Aerospace Reference Book User Guide

(Prohibit Distribution, Internal Use only)

2017. 11

Doosan Machine Tools
GKAM

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Aerospace reference roll out introduction

- **What is aerospace reference roll out ?**
  - **Introduce our sales references that are suitable for the parts that customer is producing or planning to produce**

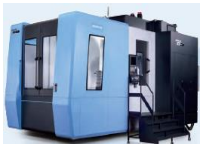
- **Roll out process**

Collect our references

Apply to sales material

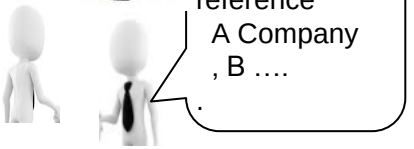
Visit customer

Introduce our references

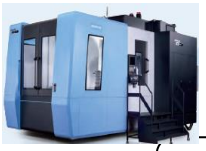


Vertical Turning

5Axis Machining



Receive inquiry



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Reference Book Introduction

- Reference Book Purpose: It is made to execute aerospace roll-out more effectively as sales material.

- Users : DMT, Subsidiary Sales Teams or Dealers

- Target Customers : Aerospace Parts Machining Customers

- Configuration : Total 17 References (’17. Oct)

  – **Structural Parts : 7**
    · Body : 2
    · Tail : 1
    · Wing : 1
    · Component : 3

  – **Engine Parts : 7**
    · Case : 4
    · Blade : 3

  – **Landing Gear Parts : 3**
    · Beam : 2
    · Disk : 1

Reference Book Introduction

①Customer Name

Customer S1

②Parts Information

Workpiece

Aircraft Door Hinge

Size

ø1390 mm (ø54.7 inch)

Material

Titanium M151

③Customer Needs

Customer Request

- More economical solution than A company
- Shorten Cycle time
- Guarantee accuracy

④ Equipment and Main Features

Solution

DHF 8000

5-axis Horizontal Machining Center

- High Speed
- High Power
- High Productivity
- Simultaneously 5-axis

⑤Machining Condition

Machining process

Process	Tooling	Feed
Roughing	Ø42.0 Insert Mill	700mm/min, 400r/min
Semi-finishing	Ø20.0 R3.0 End mill	600mm/min, 1200/min
Material	Ø20.0 End mill (45° 6 blades)	150mm/min, 250/min

Productivity Improvement

Cycle time reduce **20%** ↓

A company	22 hours
DHF 8000	16 hours

-30%

"When I used a Japanese 5-axis machine to make this part, cutting tools were totally broken because of low rigidity. Now I use DHF8000. This machine has enough power to cut titanium parts and high precision to meet strict condition of OEM. There are no precision issue on this machine by now."

-Plant Manager of Y company

Reference Book Introduction

Customer S1

①Customer Name

(Example) I will introduce to you S1 customer's reference.

Intro

Structural
- Body
- Tail
- Wing
- Component

Engine
- Case
- Blade

Landing gear
- Beam
- Disk

Appendix

Workpiece

Aircraft Door Hinge

Size

ø1390 mm (ø54.7 inch)

Material

Titanium M151

Customer Request

- More economical solution than A company
- Shorten Cycle time
- Guarantee accuracy

Solution

②Parts Information

Workpiece is Door hinge Part.

Raw material of it is Titanium and the length of it is 1,390mm.

Machining process

Productivity Improvement

Cycle time reduce 20% ↓

A company	22 hours
DHF 8000	16 hours (-30%)

③Customer Needs

Customer's needs are value for price and saving working time for machining.

Reference Book Introduction

Customer S1

④Equipment and Main Features

(Example) Customer S1 chose Doosan 5axis machine DHF8000 for their business.

DHF8000 can provide high level productivity through powerful spindle and fast feed.

⑤Machining Condition

Here is picture of jig fixture.

Our customers have been able to reduce cycle times by 20% using our products.

Solution

DHF 8000

5-axis Horizontal Machining Center

High Speed
High Power
High Productivity
Simultaneously 5-axis

Machining process

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Productivity Improvement

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When I used a Japanese 5-axis machine to make this part, cutting tools were totally broken because of low rigidity. Now I use DHF8000. This machine has enough power to cut titanium parts and high precision to meet strict condition of OEM. There are no precision issue on this machine by now.

-Plant Manager of Y company

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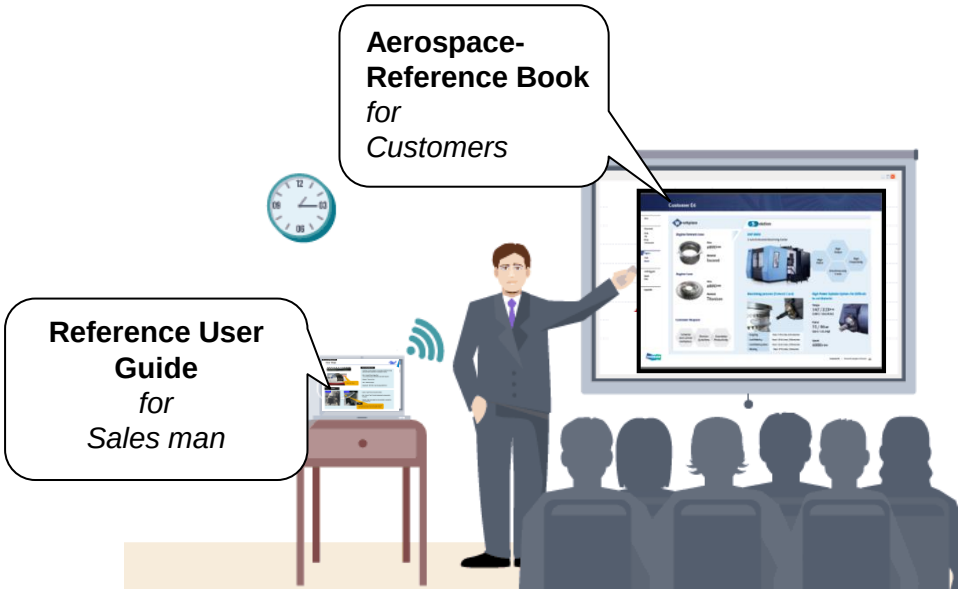
Reference Book User Guide Usage

- Objective: When a sales man introduces a reference book to a customer, the user guide material can support your presentation.

- Users : DMT, Subsidiary Sales Teams or Dealers



- Caution: Do not transfer or show this to the customer. This is contained sensitive information about customers' security. This may cause legal problems if you introduce this material directly to the customer.

Solution Structural Parts

BODY

Customer S1

Customer S2

WING

Customer S3

BODY

Customer S4

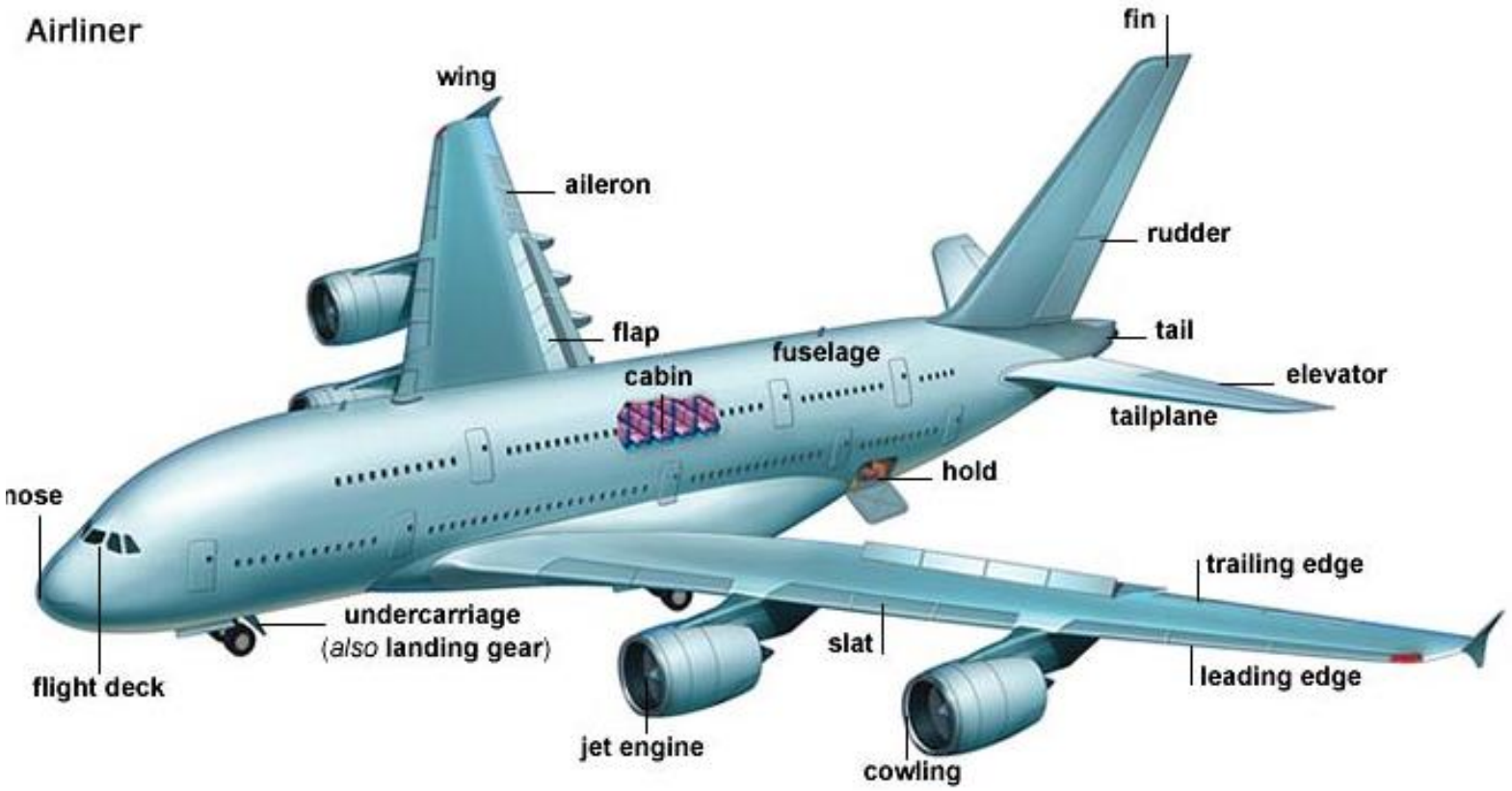
COMPONENT

Customer S5

Customer S6

Customer S7

Aircraft Fuselage Structure



Door Hinge

- Cargo Door Closer

PART INFORMATION

- **Customer : Korea company Y produces aircraft door hinge parts and Main customer is K Company in Korea.**
- **Part : Aircraft Door Hinge Part**
  - **5 Axis Machining and Ø1390mm size table required**
- **Material : Titanium Alloy**
- **Size : 1390mm(Length)**
- **Equipment : DHF 8000 , Spindle Speed 6000r/min**

SOLUTION

- **Option : High Pressure Coolant (70bar)**
- **Bed : Sensor Type Thermal displacement compensation Function**
- **Spindle : High torque gear box type spindle is required for cutting titanium**

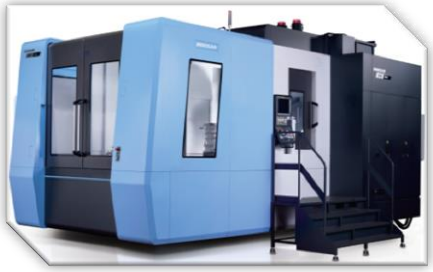
FAQ

- Is it possible to process the hole of the hinge with DHF?
  - Hole processing must be done with another machine.

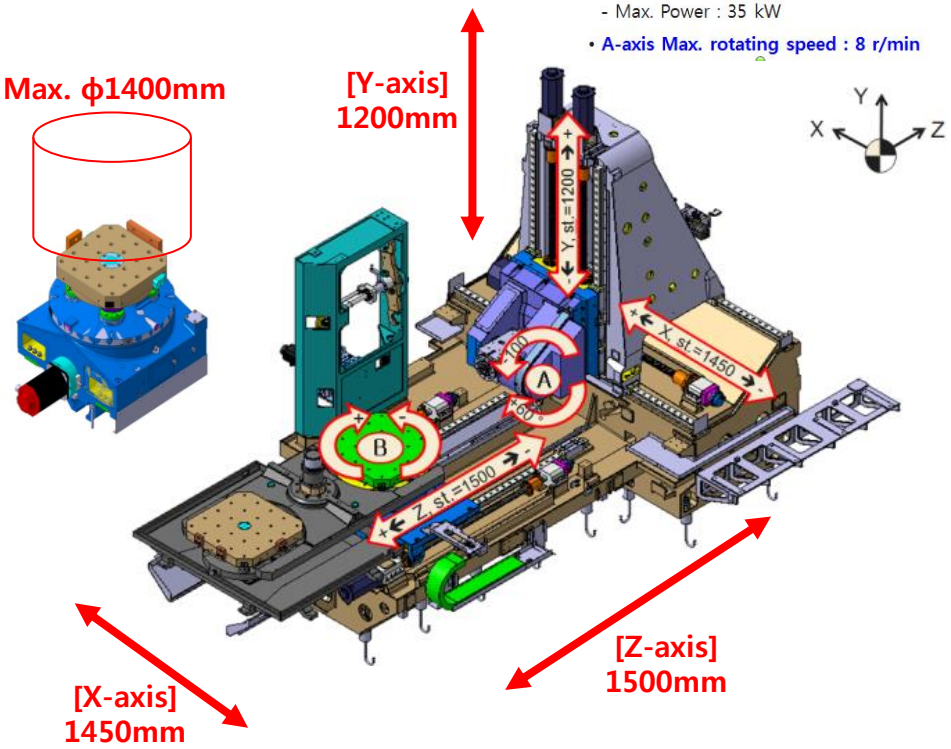
DHF 8000

FAQ

- When the 5-axis head is at Max speed, is the durability verified?
  - DHF8000 was released after enough Field Test and was tested in harsh conditions at max speed.



