



Doosan Machine Tools

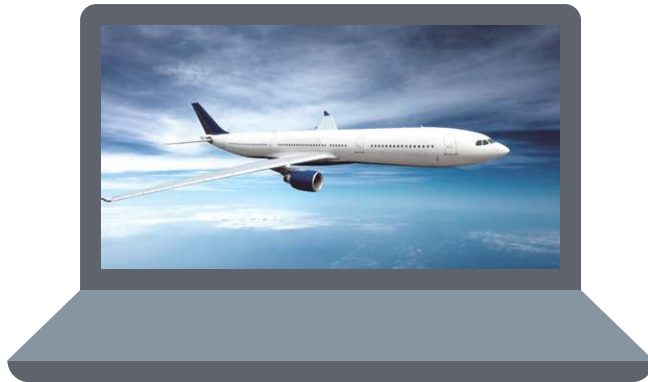
Doosan ***Aerospace Solution*** ***Reference***

ver. EN 210510 SU

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INTRO

Two kinds of story will be spoken at this section,
It include the future and optimal solutions in aerospace industry



FUTURE

The growth beyond our expecting will be come truth. If you ignore the signal of the future, you can't grab your opportunities. It's time to know and learn the future exactly.



SOLUTION

What do you do for the future? What can you do for the future? There are answers of these questions. There are optimal solutions for the future.

Future Opportunity of Aerospace Industry

Older and less efficient airplanes will be replaced with more efficient, newer generation airplanes.
During the shift in the generation, companies can grasp more opportunity to grow further.

