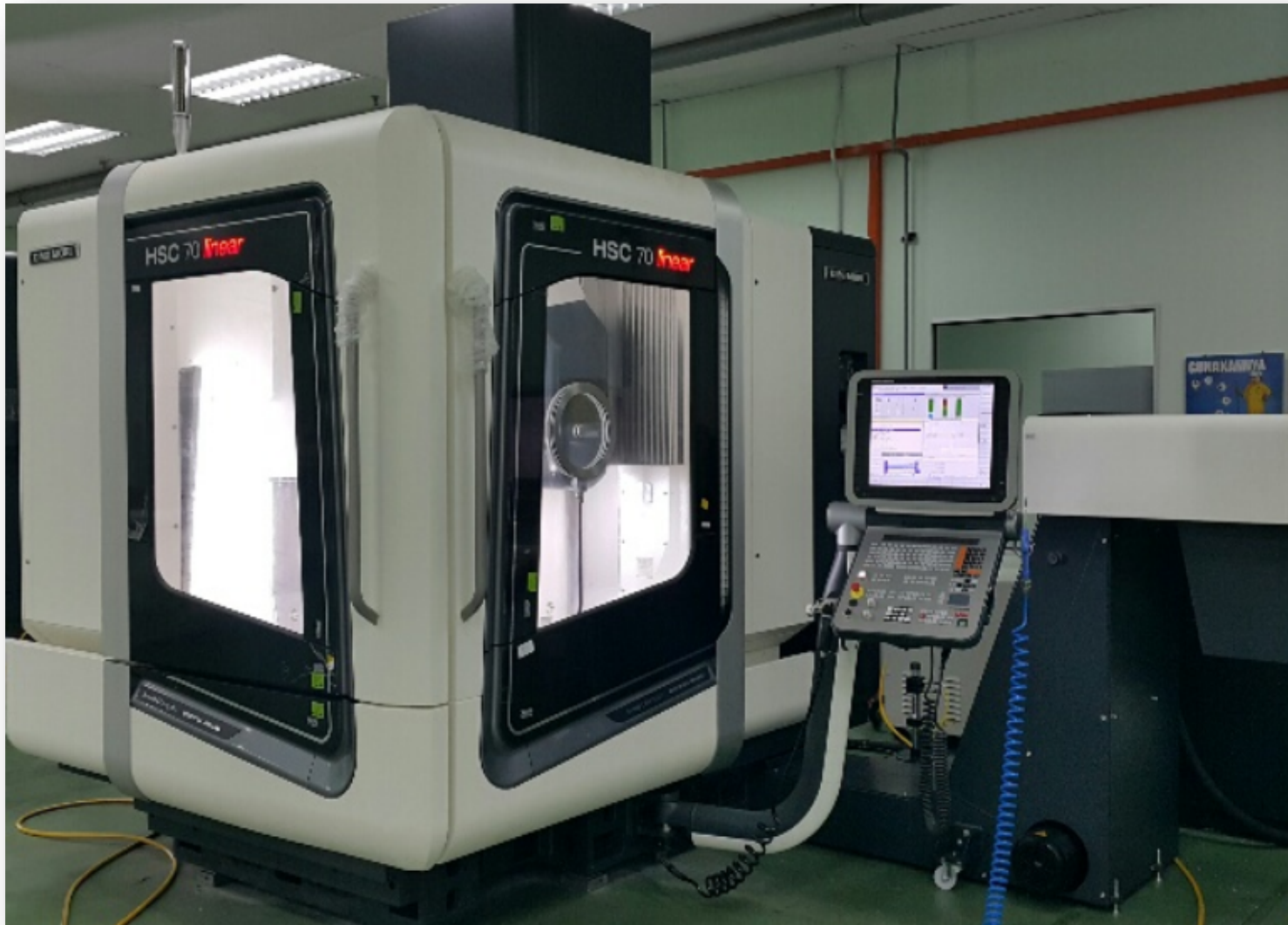6. Multi-Axis Sweeping Operation.

1

2

3

Introduction

✓3-axis machining consists of **X**, **Y**, and **Z** directions

✓There are **TWO** additional axes in 5-axis machining which rotates in every basic 3-axis axes