- Max. spindle speed : 6000 r/min
  - **Max. Torque : 960 N·m**
  - Max. Power : 35 kW
- **A-axis Max. rotating speed : 8 r/min**



SPECIFICATION

SPECIFICATION	UNIT	DHF 8000
Max. spindle speed	r/min	6000 {15000, 15000}*
Max. spindle motor power	kW	35 {86, 51}*
Max. spindle motor toque	N·m	960 {223, 147}*
Tool type	-	BT 50, HSK A100
Travel distance (X / Y / Z)	mm	1450 / 1200 / 1500
A-Axis stroke	deg	-100 ~ 60
Pallet Size	mm	800 x 800
Max. work size	mm	Ø1400 x H1400
Max. work weight	kg	2000
Tool storage capacity	ea	60 {90, 120, 150, 196 ~ 376}*
NC system	-	FANUC 31i-5 {SIEMENS 840D}*

SALES POINT

< Simultaneous 5-axis horizontal machining center with Max. Ø1400mm workpiece machining of aircraft parts >

- **Spindle**
  - **Powerful 6000r/min gear box type spindle for cutting hard part**
- **Axes**
  - **Y/Z-axis Dual Ball Screw**
  - **Ball screw nut & bearing cooling system**
  - **Linear scale**
- **Bed**
  - **Thermal displacement compensation for structure**
  - **Improved rear exit central through chip disposal**
  - **Reduced workpiece settings and unmanned operations by applying APC**

Aircraft Body Bone

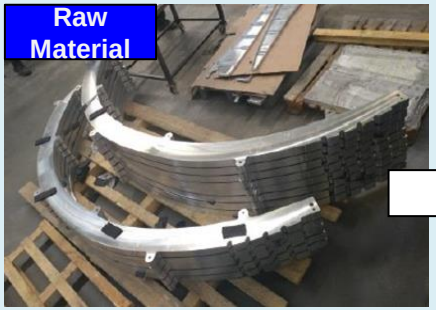
- Aircraft Body Bone

PART INFORMATION

- **Customer : Turkish Company H has 80 Doosan Machines more, and this company is vendor of major aircraft OEM companies(A Company and B Company).**
- **Part : Aircraft Fuselage Parts**
  - **Since 80-90% of the raw material is generated by the chip, chip disposal ability of the machine is important.**
- **Material : Aluminum Alloy**
- **Size : 2850mm x 500mm**
- **Equipment : BM 2740U**

SOLUTION

Raw Material



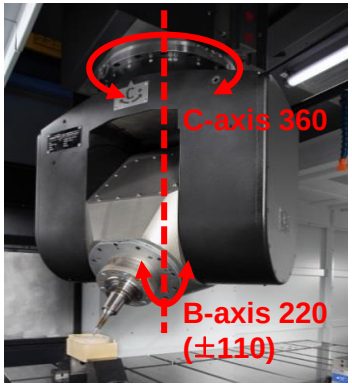
Machining Complete

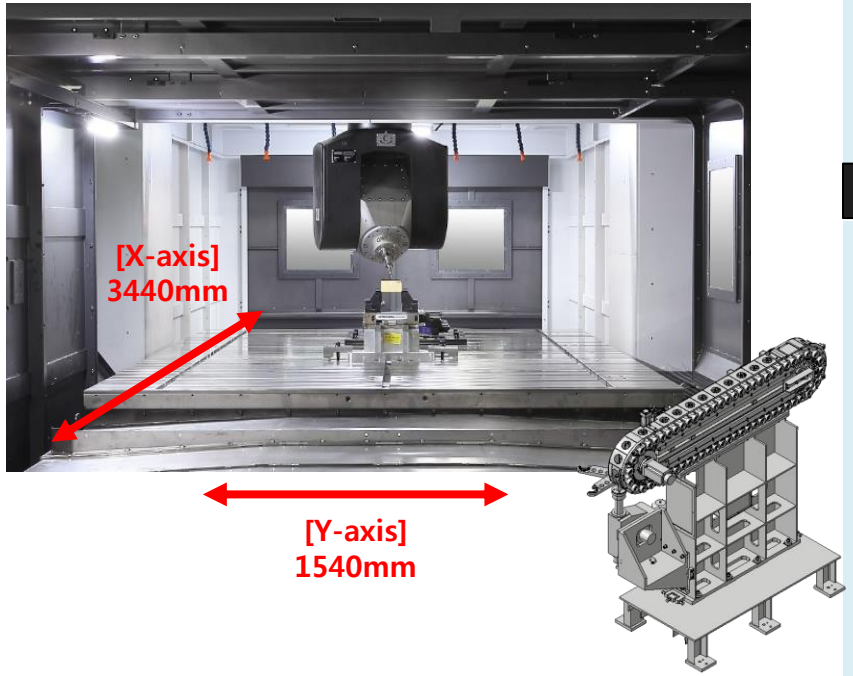
- **Fixture : Vacuum Fixture**
- **There are some customers that are divided into rough and fine cuttings**
  - **Rough Cutting by 3 Axis(30K) Machine**
  - **Fine Cutting by 5 Axis Machine**
- **Critical Point : Tolerance of Rib Thickness**
  - **Ultrasonic Tool Gage for Thickness Measuring**
  - **RMP or OMP Measuring System**

FAQ

- Rib is a critical tolerance area needed several measurement tools to perform functions such as calibration or rework.

BM 2740U





SPECIFICATION

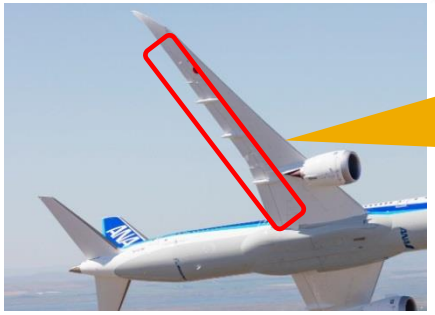
SPECIFICATION	UNIT	BM 2740U
Max. spindle speed	r/min	18000
Max. spindle motor power	kW	48
Max. spindle motor toque	N·m	138
Tool type	-	HSK-A63
Travel distance (X / Y / Z)	mm	4000 / 2500 / 700
Pallet Size	mm	4000 x 2500
Max. work size	mm	4000 x 2500
Max. work weight	kg	15000
Tool storage capacity	ea	60
CNC system	-	Heidenhain TNC640

SALES POINT

< Simultaneous 5-axis double column machining center for processing large aircraft parts >

- **Spindle**
  - **High speed machining for long time**
  - **High precision universal head**
- **Axes**
  - **Ball screw nut & bearing cooling system**
  - **X/Y/Z Linear scale**
- **Bed**
  - **Thermal displacement compensation as standard for spindle & structure without Sensor**
- **Option**
  - **Coolant shower option for chip disposal**

Hanger Link



- FTE Hanger Link as part of the main wing of the Boeing 787.
- FTE stands for Fixed Trailing Edge, which means the back of the main wing.

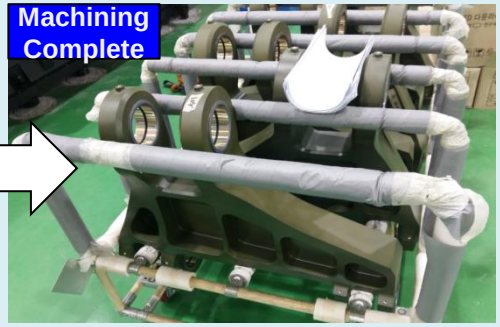
PART INFORMATION

- **Customer : Korean Company H produces aircraft wing parts and landing gear parts and Main customer is K Company in Korea.**
- **Part : Aircraft Main Wing Rudder Link Parts**
- **Material : The structure is made of aluminum alloy, and bearing part is made of brass material**
- **Size : 1000mm x 1000mm**
- **Equipment : DBC 110S**
  - **The inner diameter part machined by our DBC**

SOLUTION

Primary Machining

Machining Complete



- **Tooling : Boss Hole machining using long boring tool**
  - **Damped Boring Bar**
  - **10D(sandvik)**

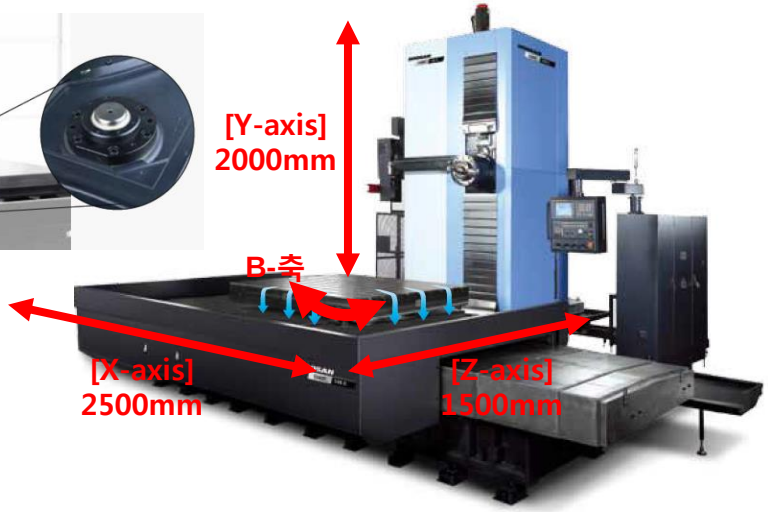
- D is the protrusion length based on the tool diameter
- ex) When tool diameter is 60mm, 10D means 600mm machining is possible.

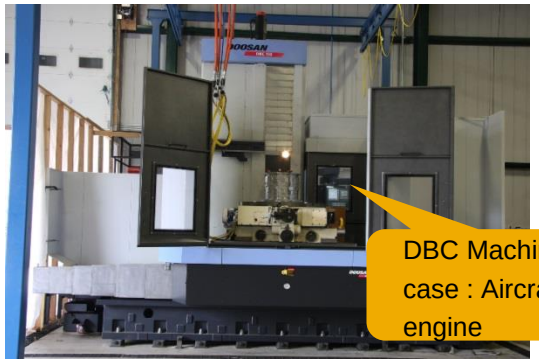
FAQ

- Why use Damped Boring Bar?

- If the tool protrusion length is long, vibration will occur during machining. This is used to prevent this phenomenon.

DBC 110 II





Semi Splash Guard

SPECIFICATION

SPECIFICATION	UNIT	DBC 110 II
Max. spindle speed	r/min	4000
Max. spindle motor power	kW	26
Max. spindle motor toque	N·m	2835{3259, 3853}*
Tool type	-	BT 50
Travel distance (X / Y / Z)	mm	2500 / 2000 / 1500 / 550
Pallet Size	mm	1400 x 1800
Max. work size	mm	2500 x 2000 x 1500
Max. work weight	kg	10000
Tool storage capacity	ea	40 {60, 90}*
CNC system	-	FANUC 31i

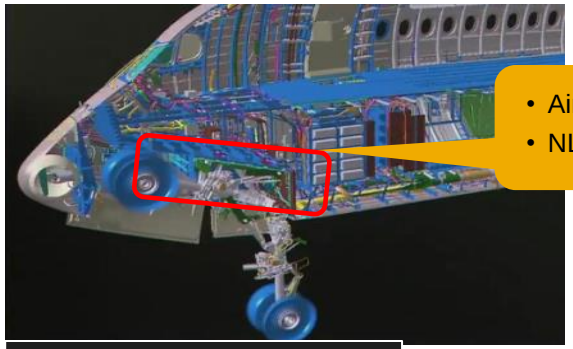
*{ } : Option

SALES POINT

< A versatile boring machine from aircraft fuselage to engine parts >

- **Spindle**
  - **High-speed, powerful cutting spindle structure**
  - **W-axis of powerful quill conveying structure(Max. 550mm)**
- **Axes :**
  - **Rotary table with built-in encoder for precise control**
- **Option**
  - **Semi Splash Guard option for chip scattering**

Rib Support

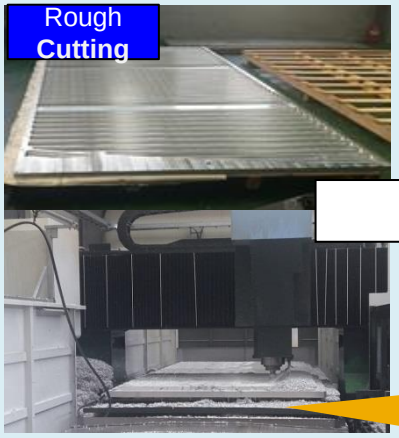


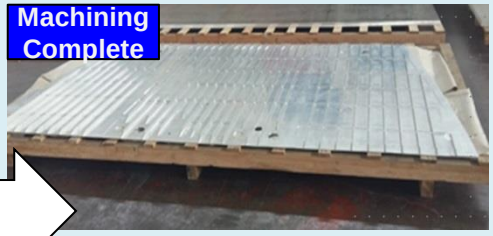
- Airbus A350 NLG Bay Roof Panel
- NLG : Nose Landing Gear