Intro

Structural

Body
Tail
Wing
Component

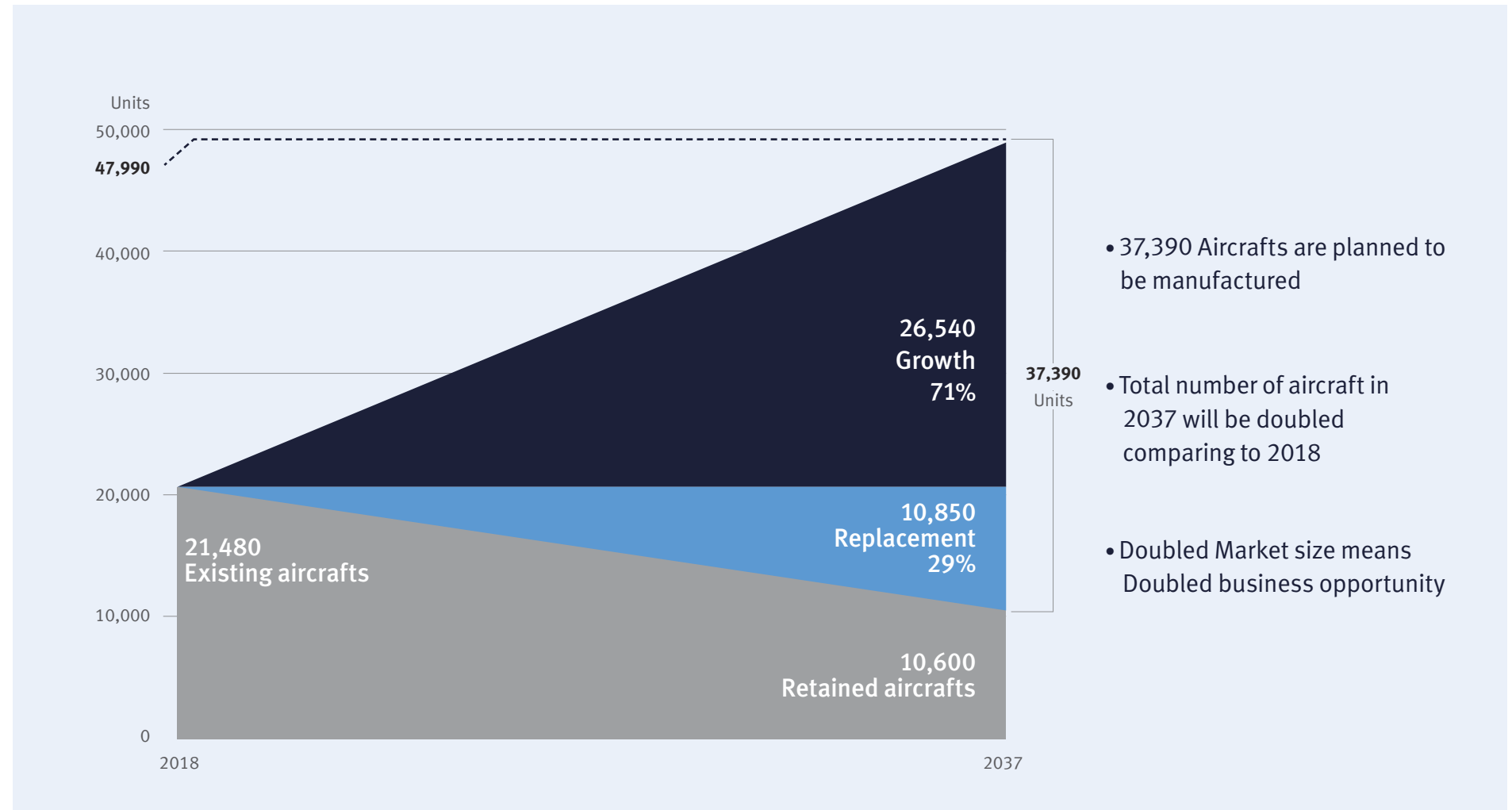
Engine

Case
Blade

Landing Gear

Beam
Disk

Appendix



Source: Airbus Global Market Forecast

Need for various solution in aerospace Industry

Intro

Structural

Body
Tail
Wing
Component

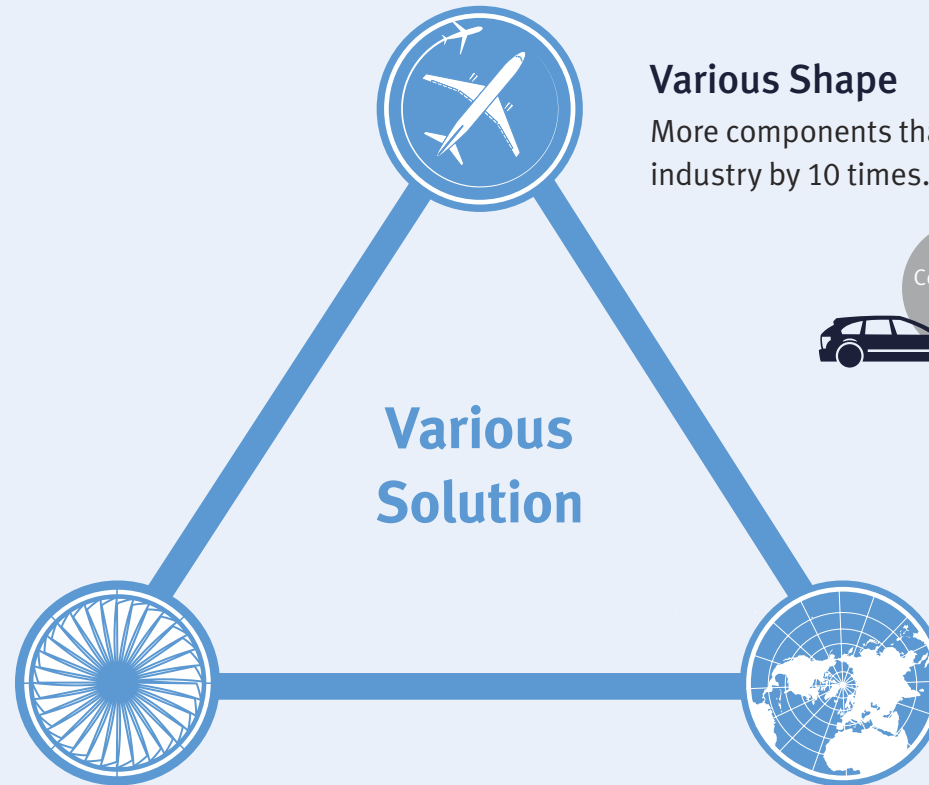
Engine

Case
Blade

Landing Gear

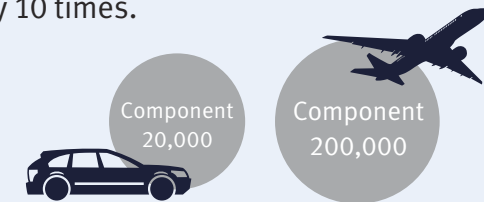
Beam
Disk

Appendix



Various Shape

More components than automotive industry by 10 times.