✓ Along axis X is A

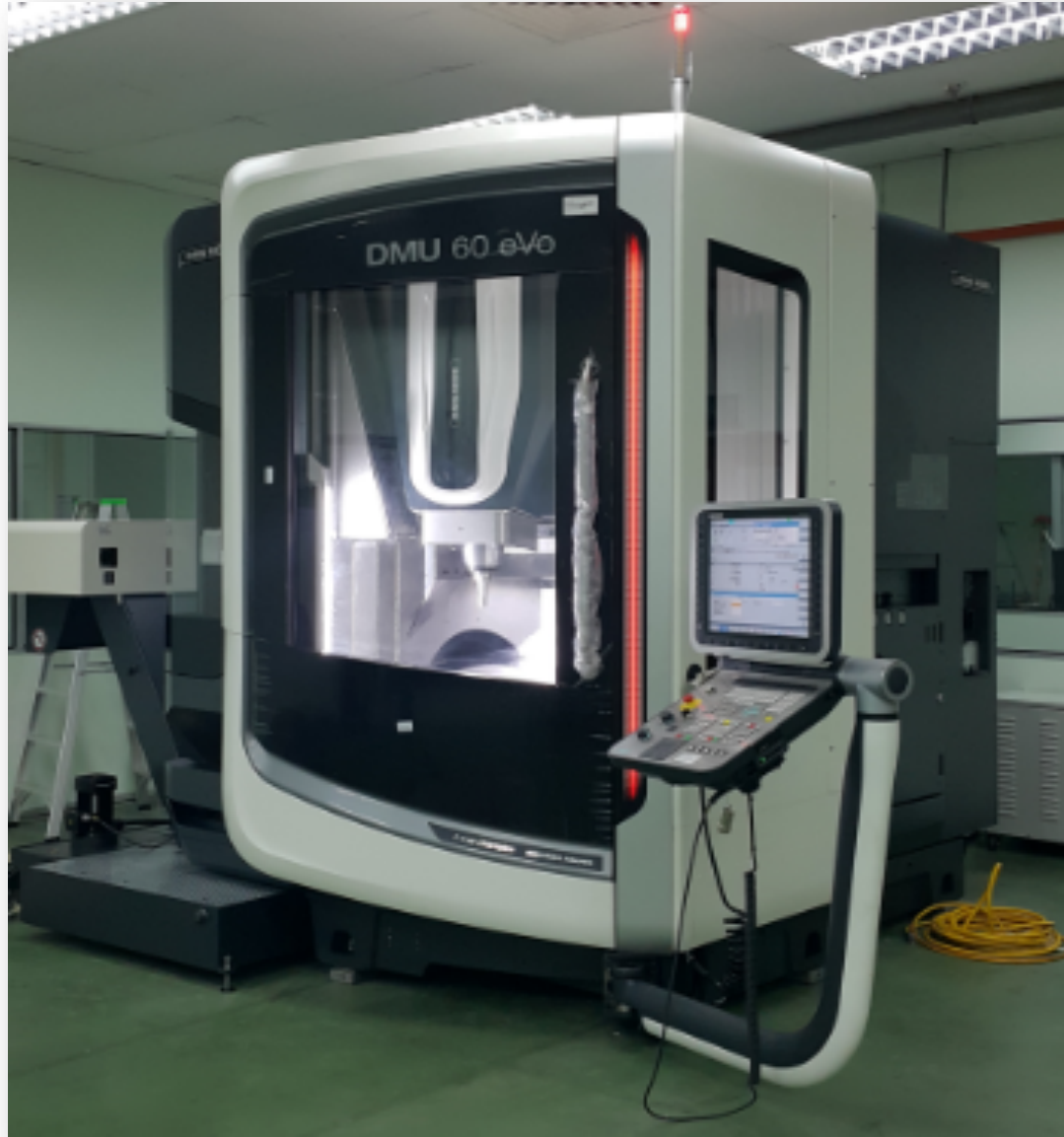✓Along axis Y is B

✓Along axis Z is C
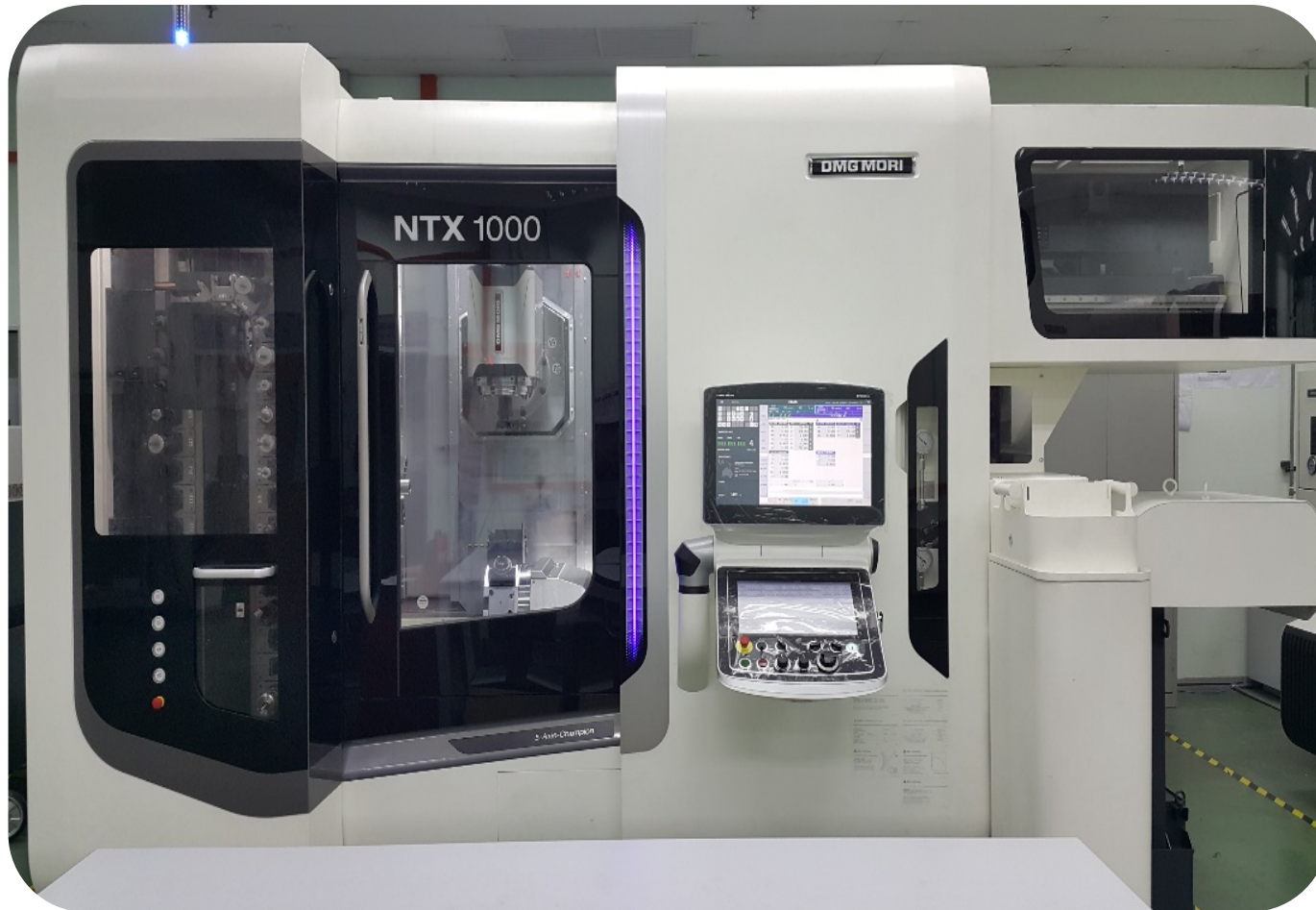
Advanced Machining Lab

5-AXIS CNC MILLING MACHINE
HEIDENHEIN 640i CONTROLLER
18,000 RPM

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5-AXIS
HIGH SPEED CNC MILLING MACHINE
SIEMENS 840D CONTROLLER
24,000 RPM

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TURN MILL MULTI-AXIS CNC MACHINE
CELOS
9-Axis (Main Spindle / Sub-Spindle / Lower Turret

Simultaneous Vs Positional

- **Positional / Indexing**
  - Motion of Discrete Operations
  - Improve cycle time due to single setup

- **Continuous / Simultaneous**
  - Movement of all related axes at one time along respected profile
  - The best for profiling parts and sculpture surfaces

Advantages

- **Creation of complex contours and parts**
  - Simultaneous motions and feed along all 5-axes
  - Flexibility of machined parts without casting process
  - Improved lead times
  - Higher accuracy attainable

- **Allows machining of ALL 5-Axes of parts**
  - Almost every angle of surfaces can be machined
  - Reduces time and cost of producing fixtures
 - Reduces inaccuracy in alignment due to multiple setups

Advantages

- **Shorter cutters can be used due to the flexibility of tilting angles**
  - Lower cutter loads, higher cutting speeds, longer tool life
  - Decreased vibration, better surface finish

Dis-Advantages

- Huge Initial investment
- Higher cost of tooling
- More complex
- Increased volume of code
- Highly skilled programmer or more sophisticated software required to generate tool paths
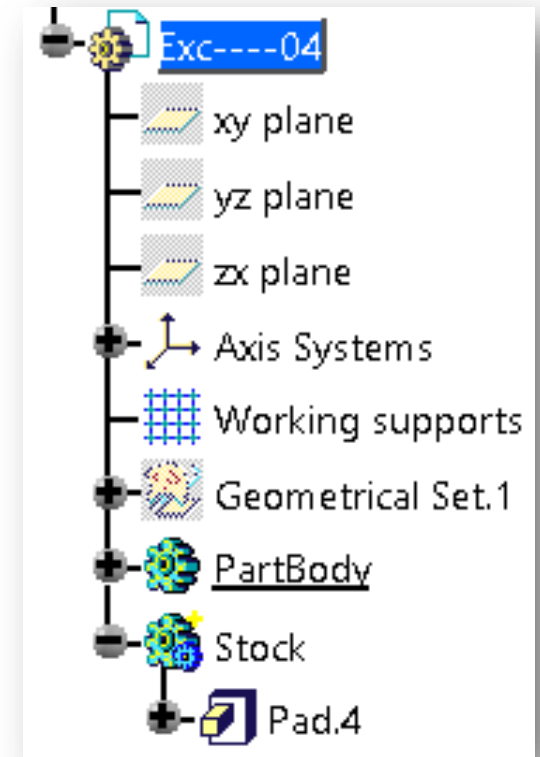- Increased cost on training skilled workers

Generating Part Design for Computer Aided Manufacturing (CAM)
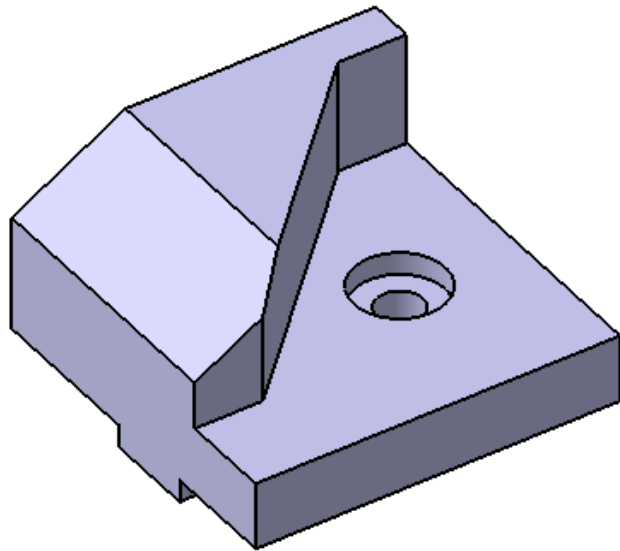
Given Part/Model
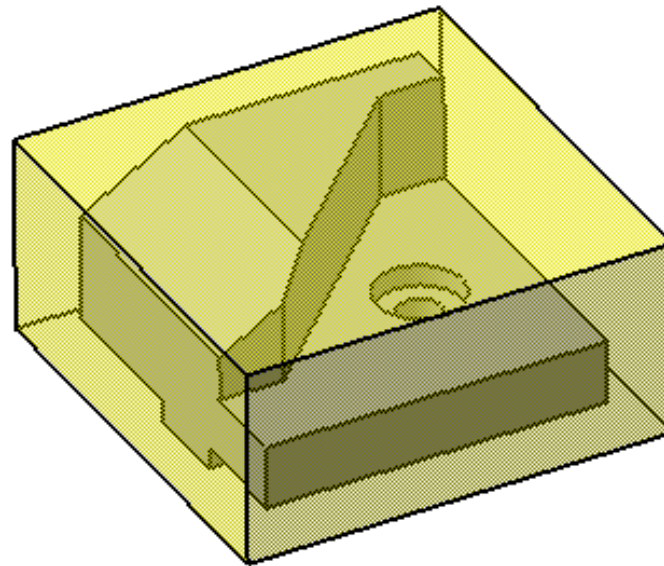
Stock Preparation