PART INFORMATION

- **Customer : Korean Company J produces structure parts and Main customer is K Company in Korea .**
- **Part : Aircraft Fuselage Inner Panel Parts**
  - **Pocket machining need to reduce the weight of the structure and increase the strength, and 80 ~ 90% of the raw material occurs as a chip.**
- **Material : Aluminum Alloy**
- **Size : 1000mm x 1700mm x 60mm**
- **Equipment : BM 2035**

SOLUTION



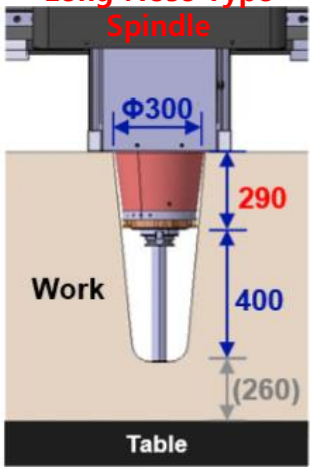


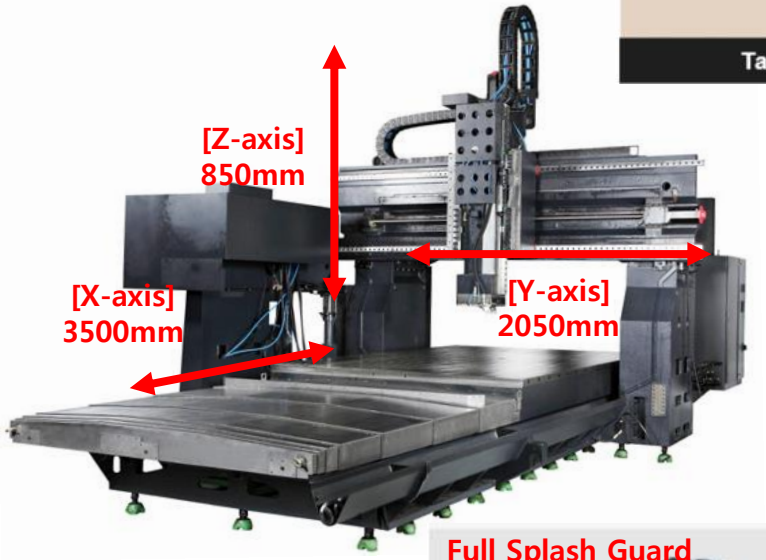
- 80 ~ 90% of raw material occurs as a chip

- **Fixture : Vacuum Fixture**
- **Process**
  - **1st Rough Cutting→ Natural Aging Transformation → 2nd Rough Cutting → Fine cutting**
- **Spindle : 10k High speed spindle for aluminum machining**

BM 2035M

Long Nose Type Spindle





Full Splash Guard

SPECIFICATION

SPECIFICATION	UNIT	BM 2035M
Max. spindle speed	r/min	12000
Max. spindle motor power	kW	30
Max. spindle motor toque	N·m	420
Tool type	-	BT 50
Travel distance (X / Y / Z)	mm	3500 / 2050 / 800
Pallet Size	mm	3000 x 1350
Max. work size	mm	3000 x 1700
Max. work weight	kg	10000
Tool storage capacity	ea	40 {60}*
CNC system	-	FANUC 31i-5 {SIEMENS 840D}*

*{ } : Option

SALES POINT

< 3-axis double column machining center for deep pocket mold cutting of aircraft structural parts >

- **Spindle**
  - **High speed & rigidity built-in spindle**
  - **Long-nose type suitable for deep pocket mold cutting**
- **Axes**
  - **Ball screw nut & bearing cooling system**
  - **X/Y/Z Linear scale**
- **Bed**
  - **Thermal displacement compensation as standard for spindle & structure without Sensor**
- **Option**
  - **Coolant shower option for chip disposal**

Various Components 01

- It is a part that is applied to the connecting part of helicopter body and is called connecting link or swivel arm.

PART INFORMATION

- **Customer : Korean Company M produces helicopter parts and Main customer is H(Korean helicopter OEM)**
- **Part : Helicopter Parts**
  - **To reduce the weight of the structure and to increase the strength, it is finished by machining the raw material without welding and bolt fastening.**
  - **5-axis machining is required for complex shape**
- **Material : Various (Steel, Titanium, Aluminum)**
- **Size : Ø600mm**
- **Equipment: VC630/5AX**

SOLUTION

Machining Complete

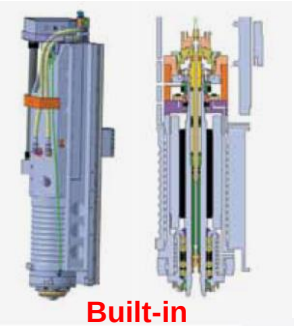
FAQ

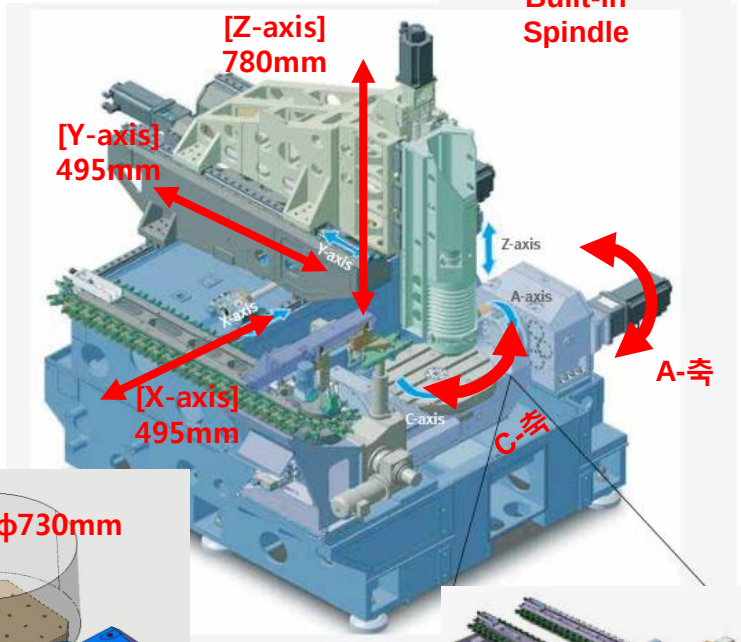
- What is DCP i?

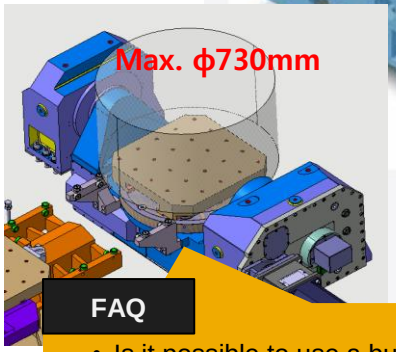
- It is the function to correct the center of rotation axis for precise 5-axis machining. It is used for minimizing the workpiece shape error and maintaining the accuracy. Fanuc is IKC (formerly DCP-i), Heidenhain is Kinematic opt. Function.

- **Process**
  - **3-axis machining is possible but 5-axis machining is necessary for accuracy**
- **Option**
  - **High Pressure Coolant (70bar)**
  - **DCP i / Kinematic Option is recommended for multi processing**

VC 630/5AX







SPECIFICATION

SPECIFICATION	UNIT	VC 630/5AX
Max. spindle speed	r/min	12000
Max. spindle motor power	kW	22/18.5
Max. spindle motor toque	N·m	204
Tool type	-	BT40
Travel distance (X / Y / Z)	mm	650 / 765 / 520
Pallet Size	mm	ϕ630
Max. work size	mm	ϕ730
Max. work weight	kg	10000
A/C-axis stroke	deg	A : 150/ C 360
Tool storage capacity	ea	40 {60,81,101,121}*
CNC system	-	FANUC 31i-5 {Heidenhain TNC640/ SIEMENS 840D}*

*{ } : Option

SALES POINT

< Simultaneous 5-axis machining center with Max. Ø730mm workpiece machining >

- **Spindle**
  - **Built-in type spindle for high-speed machining at 12000r/min**
- **Axes**
  - **Roller LM Guide Way for high speed machining**
- **Bed**
  - **5 Point Thermal displacement compensation**
- **Option**
  - **Max. 121 Tools applicable**
  - **Linear scale**

FAQ

- Is it possible to use a built-in vacuum line on the table when machining parts?

- a built-in vacuum line is available as an option!

Various Components 02

- The left part on the Reference book is processed by Lynx

PART INFORMATION

- **Customer : Poland Company W**
- **Part : Various Aircraft Fuselage Parts**
  - **To reduce the weight of the structure and to increase the strength, it is finished by machining the raw material without welding and bolt fastening.**
- **Material : Various(Aluminum, Titanium)**
- **Size : 500 x 1200mm**
- **Equipment : DNM 5700**

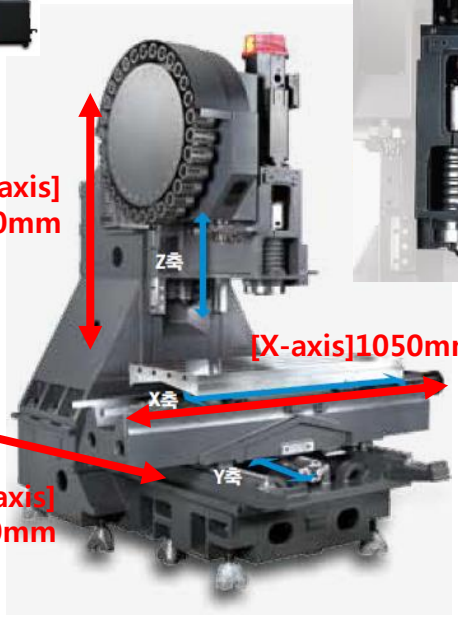
SOLUTION

- **Option : High Pressure Coolant (70bar)**

Machining Complete

DNM 5700

Direct-coupled spindle



SPECIFICATION

SPECIFICATION	UNIT	DNM 5700
Max. spindle speed	r/min	8000{12000}
Max. spindle motor power	kW	18.5{15}**
Max. spindle motor toque	N·m	118{286}**
Tool type	-	BT 40{CAT40, DIN40}
Travel distance (X / Y / Z)	mm	1050 / 570 / 510
Pallet Size	mm	1300 x 570
Max. work size	mm	1300 x 570
Max. work weight	kg	1000
Tool storage capacity	ea	30 {40}*
CNC system	-	FANUC 0iMF {Heidenhain TNC620, Siemens S828D}

SALES POINT

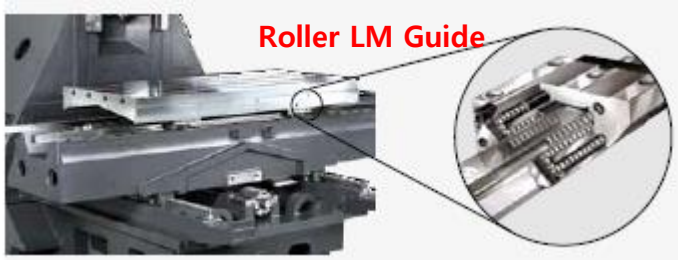
< 3-axis machining center for high speed machining >

- **Spindle**
  - **8000 or 12000r/min all direct-coupled spindle**
  - **Excellent vibration and noise compared to belt driven type**

- **Axes**
  - **Roller LM Guide Way for high speed machining**

30Tool Standard

Roller LM Guide



Main Rotor(Helicopter)

PART INFORMATION

- Customer : Korean Company H produces helicopter and aircraft engine parts.
- Part : Helicopter Main Rotor Parts
  - To reduce the weight of the structure and to increase the strength, it is finished by machining the raw material without welding and bolt fastening.
  - 5-axis machining is required for complex shape.
- Material : Stainless Steel
- Size : Ø200 x 1500mm
- Equipment : PUMA SMX3100S

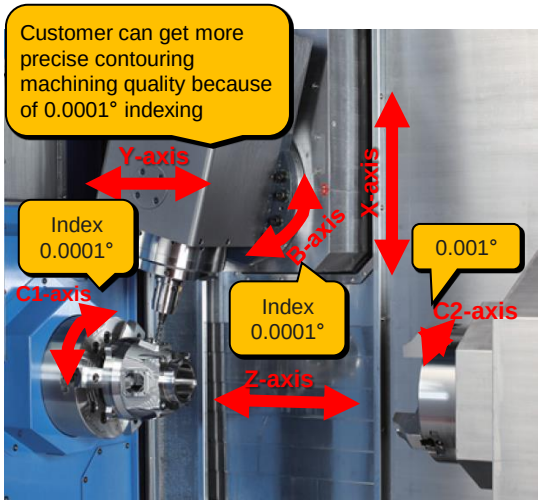
SOLUTION

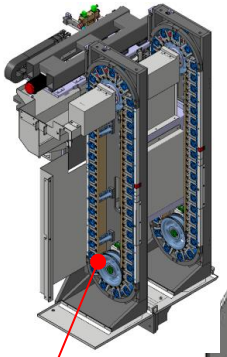
Primary Machining

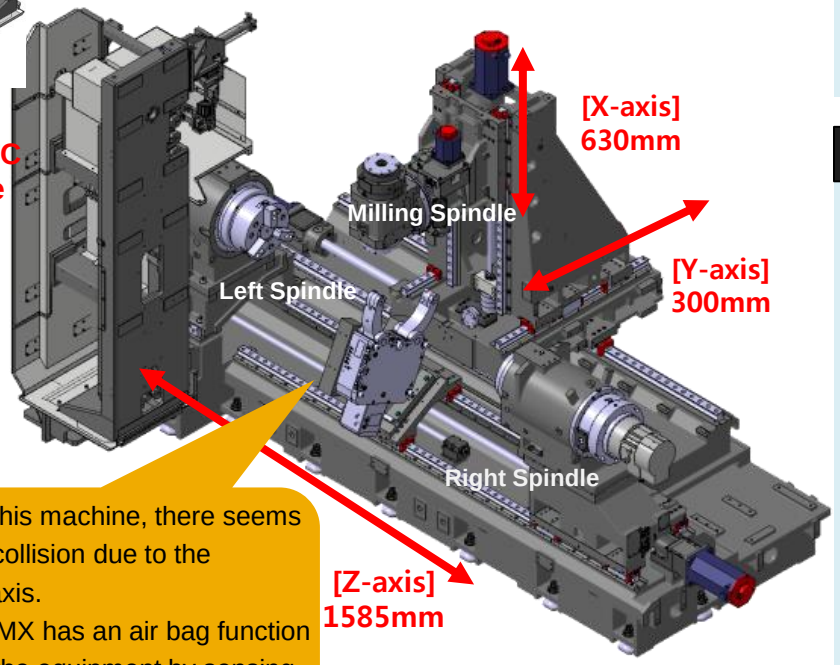
Machining Complete

- Chucking
  - Standard Chuck + Tail Stock
  - It is important to pay attention to chucking not to occur workpiece deformation.