10Times

Various Material

Difficult-to-cut Material(Titanium, Aluminum, Inconel, CFRP) become main material more and more

Difficult-to-cut Material

70%

30%

General Material

70%

Various Reference

One defective product can cause a huge calamity Qualified machine and diverse experience is required



Doosan Machine Tools Capability in Aerospace Industry

Intro

Structural

Body
Tail
Wing
Component

Engine

Case
Blade

Landing Gear

Beam
Disk

Appendix

For Various Shape

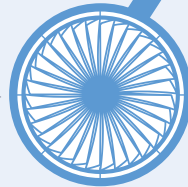
Doosan Machine Tools has to meet demands in aerospace industry.



450 Models



**Various
Solution**



For Various Material

Doosan Machine Tools has exceptional solution for difficult-to-material from diverse experience and R&D capability

450 R&D researchers



For Various Reference

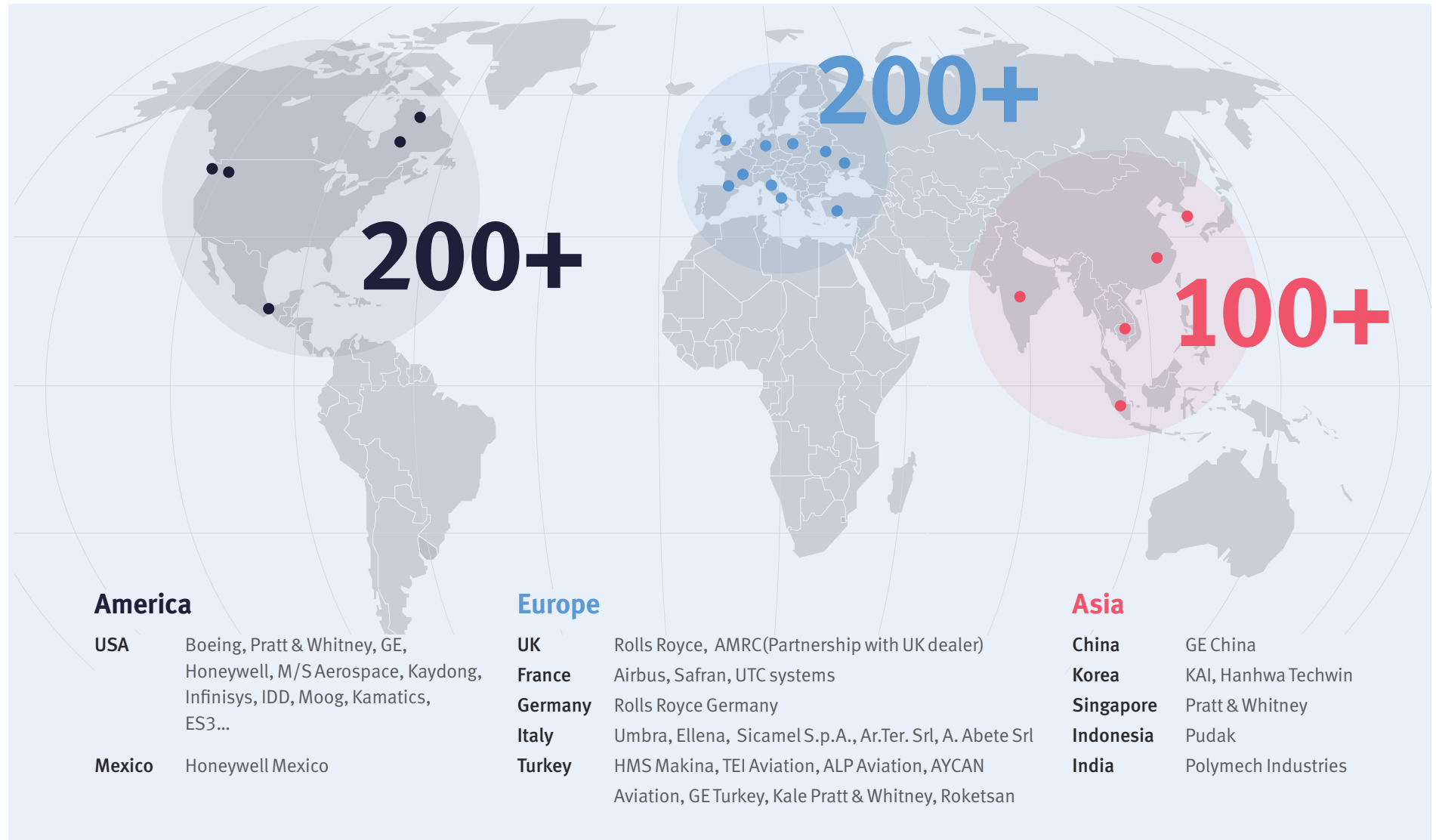
Most leading company and their partners choose Doosan Machine Tools