**Specification TREE** – Insert NEW Body – Renamed – Sketch – Pad
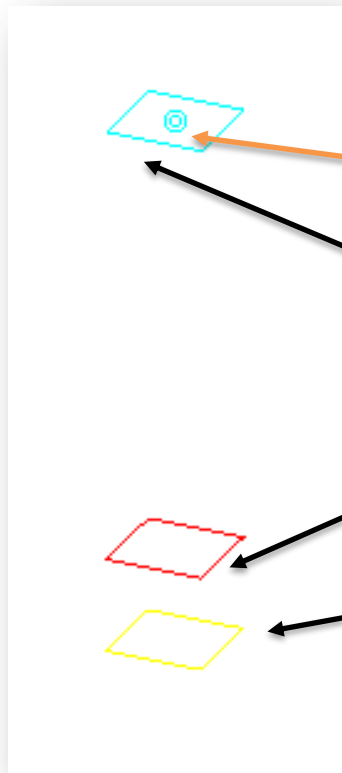
Generating Part Design for Computer Aided Manufacturing (CAM)

PLANE SYSTEM

- Consist of THREE (3) Planes
- A POINT created as Start Reference Point
- HOME Plane (**100mm** from TOP stock surface
- RAPID Plane (**30mm** from TOP stock surface
- APPROACH Plane (**15mm** from TOP stock surface)
- Workpiece Coordinate System for Assembly
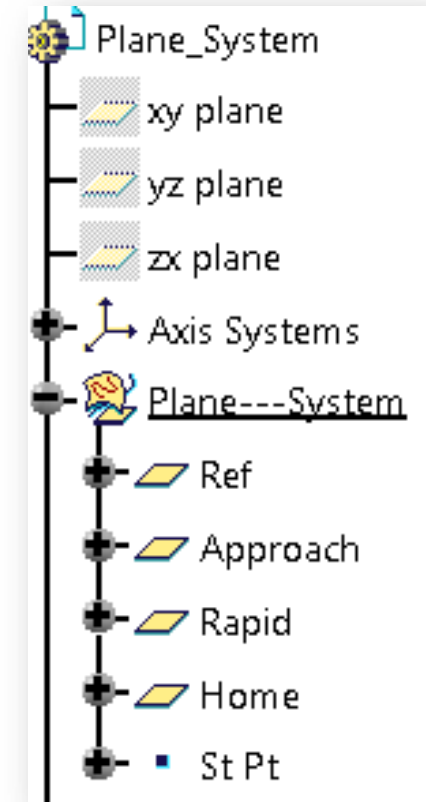
Plane System

Specification Tree of Plane System

Generating Part Design for Computer Aided Manufacturing (CAM)

Entering **Assembly Design** Workbench

2. Match Model WPC
Plane System WP
Use **COINCIDENC
CONSTRAINTS**

1. Identify the base
using **FIX COMPONENT**
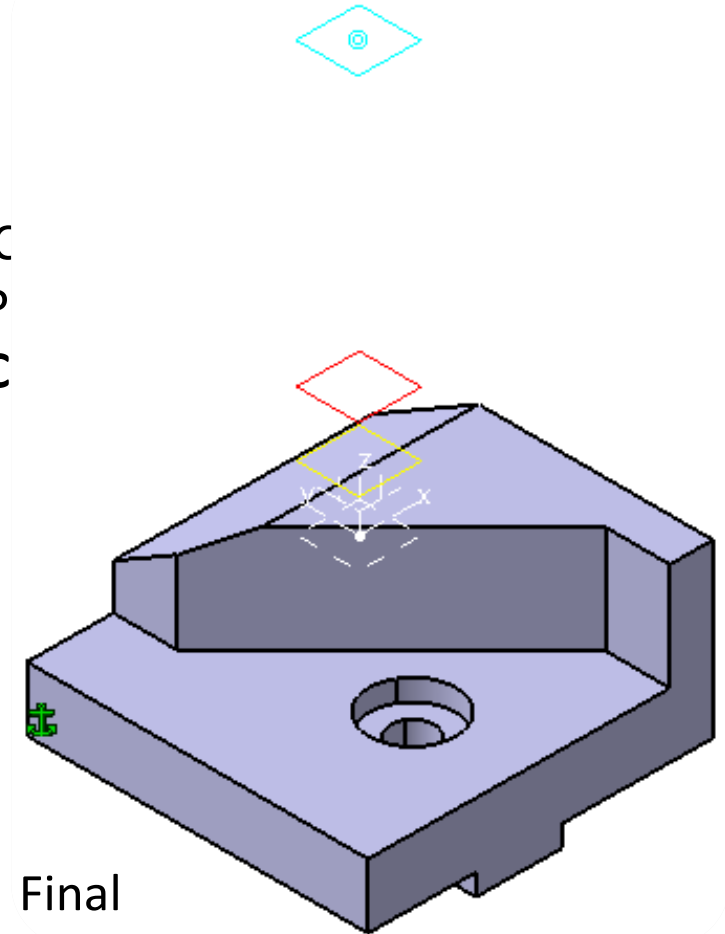
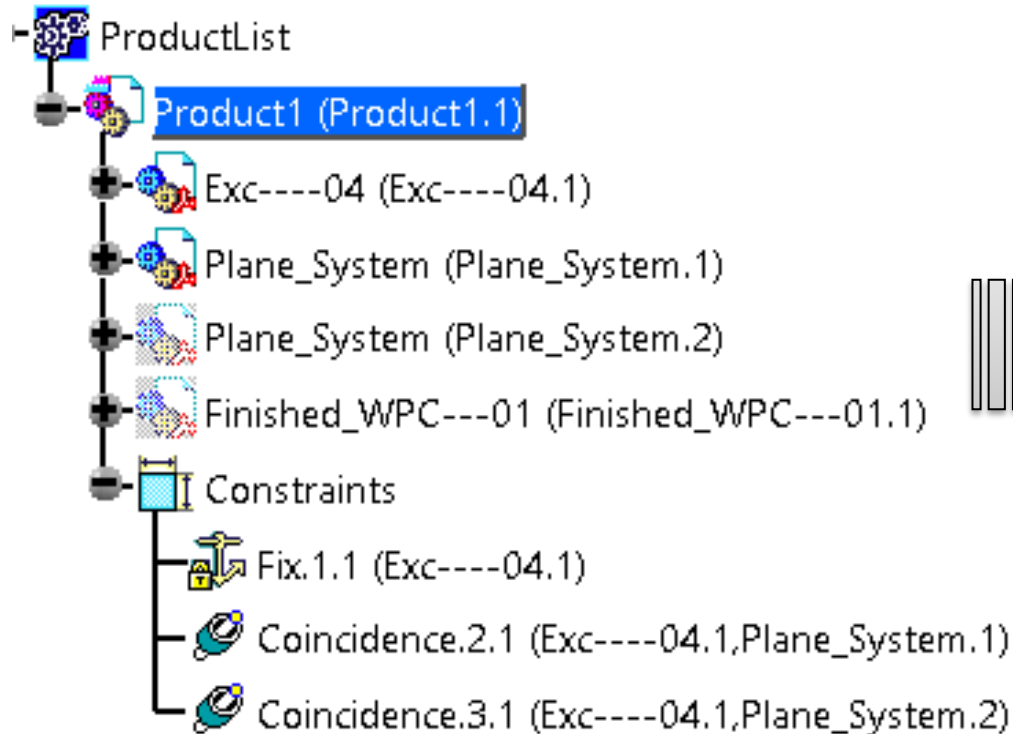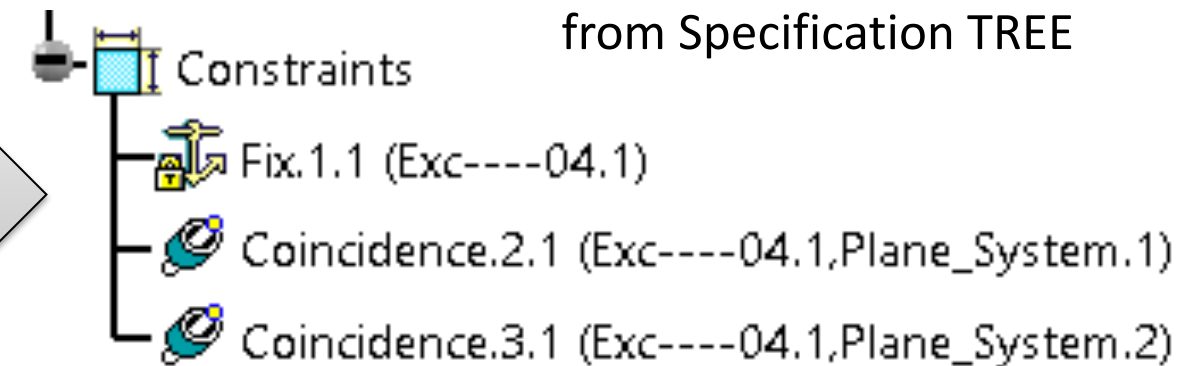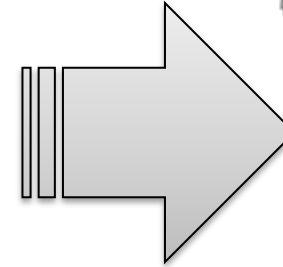Final
Assembled Part