PUMA SMX 3100S







SPECIFICATION

SPECIFICATION	UNIT	PUMA SMX3100S
Chuck size (L-Spindle)	inch	12{15}*
Chuck size (R-Spindle)	inch	10{12}*
Max. spindle speed	r/min	L-Spindle : 3000, R-Spindle : 4000
Max. spindle motor power	kW	30, 25
Max. spindle motor toque	N·m	118{286}*
Milling spindle speed	r/min	12000{8000}*
Milling spindle motor power	kW	26/18.5
Milling tool type	-	CAPTO C6{HSK-A63}*
Travel distance (X / Y / Z)	mm	1050 / 570 / 510
Max. work size	mm	ϕ660 x 1540{2540}**
Tool storage capacity	ea	40 {80}*
CNC system	-	FANUC 31i {Fanuc 31i-5}*

*{ } : Option

SALES POINT

< Multi-tasking turning featuring high productivity, high precision and easy operation >

- **Spindle**
  - **12000r/min built-in type milling spindle**
- **Axes**
  - **Maximized Y-axis machining area through orthogonal design structure**
  - **Adoption of Roller LM Guideways with high-rigidity and high precision**
- **Bed**
  - **Thermal displacement compensation for structure**
- **Option**
  - **Servo driven Steady rest**

FAQ

- In the case of this machine, there seems to be a risk of collision due to the complexity of axis.
  - The PUMA SMX has an air bag function that protects the equipment by sensing the moment of impact on the shaft.

Solution
Engine Parts

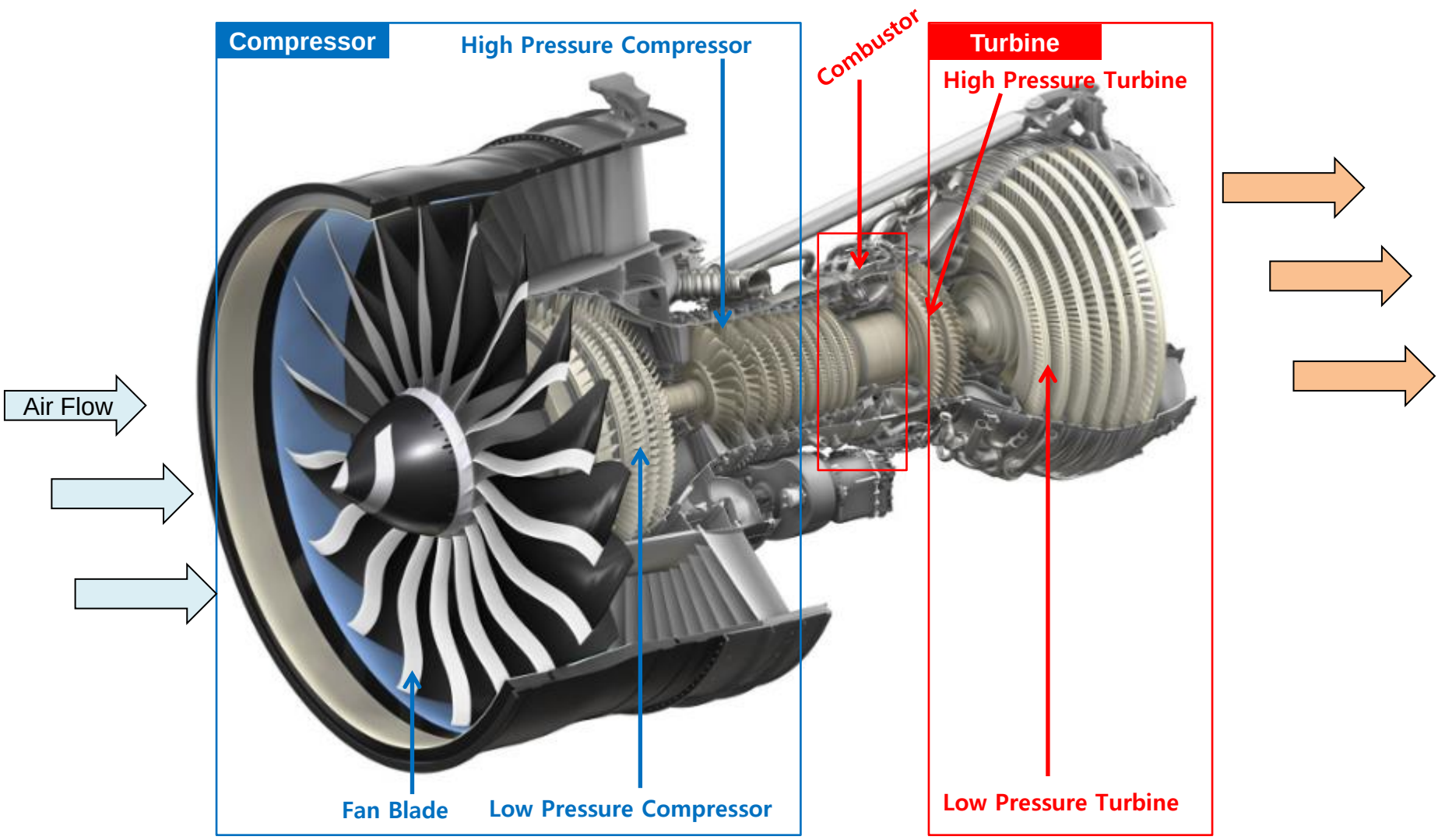
CASE

- Customer E1
- Customer E2
- Customer E3
- Customer E4
- Customer E5

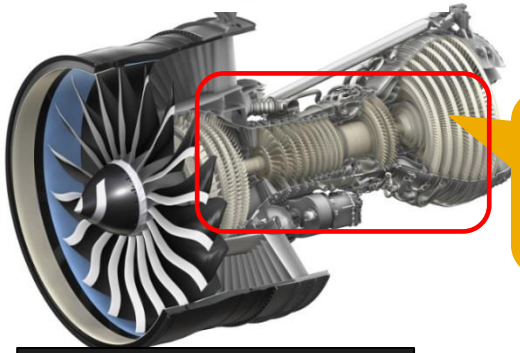
BLADE

- Customer E6
- Customer E7

Aircraft Engine Structure



Engine Case



- A case part of a Turbine where fuel and compressed air are mixed and burned in an aircraft engine.

PART INFORMATION

- **Customer : US Aircraft Engine Manufacturer P Company**
- **Part : Aircraft Engine Case Parts**
- **Material : Inconel**
  - **The strong cutting force and structural stiffness of the machine are important**
- **Size : Ø1000mm**
- **Equipment : PUMA VTR1216**

FAQ

Why do we need workpiece measurements?
- In the case of aviation parts, most of them use expensive materials. Therefore, to reduce the defects of the material, measuring process is essential after first step machining.

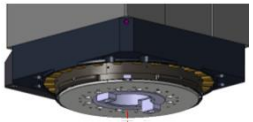
SOLUTION

Primary Machining

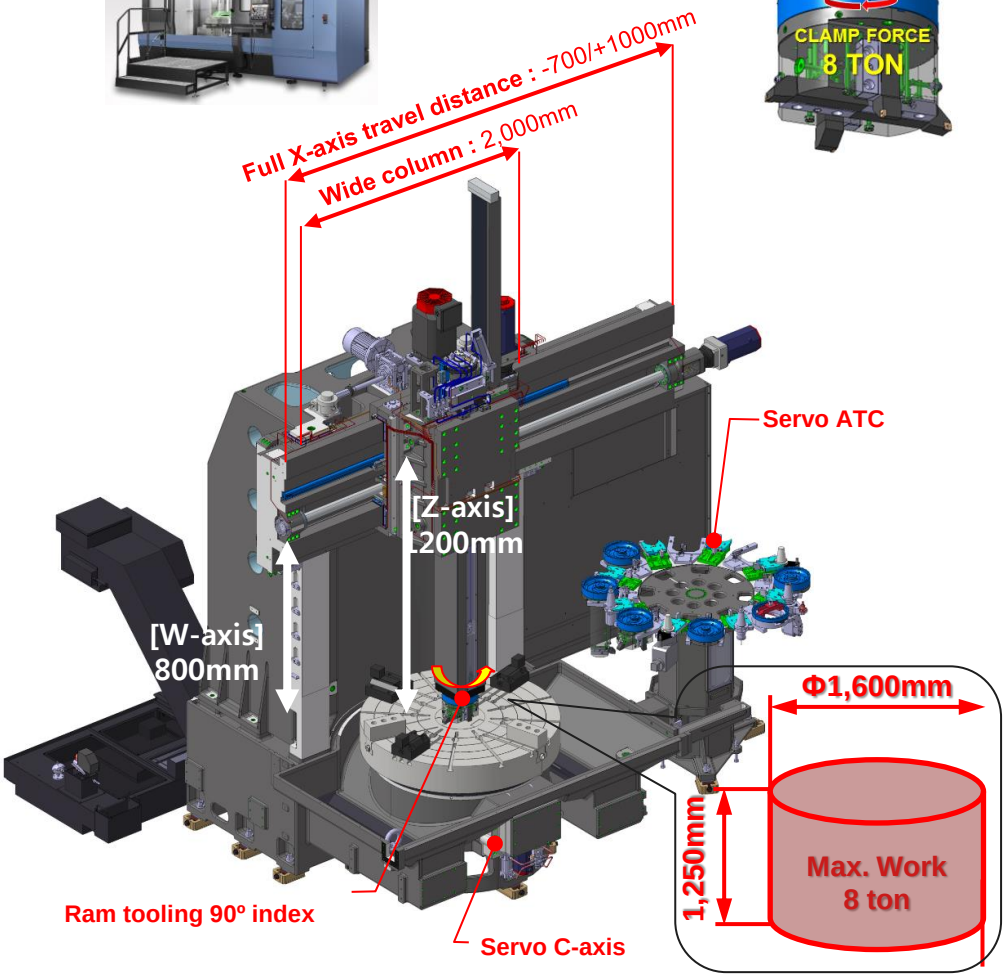
Machining Complete

- **Ring Machining Part Measurement (in Machine)**
  → VTR with Measurement System(RMP….)
- **Considering the size of the product + fixture when selecting the machine size(Approx. 300 mm)**
- **Option**
  - **High Pressure Coolant (70bar)**
  - **Full Covered Splash Guard**
- **Tool Index Function (VTR Series)**

PUMA VTR1216



90º index system



SPECIFICATION

SPECIFICATION	UNIT	PUMA VTR1216
Chuck size	inch	50{55}*
Max. spindle speed	r/min	400
Max. spindle motor power	kW	45{70}*
Max. spindle motor toque	N·m	20557{31997}*
Travel distance (X / Y / Z)	mm	-700~+1000 / 1200 / 800
Max. work size	mm	ϕ1600 x 1250
Max. work weight	kg	8000
Number of tool stations	ea	12 {24}*
CNC system	-	FANUC 0iTF

*{ } : Option

SALES POINT

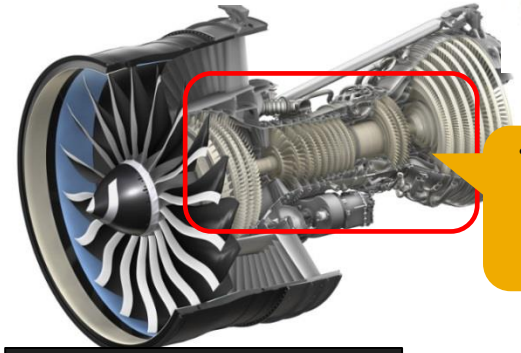
< Large vertical turning center with max Ø1600mm workpiece machining >

- **Spindle**
  - **Spindle power Max.70kW**
- **Bed**
  - **Single wide column design provides a wide machining area with extended travel distances on X-axis**
- **Tool Post**
  - **Servo type ATC : 12(24) Tools**
  - **Four times greater tooling efficiency through 90° indexing capability**

Engine Case & Turbine Case

Engine Case - Inconel

Turbine Case- Titanium



- A case part of a Turbine where fuel and compressed air are mixed and burned in an aircraft engine.