500+
aerospace customers
in the world



Doosan's global top-tier customers



Partnership to improve Aerospace solution

Intro

Structural

Body
Tail
Wing
Component

Engine

Case
Blade

Landing Gear

Beam
Disk

Appendix



Doosan's UK dealer MILLS CNC join AMRC

"These are exciting times for Mills CNC. We're delighted to have become part of the AMRC and to be involved, right from the outset, in such a high-profile and important manufacturing project"

Managing director Kevin Gilbert



AMRC(Advanced Manufacturing Research Centre)

"A world-class centre for advanced manufacturing research"

- Specialises in carrying out world-leading research into advanced machining, manufacturing and materials, which is of practical use to industry
- Partner for global giants like Boeing, Rolls-Royce, BAE Systems and Airbus
- 500 highly qualified researchers and engineers from around the globe

Two Doosan machines on AMRC



PUMA TT 1800SY



DNM 6700



MILLS CNC magazine article



Machine on the AMRC site

Specification of Aerospace Parts

Intro

Structural

Body
Tail
Wing
Component

Engine

Case
Blade

Landing Gear

Beam
Disk

Appendix



Structural Parts

BODY

Aircraft Door Hinge
Aircraft Body Bone

Component

Various Components
Main Rotor(Helicopter)

Tail

Tail Hanger
Frame
In-flight tanker part

WING

Rib Support



Engine Parts

Case

Engine Case
Turbine Disk
Engine AFT Inner
Engine Forward Case
Blisk
Engine part
Engine casing