Generating Part Design for Computer Aided Manufacturing (CAM)
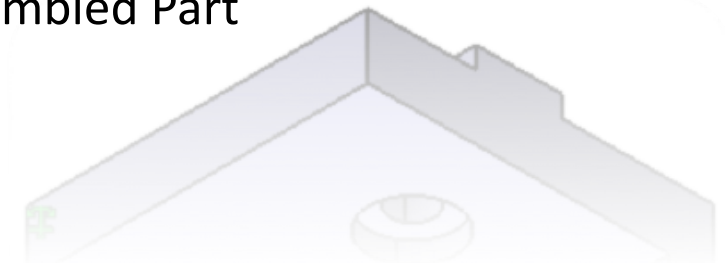
Details of **CONSTRAINTS** from Specification TREE
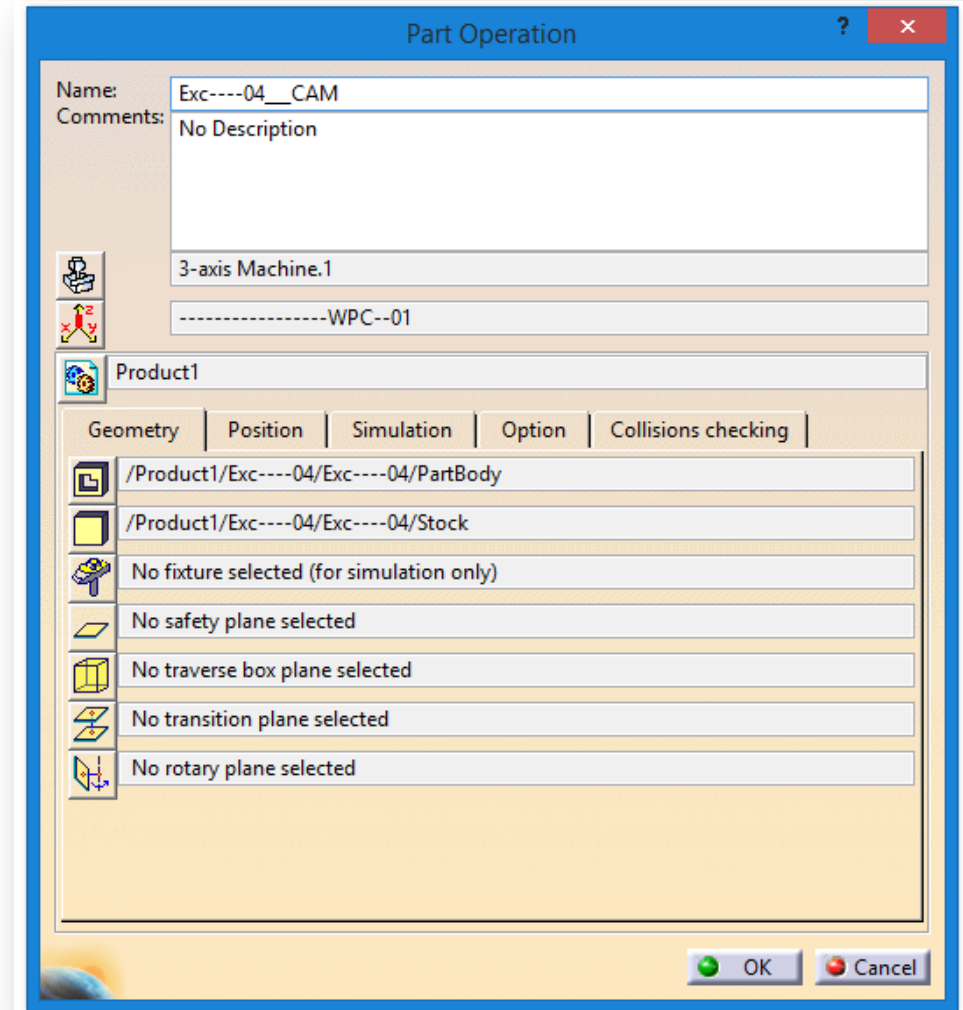
Overall **Product Specification TREE**

Entering Advanced Machining Workbench

Entering **Advanced Machining** Workbench

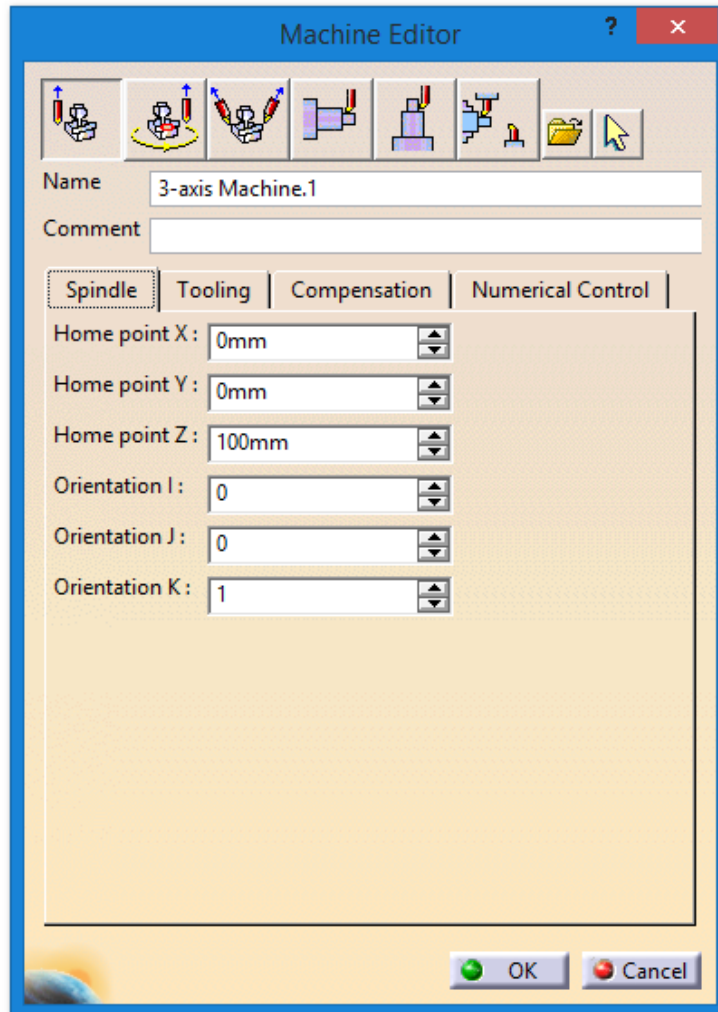There are **FIVE (5) COMPULSORY** settings need to be made in PART OPERATION