PART INFORMATION

- Customer : US Company F produces aircraft engine case and ring parts. This company is vendor of Aircraft Engine Manufacturer P Company
- Part : Engine Case, Ring Parts
- Material : Inconel and Titanium
  - –The strong cutting force and structural stiffness of the machine are important
- Size : Ø800mm
- Equipment : PUMA V8300

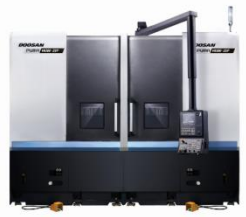
SOLUTION

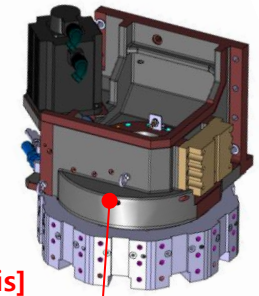
Turning

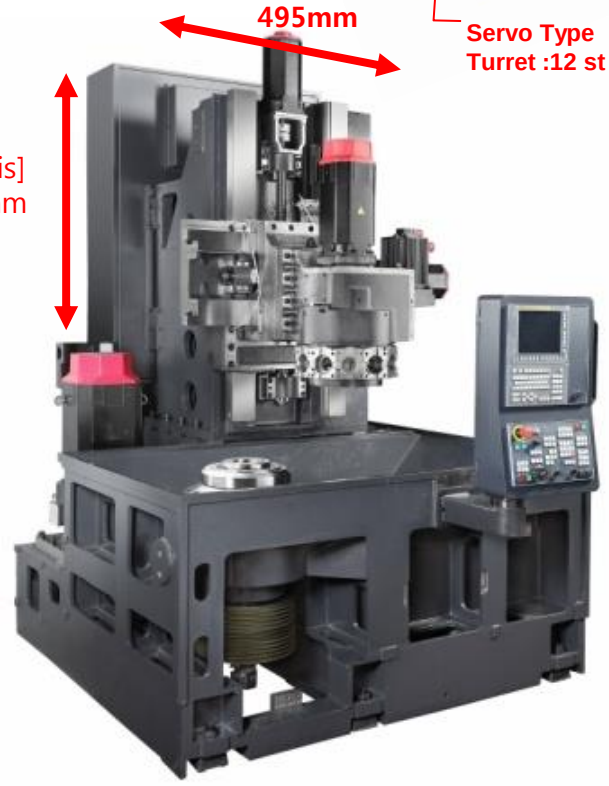
5-axis

- Fixture : Considering the size of the product + fixture when selecting the machine size(Approx. 200 mm)
- Option
  - –Tool Interference Optimize→ ATC Option Recommended

PUMA V8300







SPECIFICATION

SPECIFICATION	UNIT	PUMA V8300
Chuck size	inch	15{18, 21, 24}*
Max. spindle speed	r/min	2000
Max. spindle motor power	kW	30/22{37/30,45/37}*
Max. spindle motor toque	N·m	1345{2592, 2417}
Travel distance (X / Y / Z)	mm	-80~+415 / 780
Max. work size	mm	ϕ830 x 750
Max. work weight	kg	8000
ATC tool type	-	CAPTO C6
ATC tool storage capacity	ea	12
CNC system	-	FANUC 0iTF

*{ } : Option

SALES POINT

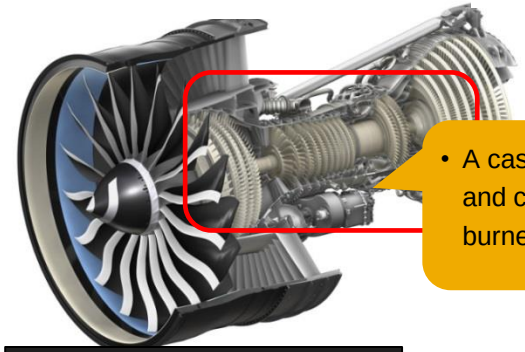
< Vertical turning center with max ϕ830mm workpiece machining>

- **Spindle**
  - **Spindle power Max. 37kW**
- **Axes**
  - **Box guide way structure for heavy duty cutting**
- **Bed**
  - **Slant-type base and improved flushing function for enhanced chip disposal**
- **Tool Post**
  - **Servo-driven turret of 12 Station Index**
  - **Servo Type ATC option for long boring bar**

AFT Inner & Engine Case

AFT Inner- Inconel

Engine Case- Titanium



- A case part of a Turbine where fuel and compressed air are mixed and burned in an aircraft engine..

PART INFORMATION

- **Customer : Korean Company Y and this company is vendor of engine part manufacturer H in Korea.**
- **Part : Engine Case Parts**
- **Material : Inconel and Titanium**
  - **The strong cutting force and structural stiffness of the machine are important**
  - **5 axis machining is required for complex shape**
- **Size : Ø700mm**
- **Equipment : DHF 8000**

FAQ

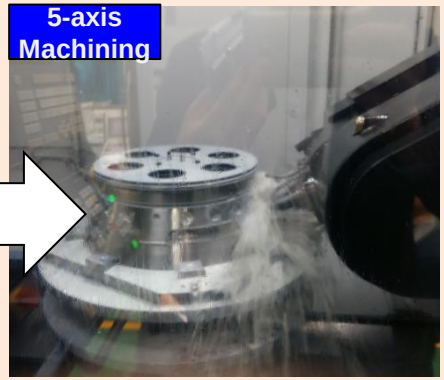
- What about dynamic offset and TWP?

- Dynamic offset corrects the setting position of the material, and TWP (Tilting Working Plane) is the function to process the slope

SOLUTION

Turning

5-axis Machining



- **Cycle time : 22 hour(Rough, Fine**
- **Inner & engine case upper hole(Tap) solution is required**
  - **Dynamic Offset sys. + TWP Function**
- **Macro function is required for rotating center setting**
  - **Touch Probe Option**

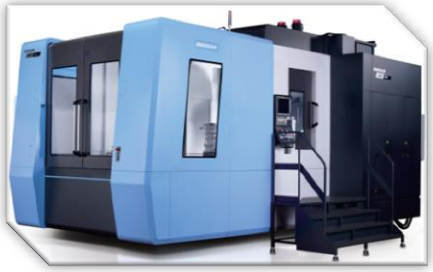
FAQ

Function can be processed even when the material is located at any position other than the center of the table

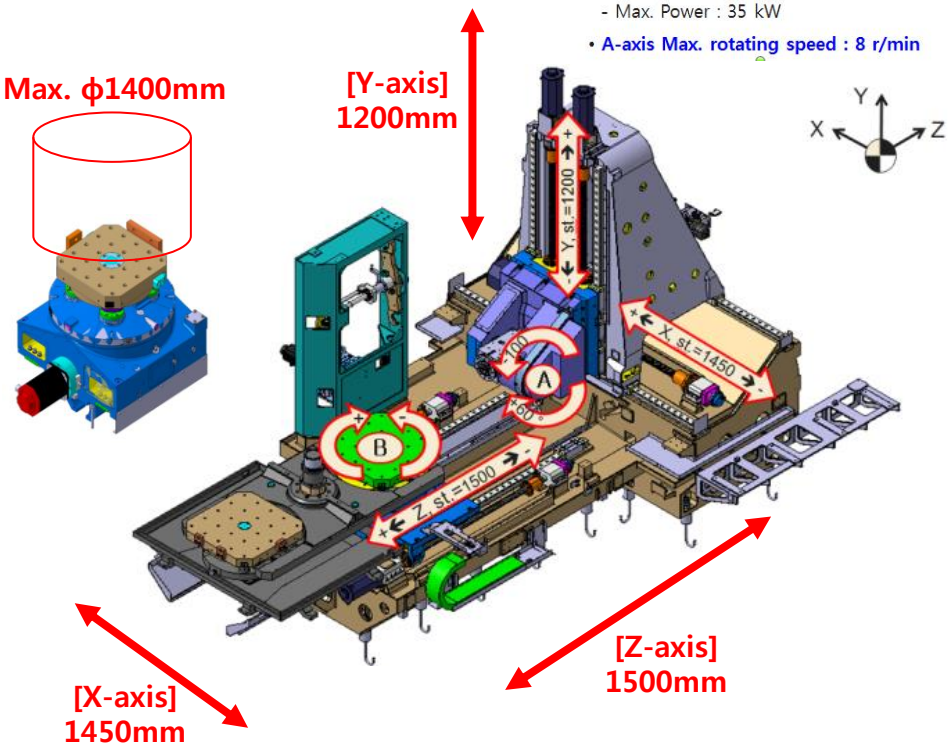
DHF 8000

FAQ

- When the 5-axis head is at Max speed, is the durability verified?
  - DHF8000 was released after enough Field Test and was tested in harsh conditions at max speed.



- Max. spindle speed : 6000 r/min
  - **Max. Torque : 960 N·m**
  - Max. Power : 35 kW
- **A-axis Max. rotating speed : 8 r/min**



SPECIFICATION

SPECIFICATION	UNIT	DHF 8000
Max. spindle speed	r/min	6000 {15000, 15000}*
Max. spindle motor power	kW	35 {86, 51}*
Max. spindle motor toque	N·m	960 {223, 147}*
Tool type	-	BT 50, HSK A100
Travel distance (X / Y / Z)	mm	1450 / 1200 / 1500
A-Axis stroke	deg	-100 ~ 60
Pallet Size	mm	800 x 800
Max. work size	mm	Ø1400 x H1400
Max. work weight	kg	2000
Tool storage capacity	ea	60 {90, 120, 150, 196 ~ 376}*
NC system	-	FANUC 31i-5 {SIEMENS 840D}*

SALES POINT

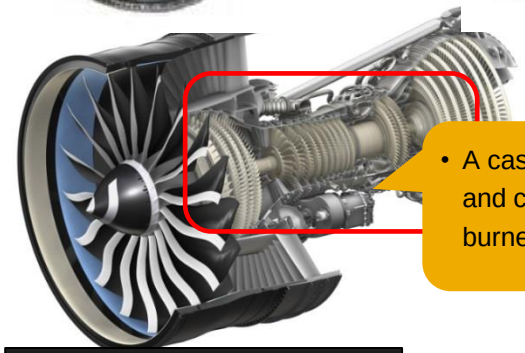
< Simultaneous 5-axis horizontal machining center with Max. Ø1400mm workpiece machining of aircraft parts >

- **Spindle**
  - **Powerful 6000r/min gear box type spindle for cutting hard part**
- **Axes**
  - **Y/Z-axis Dual Ball Screw**
  - **Ball screw nut & bearing cooling system**
  - **Linear scale**
- **Bed**
  - **Thermal displacement compensation for structure**
  - **Improved rear exit central through chip disposal**
  - **Reduced workpiece settings and unmanned operations by applying APC**

Engine Forward Case & Blisk

Forward Case - Inconel

Blisk - Titanium



- A case part of a Turbine where fuel and compressed air are mixed and burned in an aircraft engine..

PART INFORMATION

- **Customer : Korean Company H and this is vendor of Aircraft Engine Manufacturer R Company and P Company**
- **Part : Aircraft Engine Parts**
  - **The strong cutting force and structural stiffness of the machine are important**
- **Material : Inconel Titanium**
- **Size : Ø800mm**
- **Equipment : DHF 8000**

FAQ

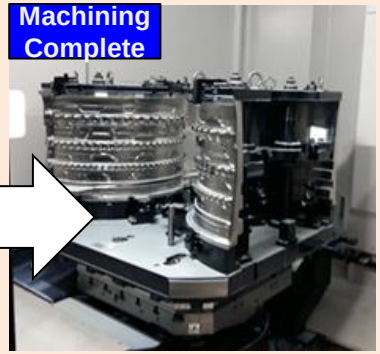
- What about dynamic offset and TWP?