Blade

Aerofoil (Engine Blade)
Engine Fan Blade
Geared Turbo Fan



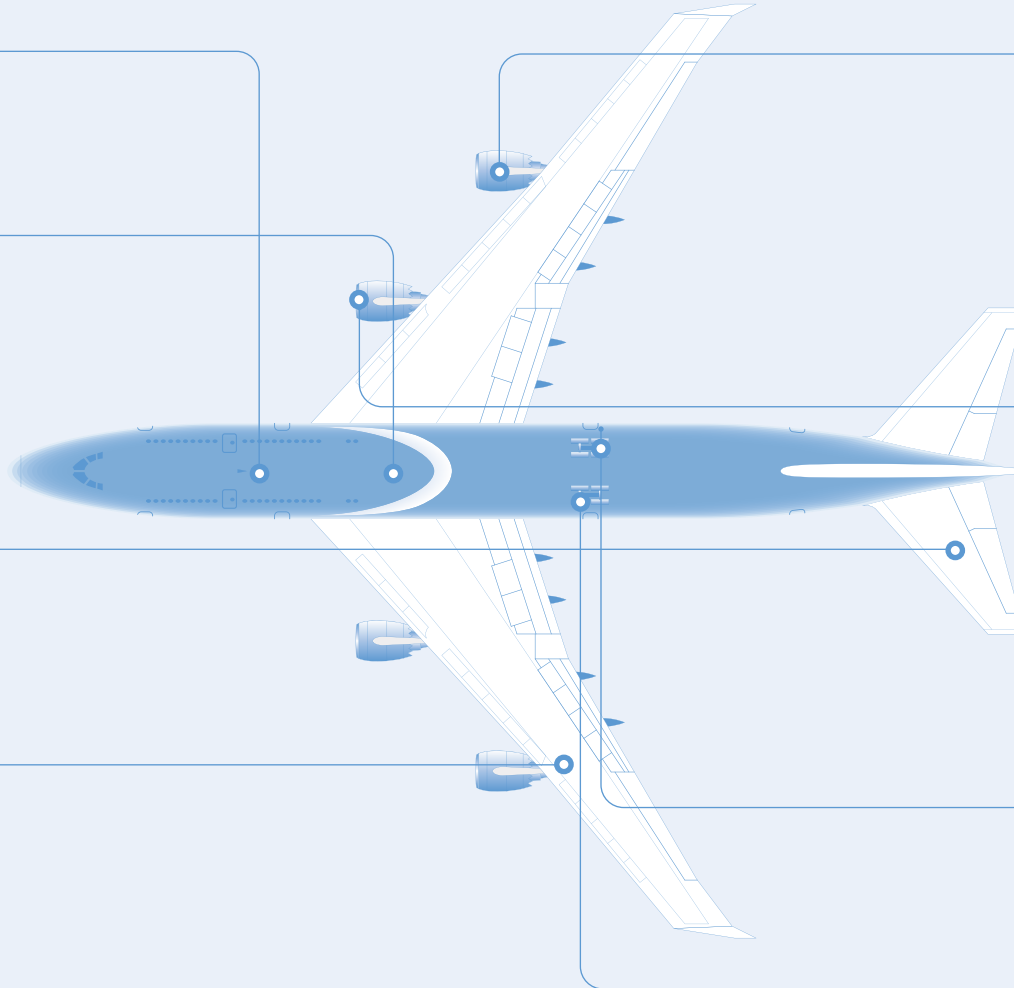
Landing Gear Parts

Beam

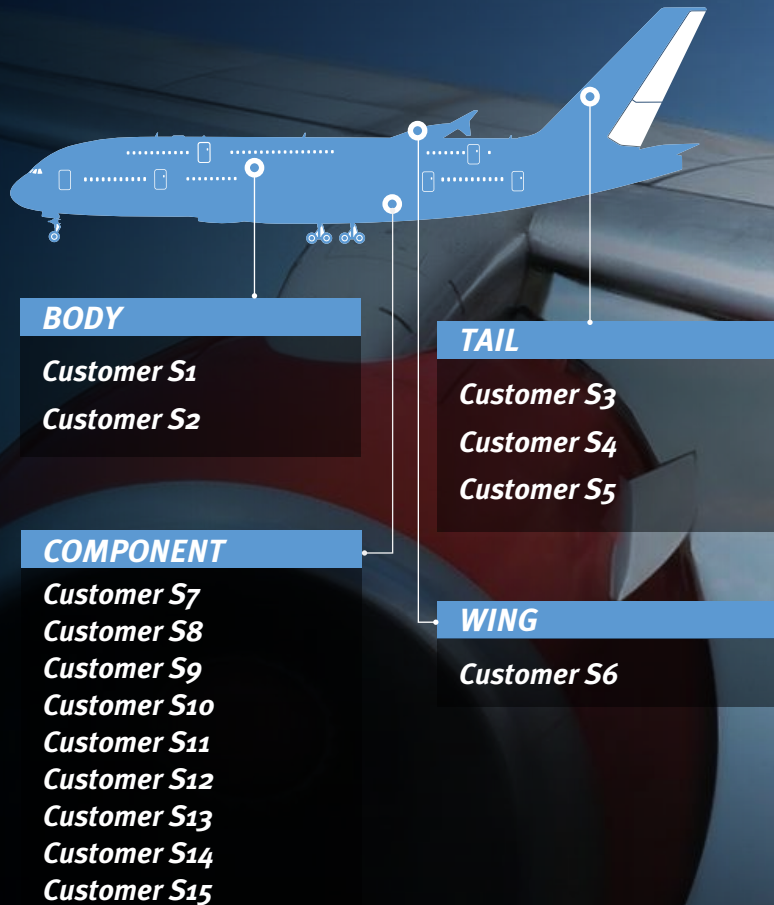
Landing Gear Pylon
Support

Disk

Brake Disk



Solution Structural Parts



Customer S1

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

Customer Request

More Economical Solution than a Company

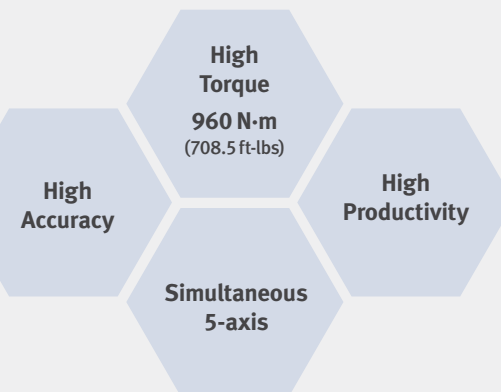
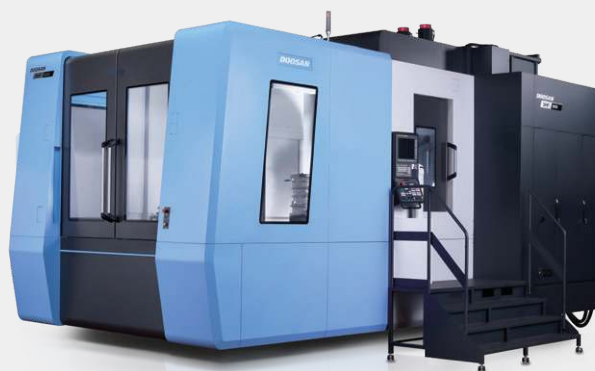
Guarantee Accuracy

Curved Workpiece

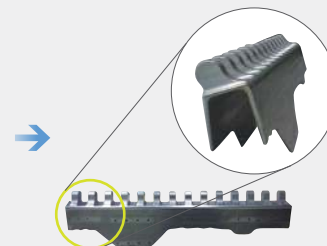
Solution

DHF 8000

Simultaneous 5-axis Horizontal Machining Center



Machining Process



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 DHF 8000. 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

Process	Tooling	Cutting Condition
Roughing	Ø42 mm (Ø1.7 inch) Insert Mill	700mm/min (27.6 ipm), 400r/min