1. **Type Of MACHINE**
2. **Workpiece Coordinate System (WPC)**
3. **Designated Part to be Machined file**
4. **Define Part to be Machined model**
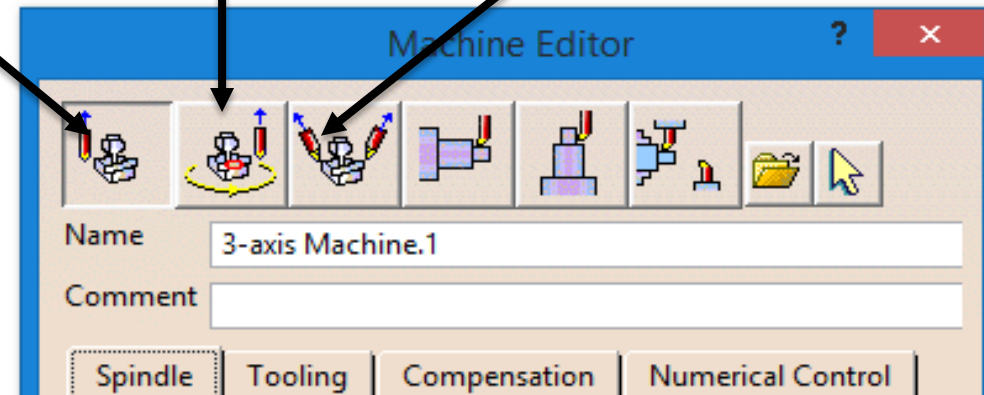5. **Define STOCK model**

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1. Type Of MACHINE

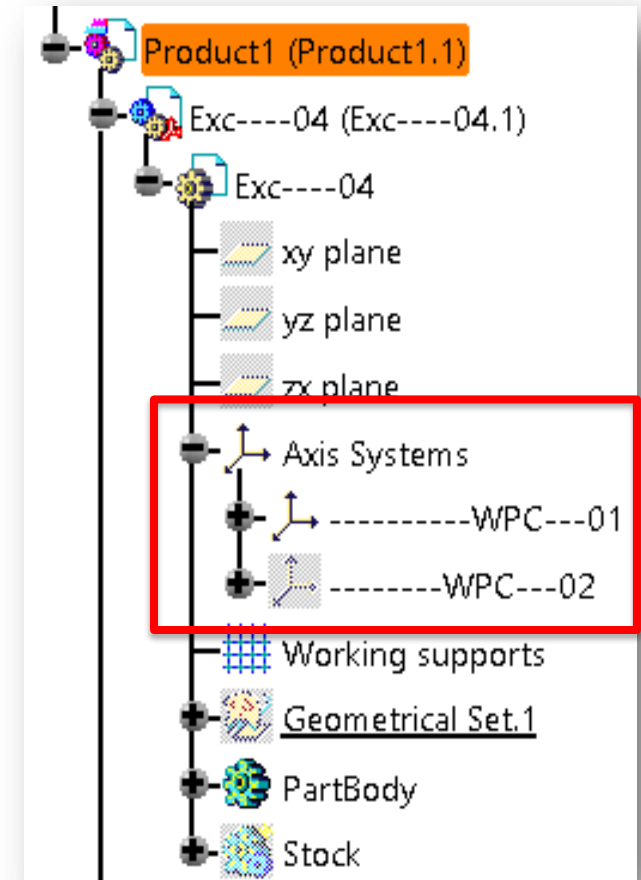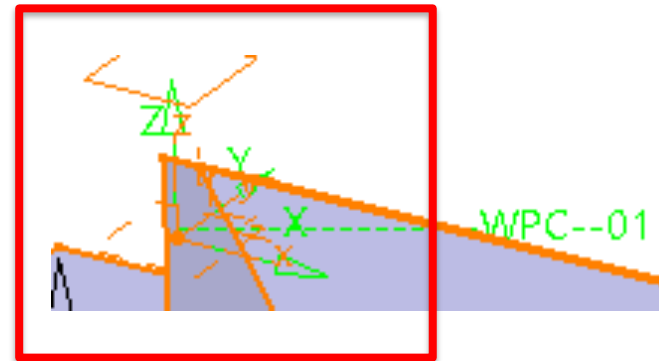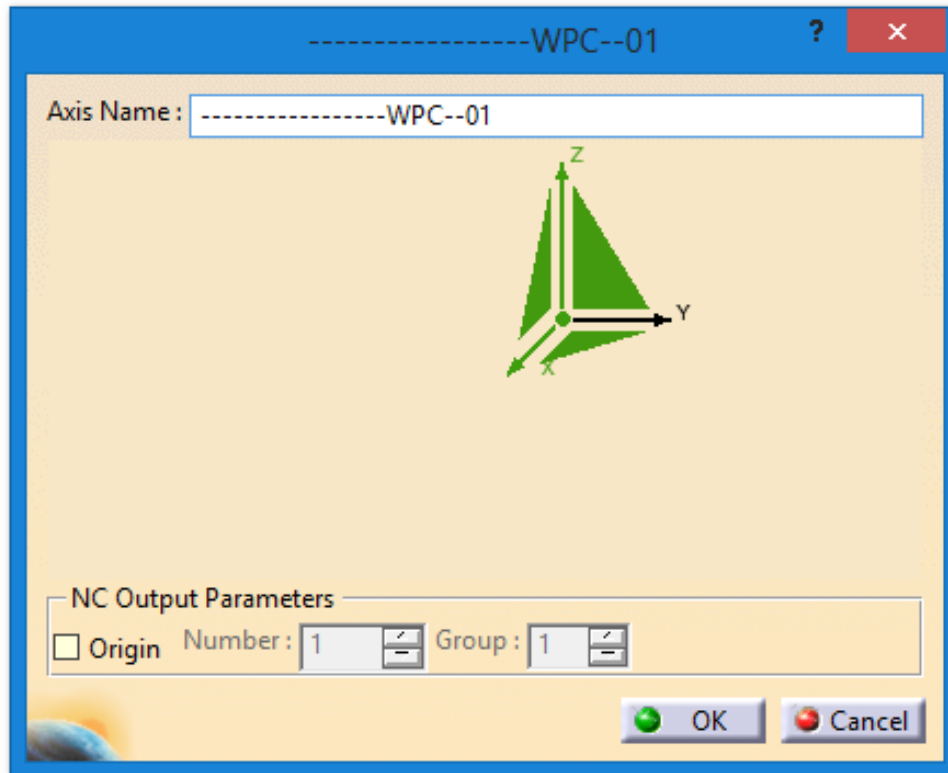3-Axis Machine

3-Axis with Rotary Table Machine
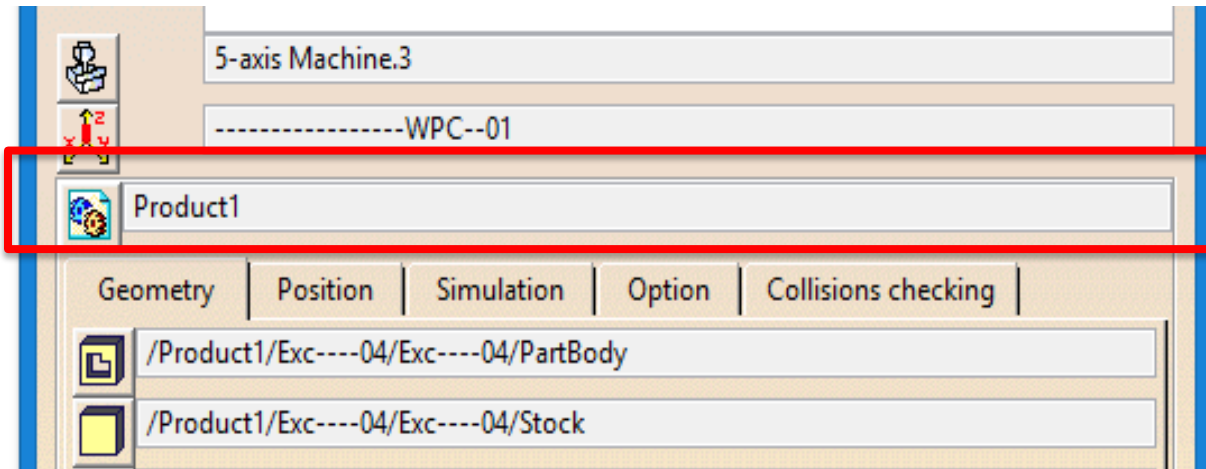
5-Axis Machine