- Dynamic offset corrects the setting position of the material, and TWP (Tilting Working Plane) is the function to process the slope

SOLUTION

Machining Processing

Machining Complete



- **Cycle time : 7~8 hour**
- **Inner & engine case upper hole(Tap) solution is required**
  - **Dynamic Offset sys. + TWP Function**
- **Macro function is required for rotating center setting**
  - **Touch Probe Option**

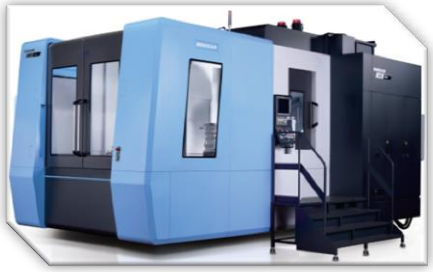
FAQ

Function can be processed even when the material is located at any position other than the center of the table

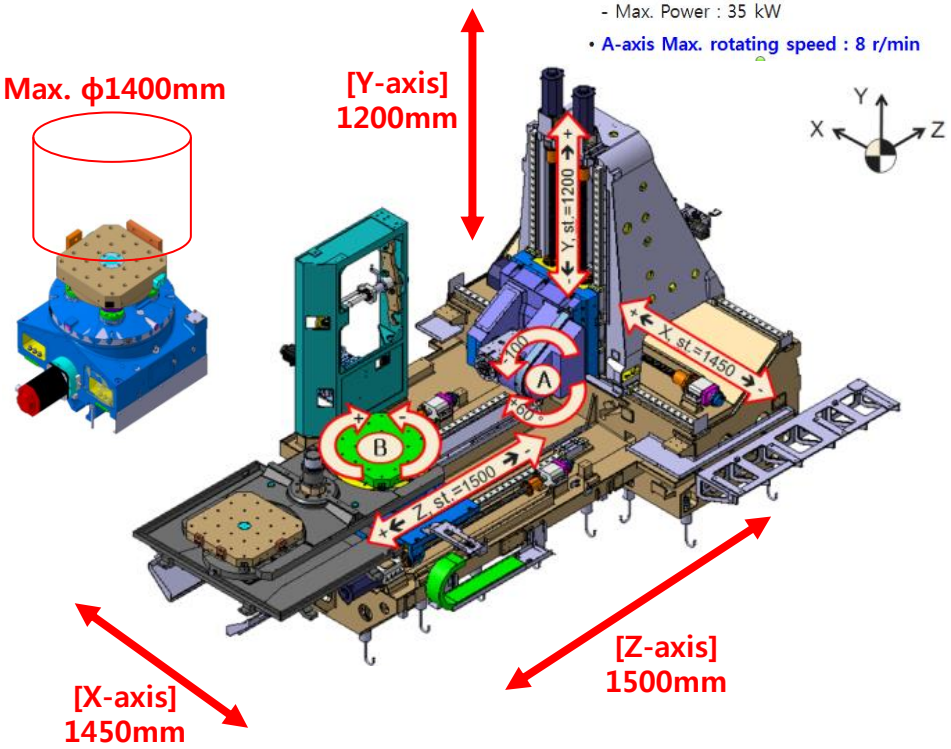
DHF 8000

FAQ

- When the 5-axis head is at Max speed, is the durability verified?
  - DHF8000 was released after enough Field Test and was tested in harsh conditions at max speed.



- Max. spindle speed : 6000 r/min
  - **Max. Torque : 960 N·m**
  - Max. Power : 35 kW
- **A-axis Max. rotating speed : 8 r/min**



SPECIFICATION

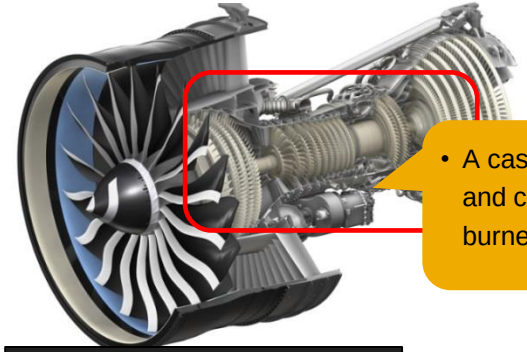
SPECIFICATION	UNIT	DHF 8000
Max. spindle speed	r/min	6000 {15000, 15000}*
Max. spindle motor power	kW	35 {86, 51}*
Max. spindle motor toque	N·m	960 {223, 147}*
Tool type	-	BT 50, HSK A100
Travel distance (X / Y / Z)	mm	1450 / 1200 / 1500
A-Axis stroke	deg	-100 ~ 60
Pallet Size	mm	800 x 800
Max. work size	mm	Ø1400 x H1400
Max. work weight	kg	2000
Tool storage capacity	ea	60 {90, 120, 150, 196 ~ 376}*
NC system	-	FANUC 31i-5 {SIEMENS 840D}*

SALES POINT

< Simultaneous 5-axis horizontal machining center with Max. Ø1400mm workpiece machining of aircraft parts >

- **Spindle**
  - **Powerful 6000r/min gear box type spindle for cutting hard part**
- **Axes**
  - **Y/Z-axis Dual Ball Screw**
  - **Ball screw nut & bearing cooling system**
  - **Linear scale**
- **Bed**
  - **Thermal displacement compensation for structure**
  - **Improved rear exit central through chip disposal**
  - **Reduced workpiece settings and unmanned operations by applying APC**

Engine Part



- A case part of a Turbine where fuel and compressed air are mixed and burned in an aircraft engine.

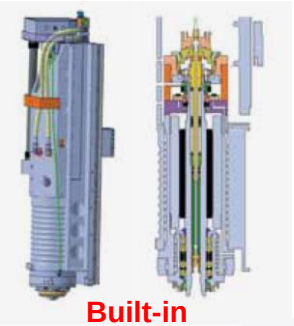
PART INFORMATION

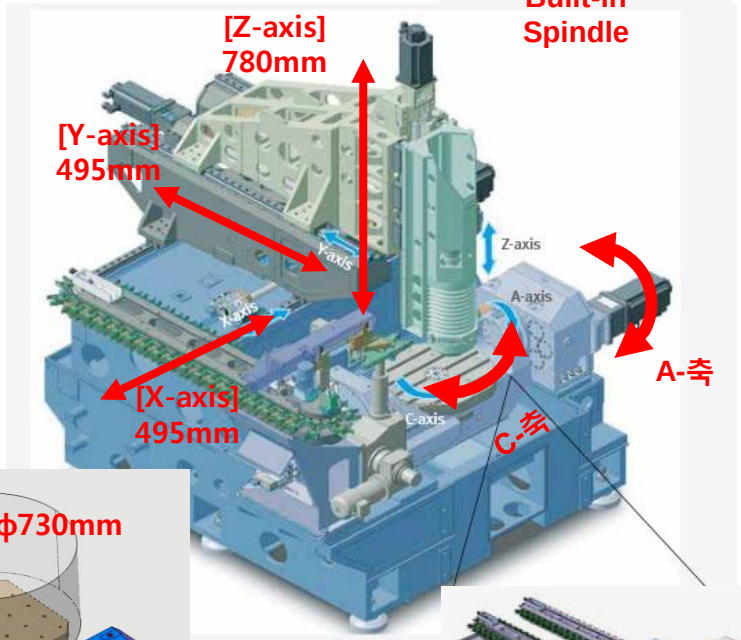
- **Customer : Turkish Company I is vendor of Aircraft Engine Manufacturer P Company**
- **Part : Aircraft Engine Parts**
- **Material : Inconel**
- **Size : Ø500mm**
- **Equipment : VC 630/5AX**

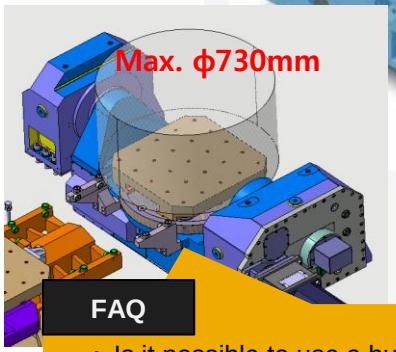
SOLUTION

Machining Complete

VC 630/5AX







FAQ

- Is it possible to use a built-in vacuum line on the table when machining parts?

- a built-in vacuum line is available as an option!

SPECIFICATION

SPECIFICATION	UNIT	VC 630/5AX
Max. spindle speed	r/min	12000
Max. spindle motor power	kW	22/18.5
Max. spindle motor toque	N·m	204
Tool type	-	BT40
Travel distance (X / Y / Z)	mm	650 / 765 / 520
Pallet Size	mm	ϕ630
Max. work size	mm	ϕ730
Max. work weight	kg	10000
A/C-axis stroke	deg	A : 150/ C 360
Tool storage capacity	ea	40 {60,81,101,121}*
CNC system	-	FANUC 31i-5 {Heidenhain TNC640/ SIEMENS 840D}*

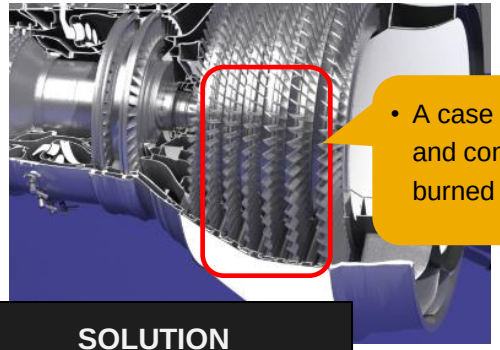
*{ } : Option

SALES POINT

< Simultaneous 5-axis machining center with Max. Ø730mm workpiece machining >

- **Spindle**
  - **Built-in type spindle for high-speed machining at 12000r/min**
- **Axes**
  - **Roller LM Guide Way for high speed machining**
- **Bed**
  - **5 Point Thermal displacement compensation**
- **Option**
  - **Max. 121 Tools applicable**
  - **Linear scale**

Air Foil(Engine Blade)



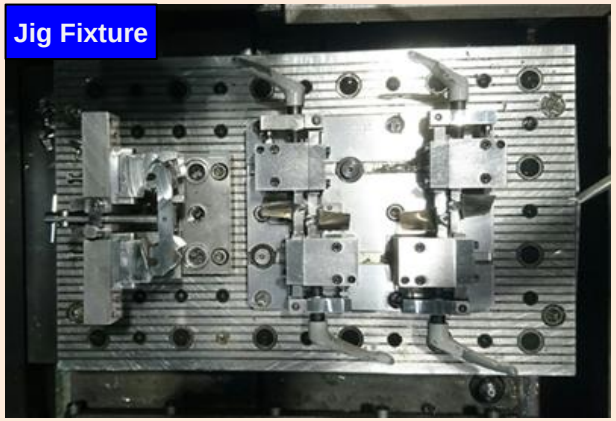
- A case part of a Turbine where fuel and compressed air are mixed and burned in an aircraft engine.

PART INFORMATION

- **Customer : UK Aircraft Engine Manufacturer R Company**
- **Part : Aircraft Engine Blade Parts**
  - **The strong cutting force and structural stiffness of the machine are important**
- **Material : Inconel 718**
- **Size : 50mm**
- **Equipment : VC 510**

SOLUTION

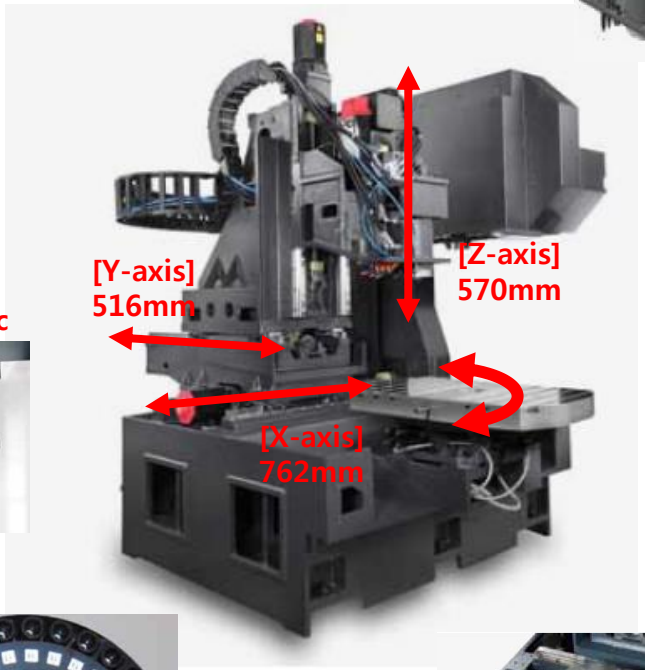
Jig Fixture



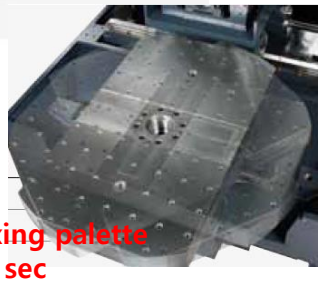
- **Option**
  - **Drum filtration coolant system**
  - **Machine ATC guard modified to take over size tool Ø200mm**
- **Tooling**
  - **Machine overall Length to size Ø200mm x 4mm Grinding Wheel**
  - **Scallop Mill Roughing R31,4MM RH Seco Tool**
  - **Finish Mill Scallop 10mm x R1,7mm Technicut R/H EndMill**
  - **Chamfer 8MM X 45 DEG Iscar Chamfer Tool**

VC 510

10000r/min
Direct-coupled spindle



ATC
T-T-T 1.3 sec



Rapid indexing palette
5.5 sec

SPECIFICATION

SPECIFICATION	UNIT	VC 510
Max. spindle speed	r/min	10000
Max. spindle motor power	kW	18.5/15
Max. spindle motor toque	N·m	117.7 {191.1, 167.6}*
Tool type	-	BT 40{CAT40, DIN40}
Travel distance (X / Y / Z)	mm	762 / 516 / 570
Number of pallet	ea	2
Pallet Size	mm	2-860 x 570
Max. work size	mm	860 x 570
Max. work weight	kg	2-350
Tool storage capacity	ea	30 {40}*
CNC system	-	FANUC 0iTF

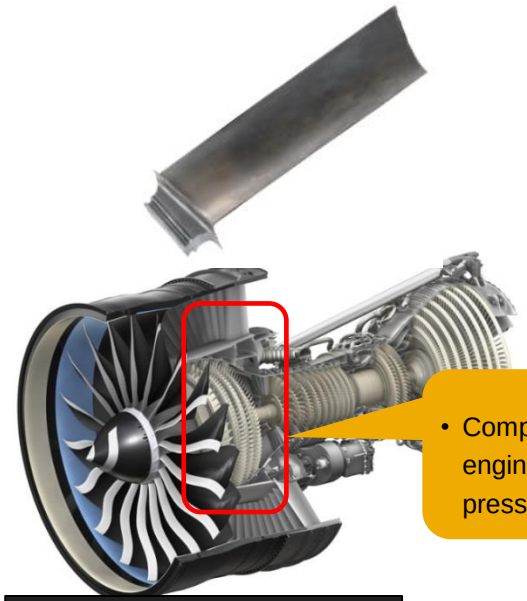
*{ } : Option

SALES POINT

< High productivity machining center equipped with dual pallet >

- **Spindle**
  - **All direct-coupled spindle for high speed**
- **Axes**
  - **3-axis column moving structure suitable for mass production line**
  - **Roller LM Guide Way structure for high-speed and high-speed cutting**
- **Bed**
  - **Rapid indexing palette with rack & pinion drive reduces non-cutting time**

Engine Fan Blade

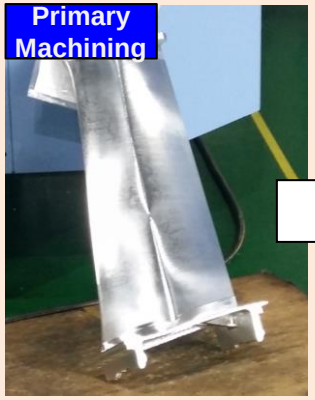


- Compressor parts in the aircraft engine compress air to high pressure..