Semi-finishing	Ø20 x R3.0 mm (Ø0.8 x R0.1 inch) End mill	600mm/min (23.6 ipm), 1200/min
Finishing	Ø20 mm (Ø0.8 inch) End mill (45° 6 blades)	150mm/min (5.9 ipm), 250/min

Customer S2

Intro

Structural

Body

Tail

Wing

Component

Engine

Case

Blade

Landing Gear

Beam

Disk

Appendix

Workpiece

Aircraft Body Bone



Size

2850 x 850 mm (112.2 x 33.5 inch)

Material

Aluminum

Customer Request

Large size Workpiece

Curved Shape

Universal Spindle

Solution

BM 2740U

Simultaneous 5-axis Universal Head Attached Bridge type Machining Center



30000 r/min

Large size
Table
4000 x 2500 mm
(157.5 x 98.4 inch)

Simultaneous
5-axis

Various Spindle Line-up

Speed

**12000~
30000 r/min**

Power

30 ~ 75 kW
(40.2 ~ 100.6 Hp)

Torque

143 ~ 48 N·m
(105.5 ~ 35.4 ft-lbs)



Better Chip Disposal



High Pressure TSC 7MPa (70 bar)

Workpiece

Tail Hanger



Size

1000 x 1000 mm (39.4 x 39.4 inch)