Entering Advanced Machining Workbench

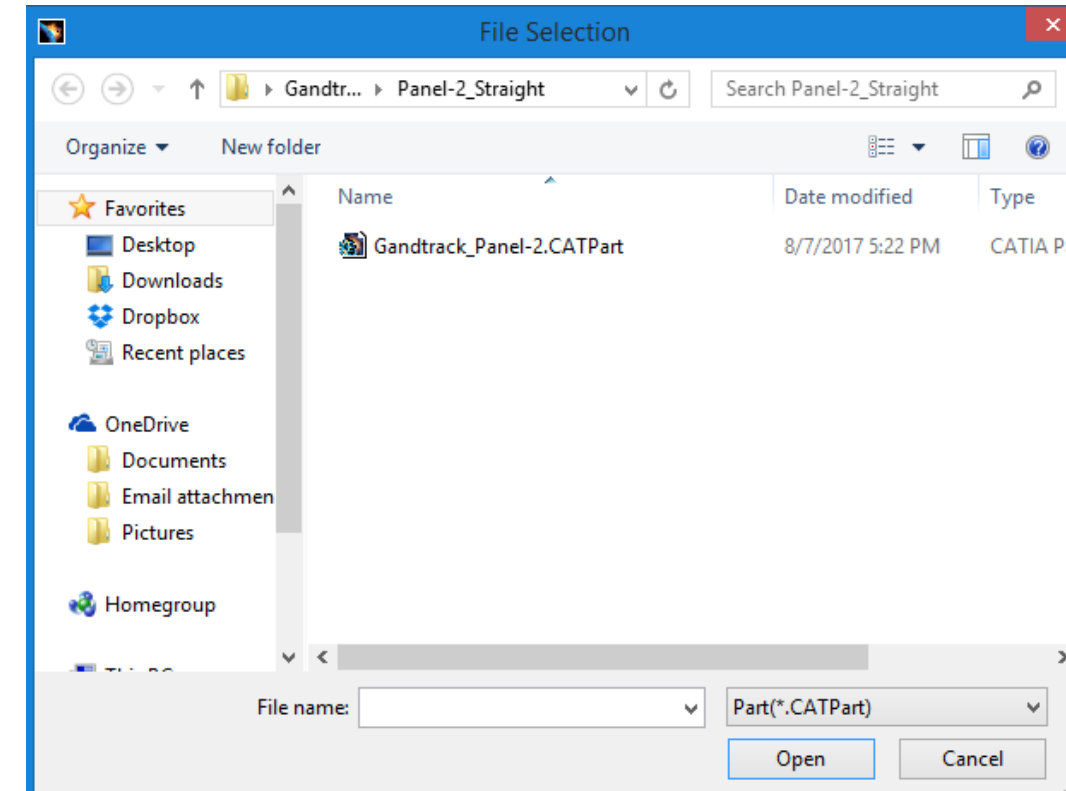**2. Workpiece Coordinate System (WPC)**

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3. Designated Part to be Machined file
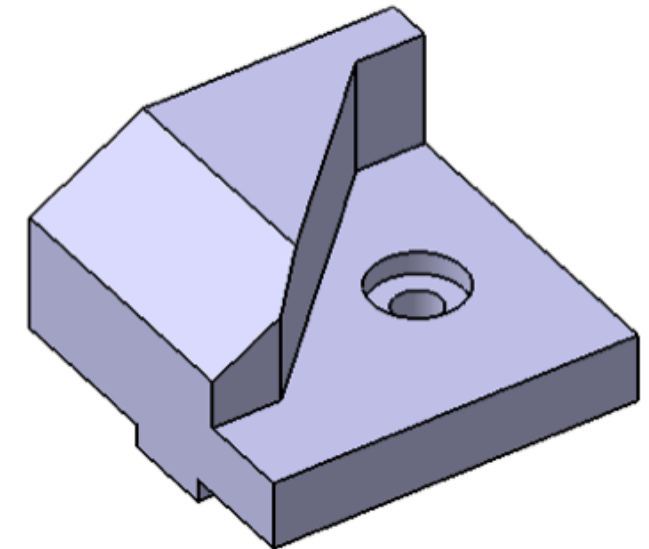

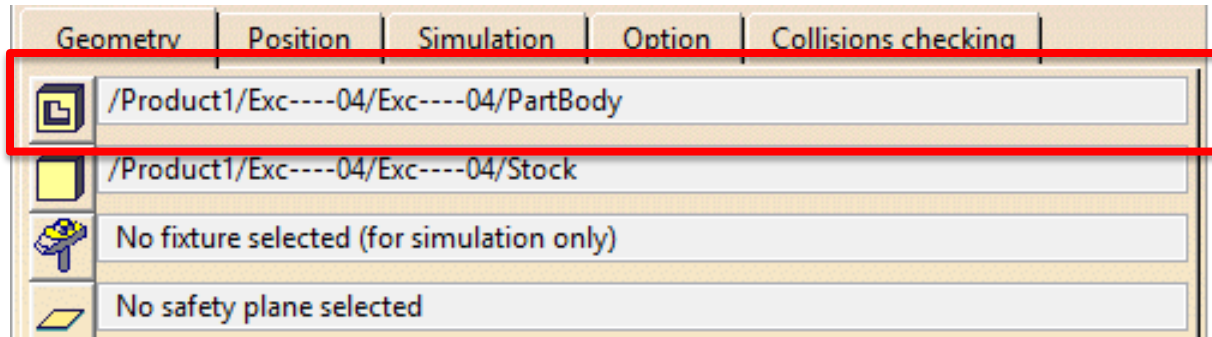Select the section as highlighted above

Find and choose the desired CAD Model. The **BEST** format to export is .**CATProduct**. But .**CATPart** can be used as well

Entering Advanced Machining Workbench
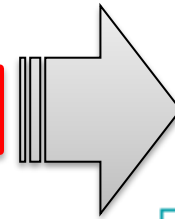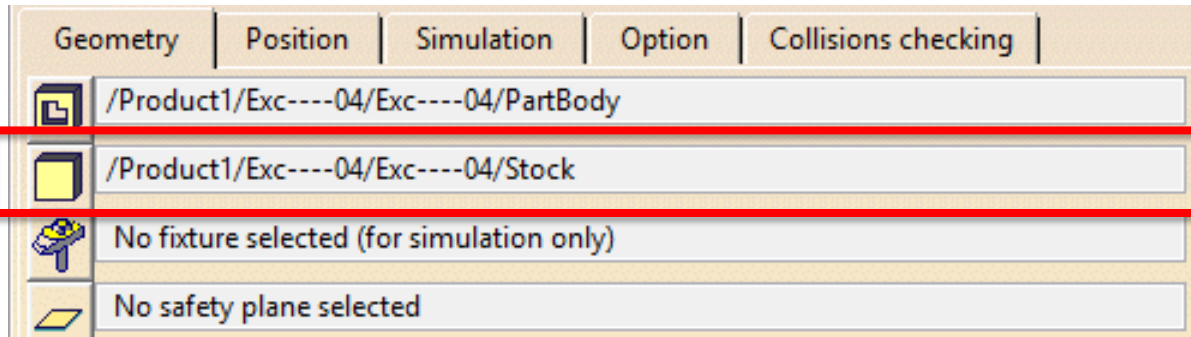
4. Define Part to be Machined model

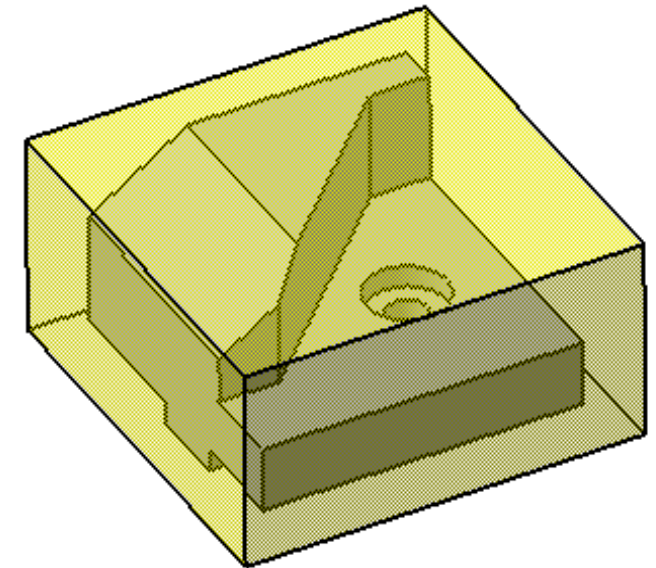| Geometry	Position	Simulation	Option	Collisions checking