PART INFORMATION

- **Customer : Korean Company Y is vendor of Aircraft Engine Manufacturer P Company**
- **Part : Aircraft Engine Blade**
- **Material : 7075 Aluminum**
- **Size : 300 x 700mm**
- **Equipment : VC 630/5AX**
  - **Primary Machining Machine : HMC(NHP)**

SOLUTION

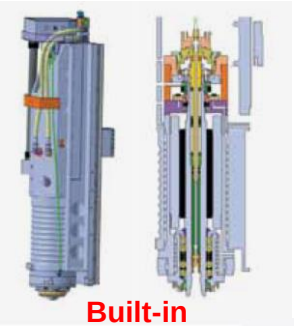


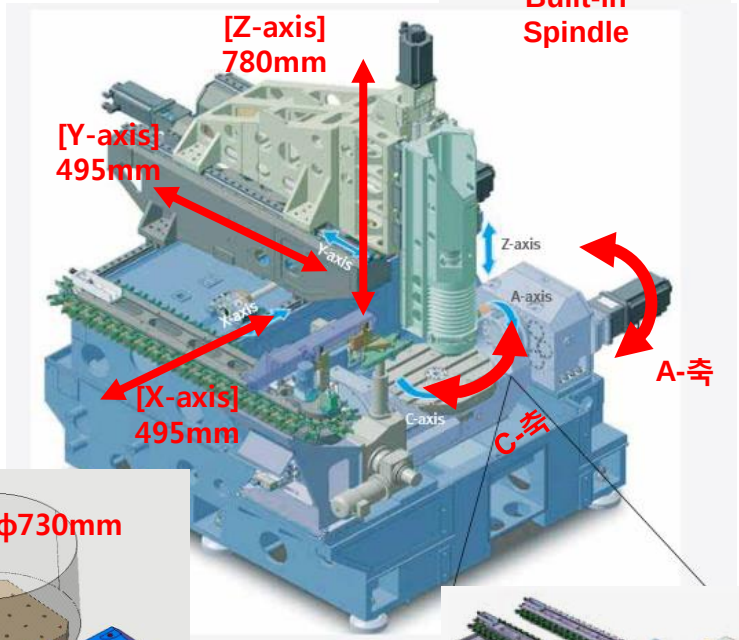
- **Process**
  - **Primary Machining : NHP6300**
  - **Second Machining : VC630/5AX**
  - **7 Steps Process**
  - **3 Steps Process is available**
- **Fixture : Pay Attention to Deformation of Workpiece**

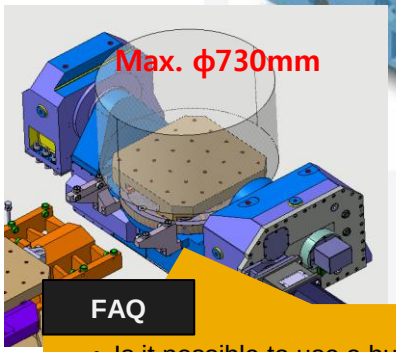
FAQ

- Why does deformation occur during machining?
  - Depending on the processing, the thickness of the material is thinned and deformed by the heat of processing

VC 630/5AX







FAQ

- Is it possible to use a built-in vacuum line on the table when machining parts?

- a built-in vacuum line is available as an option!

SPECIFICATION

SPECIFICATION	UNIT	VC 630/5AX
Max. spindle speed	r/min	12000
Max. spindle motor power	kW	22/18.5
Max. spindle motor toque	N·m	204
Tool type	-	BT40
Travel distance (X / Y / Z)	mm	650 / 765 / 520
Pallet Size	mm	ϕ630
Max. work size	mm	ϕ730
Max. work weight	kg	10000
A/C-axis stroke	deg	A : 150/ C 360
Tool storage capacity	ea	40 {60,81,101,121}*
CNC system	-	FANUC 31i-5 {Heidenhain TNC640/ SIEMENS 840D}*

*{ } : Option

SALES POINT

< Simultaneous 5-axis machining center with Max. Ø730mm workpiece machining >

- **Spindle**
  - **Built-in type spindle for high-speed machining at 12000r/min**
- **Axes**
  - **Roller LM Guide Way for high speed machining**
- **Bed**
  - **5 Point Thermal displacement compensation**
- **Option**
  - **Max. 121 Tools applicable**
  - **Linear scale**

Solution
Landing Gear Parts

BEAM

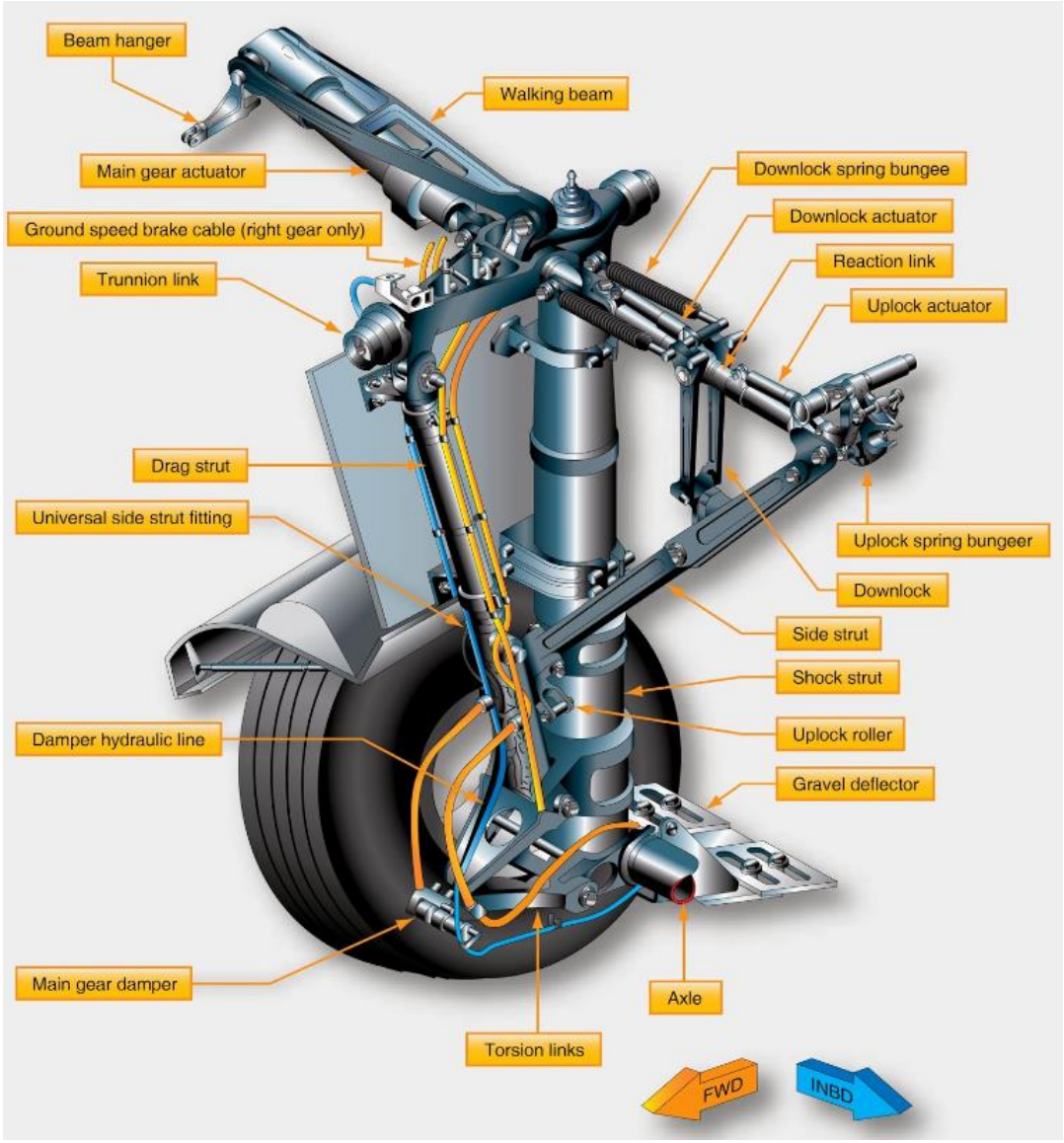
Customer L1

Customer L2

DISK

Customer L3

Aircraft Landing Gear Structure



Landing Gear Pylon

- Aircraft landing gear pylon parts.

PART INFORMATION

- **Customer : UK Company M**
- **Part : Pilot parts connected to the aircraft landing gear strut**
  - **Robust machine structure and spindle specifications are required to process titanium forgings**
- **Material : Titanium Forging**
- **Size : Ø380mm**
- **Equipment : Mynx 9500**

SOLUTION

Slotting

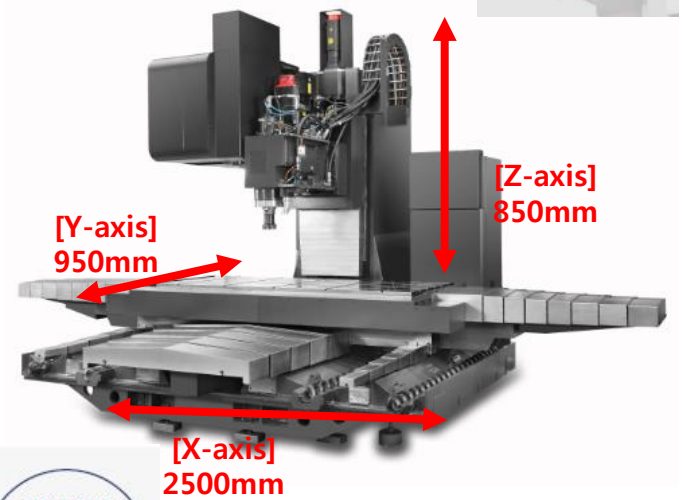
FAQ

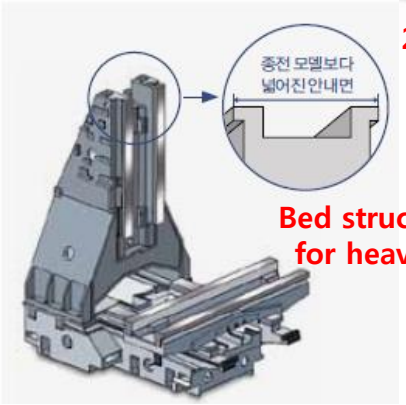
- Machining RPM too low
  - As the tool size increases, the tip cutting speed (Vc) increases, and the rotation speed becomes relatively low.