Material

Aluminum

Customer Request

Guarantee Productivity

High Torque Boring

Compact Working Area

Solution

DBC 110S

Column Moving Type Boring Machine



Compact
Size

Boring
3000 r/min

High
Torque
1273 N·m
(939.5 ft-lbs)

Various Spindle Line-up

Torque

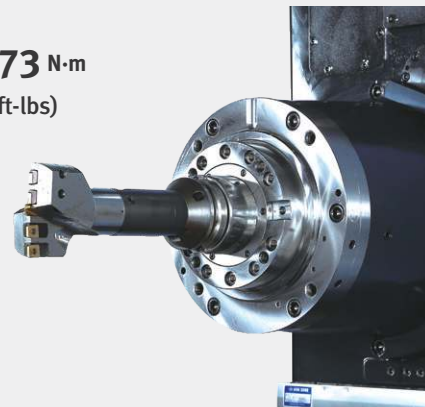
1137 / 1273 N·m
(839.1 / 939.5 ft-lbs)

Power

26 kW
(34.9 Hp)

Speed

3000 r/min



Working Area

Travel (X / Y / Z / W)

2000 / 1500 / 1200 / 500 mm
(78.7 / 59.1 / 47.2 / 19.7 inch)

Table Size

1400 x 1600 mm
(55.1 x 63.0 inch)

Customer S4

Intro

Structural

Body
Tail
Wing
Component

Engine

Case
Blade

Landing Gear

Beam
Disk

Appendix

Workpiece

Frame



Size
1550 mm (61.0 inch)

Material
Titanium

Customer Request

Guarantee Productivity

Heavy Duty Machine

480pcs/Year

Solution

VM 960

Vertical Machining center

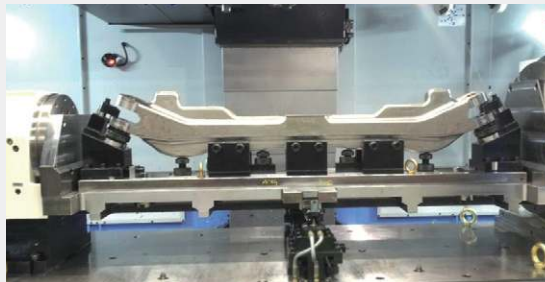


High Rigidity

Box
Guideway

High Torque
826N·m
(609.6 ft-lbs)

Additional 4th axis

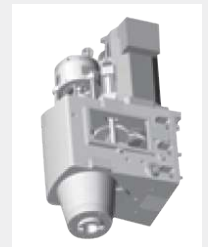


High Torque Spindle

Speed
6000 r/min

Power
26 kW (34.9 Hp)

Torque
825.9 N·m (609.5 ft-lb)



Workpiece

In-flight tanker part



Size
430 x 180 mm (16.9 X 7.1 inch)

Material
CRES

Customer Request

- High Productivity
- Complex Shaped Workpiece
- Precision part

Solution

VC 630/5AX

Simultaneous 5-axis Vertical Machining center



- High Rigidity Design
- Simultaneous 5-axis
- High Accuracy

High Speed Built-in Spindle

Max. spindle speed
12000 r/min
(20000r/min **option**)

Good for High Speed Solution

- Low centrifugal force
- Minimum heat generation



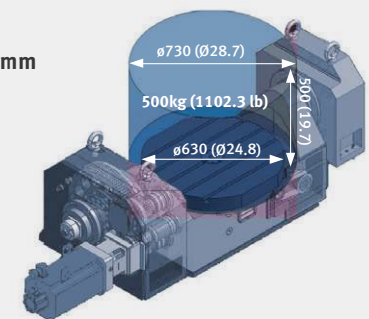
Response to Various size Workpieces

Max. size
Ø730 x 500 mm
(Ø28.7 x 19.7 inch)

Max. Weight
500 kg
(1102.3 lb)

From Big to Small

- Machining a variety of workpieces by single machine



Customer S6

Intro

Structural

Body

Tail

Wing

Component

Engine

Case

Blade

Landing Gear

Beam

Disk

Appendix

Workpiece

Rib Support



Size

1000 x 1700 x 60 mm
(39.4 x 66.9 x 2.4 inch)