/Product1/Exc----04/Exc----04/PartBody

/Product1/Exc----04/Exc----04/Stock

No fixture selected (for simulation only)

No safety plane selected

PartBody

Stock

Select Model

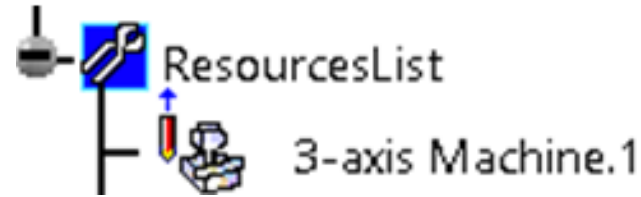# Entering Advanced Machining Workbench

4. Define STOCK model

Define Stock

Geometry	Position	Simulation	Option	Collisions checking
/Product1/Exc----04/Exc----04/PartBody				
/Product1/Exc----04/Exc----04/Stock				
No fixture selected (for simulation only)				
No safety plane selected				

PartBody

Stock

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Creating **CUTTING TOOLS** in Resources List

➡️ ResourcesList
└ 3-axis Machine.1

Please ANALYSE the CAD Model and list down your cutting tools before creating and inserting the tools
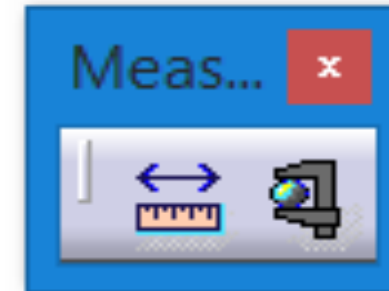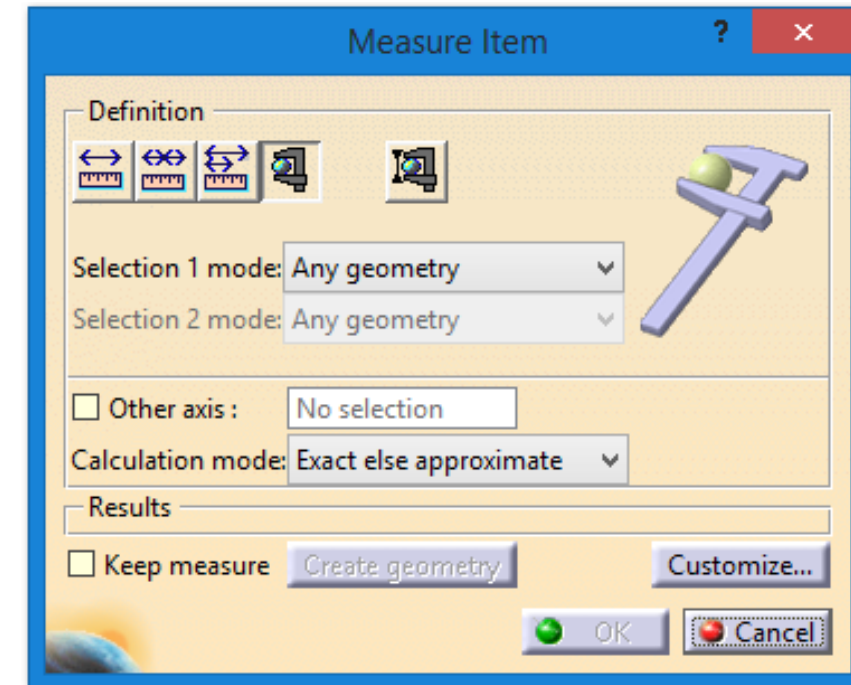
➡️ Meas...

Entering Advanced Machining Workbench
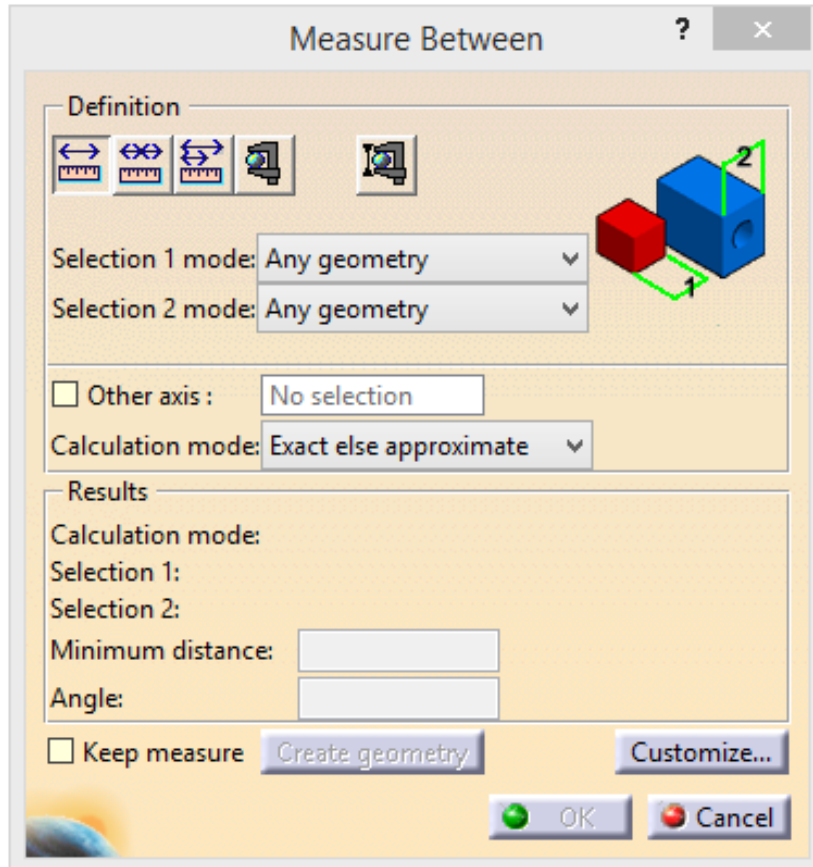
RULER – can be used to measure distance between two profile, length, angle ect.

Caliper - can be used to measure diameter / radius of hole. This function also normally used to analyze the general shape of any given profiles

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Once any given part has been **ANALYSED** then a list of **REQUIRED CUTTING TOOLS** need to be created before begin the machining process programming.

There are various cutting tools options are given by CATIA V5 as shown above namely (*from left*):

1. Drill
2. Tap
3. Thread Mill
4. Countersink
5. Reamer
6. Center Drill
7. Spot Drill
8. Multi-Diameter Drill

9. Boring & Chamfering
10. Two Sides Chamfering
11. Boring Bar
12. Counterbore
13. End Mill
14. Face Mill
15. Conical Mill
16. T-Slotter

17. Barrel Mill
18. Ball Stylus
19. Cylinder Stylus
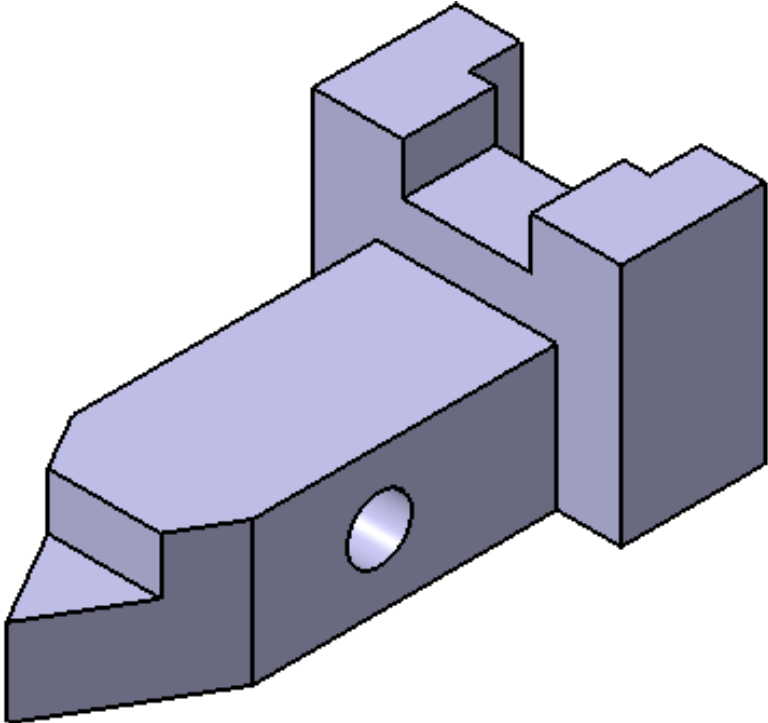
Entering Advanced Machining Workbench