- **Tooling**
  - **Kennametal Ø380mm Slotting Cutter**
  - **Width: 15mm (2 x 5mm by 45 Deg) Inserts**
  - **8 Effective teeth, staggered top, middle & bottom**
  - **24 inserts in total**
- **Machining Condition**
  - **Speed: 34 RPM**
  - **Feed: 60mm/Min**
  - **Required Torque 450Nm**

Mynx 9500

6000r/min
Gear-driven spindle





Bed structure optimized
for heavy-duty cutting

SPECIFICATION

SPECIFICATION	UNIT	Mynx 9500
Max. spindle speed	r/min	6000{10000}*
Max. spindle motor power	kW	30/18.5{30/25}*
Max. spindle motor toque	N·m	617.4{420}
Tool type	-	BT 50
Travel distance (X / Y / Z)	mm	2500 / 950 / 850
Pallet Size	mm	2500 x 950
Max. work size	mm	2500 x 950
Max. work weight	kg	3500
Tool storage capacity	ea	30 {40}*
CNC system	-	FANUC 0iMF {Heidenhain TNC620, Siemens S828D}

*{ } : Option

SALES POINT

< Powerful vertical machining center suitable for heavy-duty cutting >

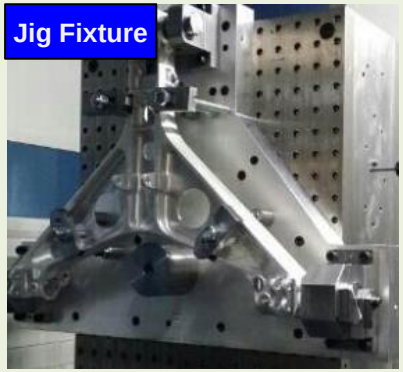
- **Spindle**
  - **High torque 2 step gear driven spindle for heavy-duty cutting**
- **Axes**
  - **Powerful and heavy-duty cutting enabled with the box guide ways on all axes**
- **Bed**
  - **High Durability and Stable Accuracy Achieved by Arch-type design**
  - **Thermal displacement compensation as a Standard**

Support Component

PART INFORMATION

- **Customer : French Company A**
- **Part : Aircraft Landing Gear Support Parts**
- **Material : Titanium**
- **Size : 800 x 800mm**
- **Equipment : NHP 8000**
  - **Horizontal machining center with excellent chip disposal ability due to large amount of chip generated by structure processing is suitable**

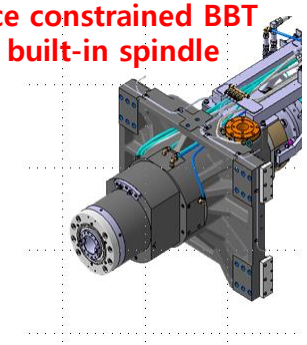
SOLUTION

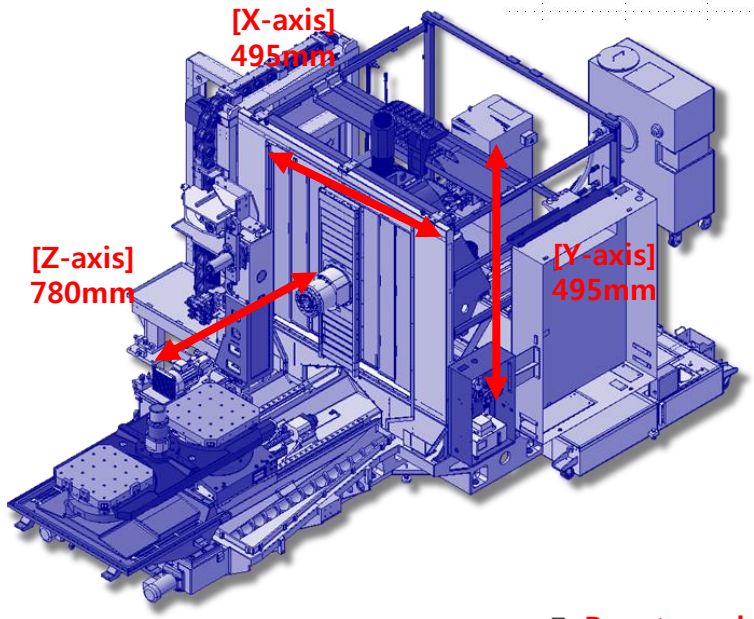


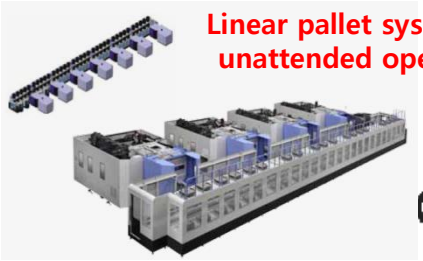
- **High Pressure Coolant (70bar)**
- **HM Series is recommended (Gear Box SPD for High Torque)**

NHP 8000

Two-face constrained BBT
And built-in spindle

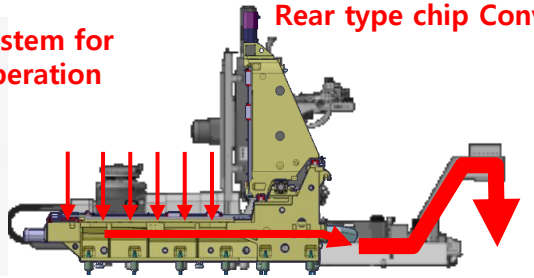






Linear pallet system for
unattended operation

Rear type chip Conveyor



SPECIFICATION

SPECIFICATION	UNIT	NHP 8000
Max. spindle speed	r/min	10000{6000, 15000}*
Max. spindle motor power	kW	45
Max. spindle motor toque	N·m	600{809, 398}*
Tool type	-	BT 50{CAT50, DIN50, HSK-A100}*
Travel distance (X / Y / Z)	mm	1400 / 1200 / 1370
Number of pallet	ea	2
Pallet Size	mm	2-800 x 800
Max. work size	mm	800 x 800
Max. work weight	kg	2000
Tool storage capacity	ea	40{60, 90, 120, 150,….,376}*
CNC system	-	FANUC 31iMF {Siemens S840D}

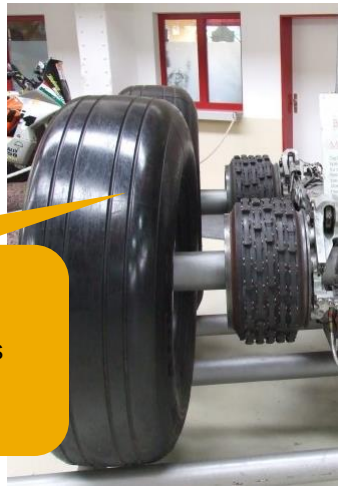
*{ } : Option

SALES POINT

< High Speed/Productivity Horizontal Machining Center >

- **Spindle**
  - **Built-in type spindle for high-speed machining**
- **Axes**
  - **Roller LM Guide Way for high speed machining**
  - **Ball screw nut & bearing cooling system**
- **Bed**
  - **Improved stiffness with integrated bed structure and step guide**
- **Option**
  - **Rear type chip Conveyor adaptive to chip disposal for automatic system**
  - **Linear pallet system option for unattended operation**

Brake Disk



- Aircraft Brake Disc
- Why use carbon materials?
  - It is lighter than ordinary cast iron, has higher coefficient of friction and less thermal deformation

PART INFORMATION

- **Customer : French Landing Gear Manufacturer S Company**
- **Part : Landing Gear Brake Disk**
- **Material : Carbon**
- **Size : Ø500mm**
- **Equipment : PUMA V8300 + DNM 6700 + Robot**

FAQ

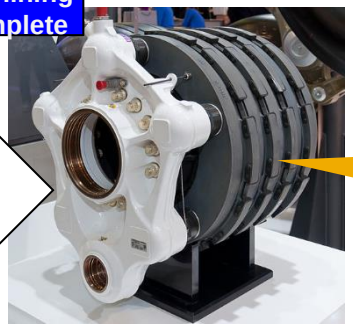
What is a PCD tool?
- PCD (Poly Crystalline Diamond) is an insert tool made of diamond sintered body

SOLUTION

- **Tool : PCD Tool**

Raw Material

Machining Complete

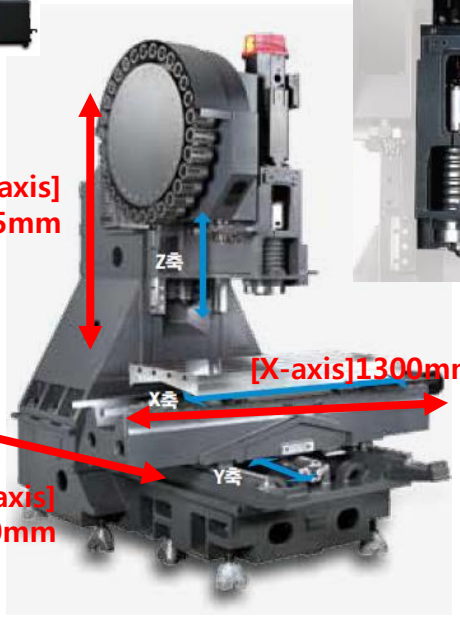


FAQ

- What are the equipment specifications for carbon processing?
  - Slide cover of machine body should be changed to bellows type and mist collector should be installed separately.

DNM 6700

Direct-coupled spindle



SPECIFICATION

SPECIFICATION	UNIT	DNM 6700
Max. spindle speed	r/min	8000{12000}
Max. spindle motor power	kW	18.5{15}**
Max. spindle motor toque	N·m	118{286}**
Tool type	-	BT 40{CAT40, DIN40}
Travel distance (X / Y / Z)	mm	1300 / 670 / 625
Pallet Size	mm	1500 x 670
Max. work size	mm	1500 x 670
Max. work weight	kg	1300
Tool storage capacity	개	30 {40}*
CNC system	-	FANUC 0iMF {Heidenhain TNC620, Siemens S828D}

*{ } : Option

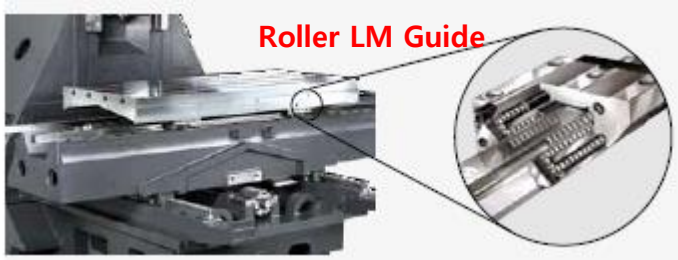
SALES POINT

< 3-axis machining center for high speed machining >

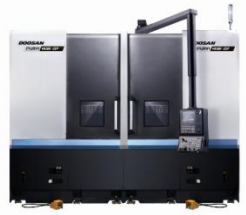
- **Spindle**
  - **8000 or 12000r/min all direct-coupled spindle**
  - **Excellent vibration and noise compared to belt driven type**

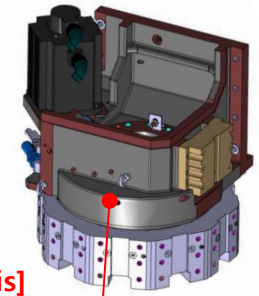
- **Axes**
  - **Roller LM Guide Way for high speed machining**

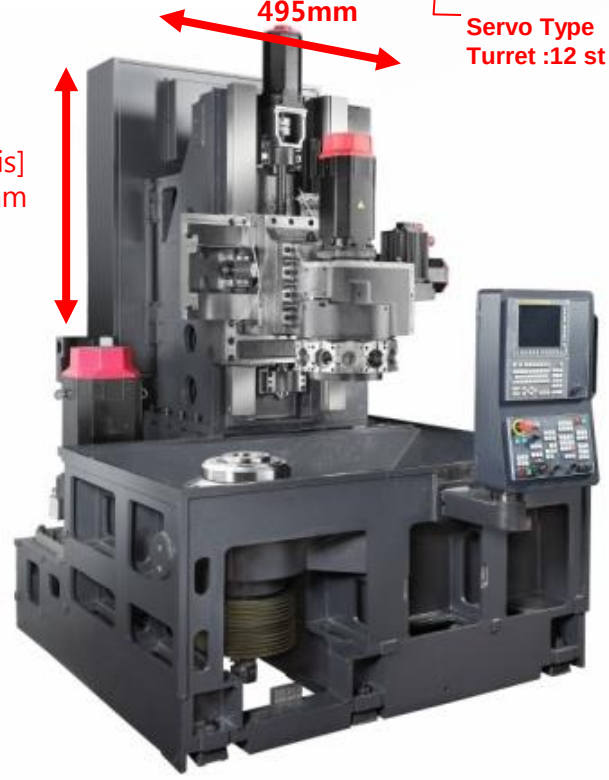
30Tool Standard



PUMA V8300







SPECIFICATION

SPECIFICATION	UNIT	PUMA V8300
Chuck size	inch	15{18, 21, 24}*
Max. spindle speed	r/min	2000
Max. spindle motor power	kW	30/22{37/30,45/37}*
Max. spindle motor toque	N·m	1345{2592, 2417}
Travel distance (X / Y / Z)	mm	-80~+415 / 780
Max. work size	mm	ϕ830 x 750
Max. work weight	kg	8000
ATC tool type	-	CAPTO C6
ATC tool storage capacity	ea	12
CNC system	-	FANUC 0iTF

*{ } : Option

SALES POINT

< Vertical turning center with max ϕ830mm workpiece machining>

- **Spindle**
  - **Spindle power Max. 37kW**
- **Axes**
  - **Box guide way structure for heavy duty cutting**
- **Bed**
  - **Slant-type base and improved flushing function for enhanced chip disposal**
- **Tool Post**
  - **Servo-driven turret of 12 Station Index**
  - **Servo Type ATC option for long boring bar**

Table of Contents

Cooperation_Reference Collection

Cooperation of dealers is required for aerospace roll-out as below.

Item	Detailed Description
Purpose	• Collecting aerospace reference so that they can be used for sales to aerospace customers is required
Collector	• Doosan Sales Men, Dealers
What info to collect	• Collected Information –Customer Name –Target Product : Aircraft Structure/ Engine –Main Buyer: Boeing, Airbus, Bombardier….. –Doosan Models in Customer Site : Model Name, Spindle Specification –Workpiece Machined by Doosan Models : Name of Workpiece, Material and Picture of it –FAQ : Customer's Questions regarding Our Machines ※ Sensitive information (customer name, major customer, processed product picture) will be edited so that there is no legal issues
How to Reply	• Contact –GKAM Team : Shin Jeon shin.jeon@doosanmt.com –Marketing Team : Jongwon Yoo jongwon.yoo@doosanmt.com

E.O.D