List of created **CUTTING TOOLS** in Resources List
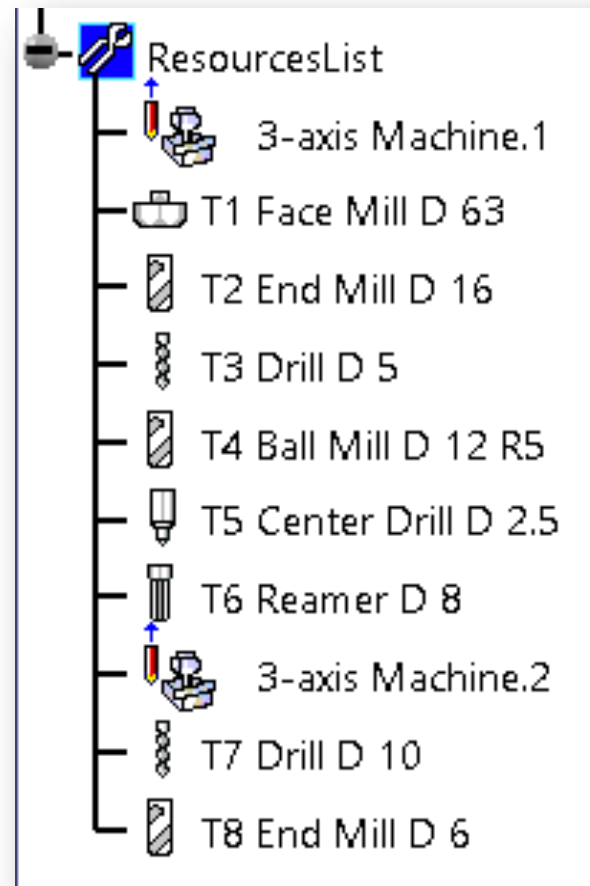
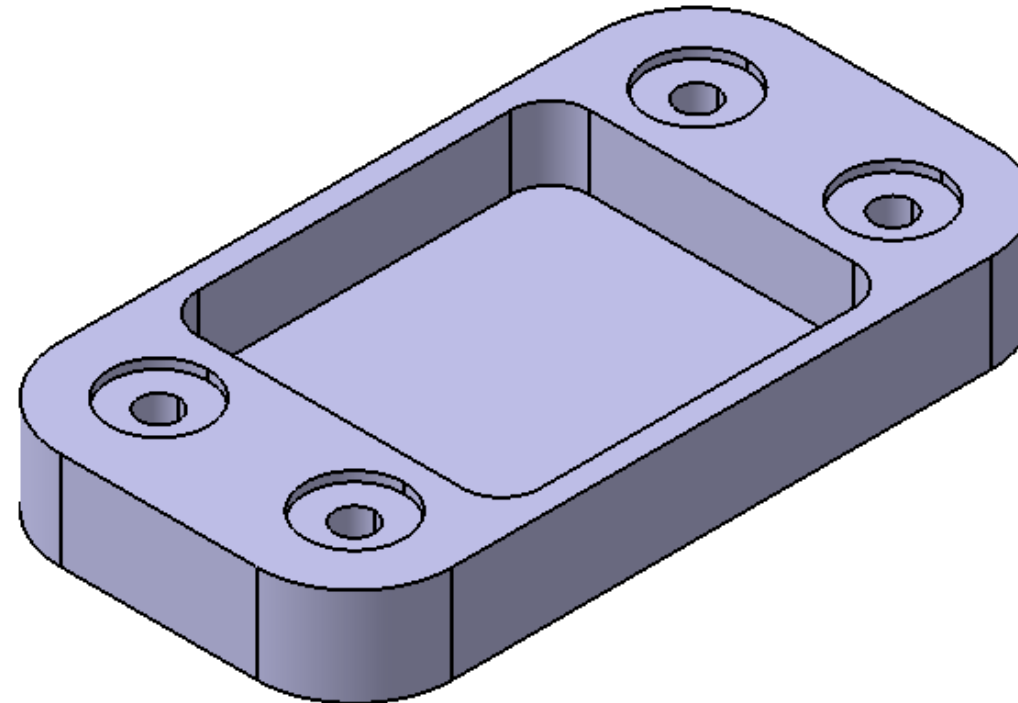# Entering Advanced Machining Workbench

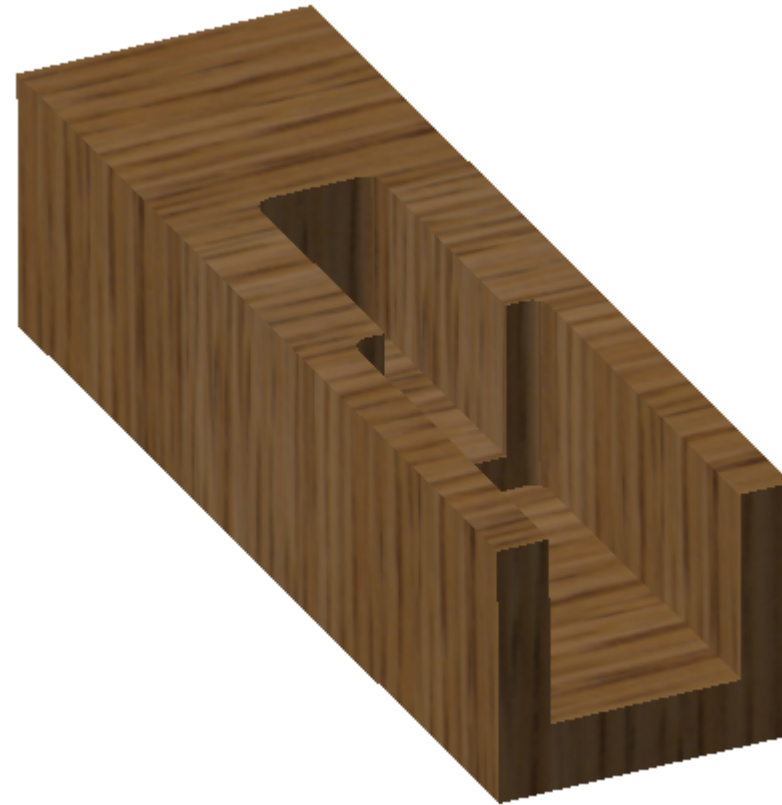**Exercise 1 : Safety Key**

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Exercise 2 : Pen & Sticky Notes Holder
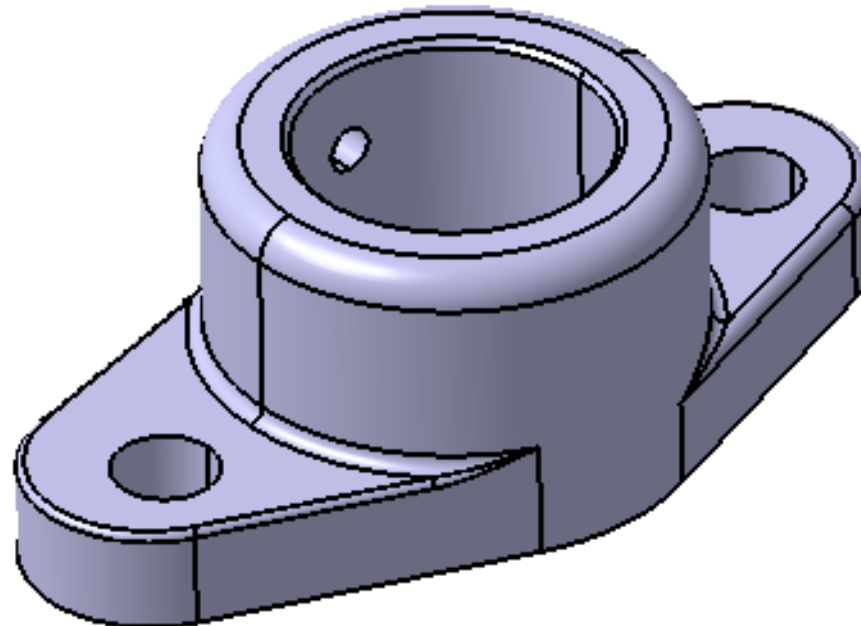
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Exercise 3 : Balsa Wood Mold

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Exercise 4 : Bearing Housing

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ALL THE BEST

THANK YOU