Material

Aluminum

Customer Request

High Productivity

Large Working Area

High Speed Machining

Solution

BM 2035

Bridge type Machining Center for General Parts

Large size
Table
3000 x 1850 mm
(118.1 x 72.8 inch)

High
Productivity

30000 r/min



For High-speed Machining

Max. Spindle Speed

30000 r/min

Machining Process

27500 r/min

11050 mm/min (435.0 ipm)



For Large Workpiece

Table Size

3500 x 1850 mm (137.8 x 72.8 inch)

Max. Weight on Table

10000 kg (22045.9 lb)



Workpiece

Various Components



Size
Various

Material
Steel, Aluminum, Titanium

Customer Request

- High Productivity
- Complex Shaped Workpiece
- Precision Parts

Solution

VC 630/5AX

Simultaneous 5-axis Vertical Machining Center



20000 r/min

High
Rigidity
Design

Simultaneous
5-axis

High Speed Built-in Spindle

Max. Spindle Speed
12000 r/min
(20000r/min **option**)

Good for High Speed Solution

- Low centrifugal force
- Minimum heat generation



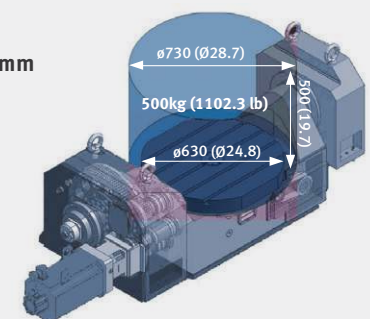
Response to Various size Workpieces

Max. Size
ø730 x 500 mm
(ø28.7 x 19.7 inch)

Max. Weight
500 kg
(1102.3 lb)

From Big to Small

- Machining a variety of workpieces by single machine



Customer S8

Intro

Structural

Body

Tail

Wing

Component

Engine

Case

Blade

Landing Gear

Beam

Disk

Appendix

Workpiece

Various Components



Size

Various

Material

Steel, Aluminum, Titanium

Customer Request

Guarantee Productivity

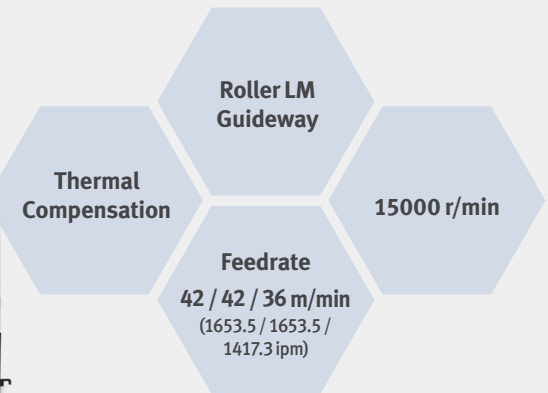
High Rigidity

High Accuracy

Solution

DNM S series

Productivity Vertical Machining Center



More Capacity

Table Size (A x B)

DNM 4500S

1000 x 450 mm
(39.4 x 17.7 inch)

DNM 5700S

1300 x 570 mm
(51.2 x 22.4 inch)

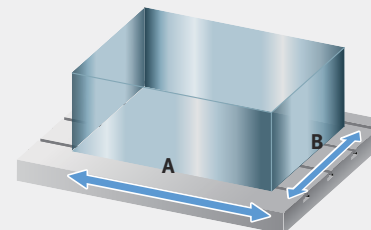
Max Weight on Table

DNM 4500S

600 kg
(1322.8 lb)

DNM 5700S

1000 kg
(2204.6 lb)



High Speed Spindle for Productivity of DNM 4500S / 5700S

Speed

15000 r/min

Feedrate (X / Y / Z)

42 / 42 / 36 m/min
(1653.5 / 1653.5 / 1417.3 ipm)

Power

11/18.5 kW
(14.8 / 24.8 Hp)



Customer S9

Intro

Structural

Body

Tail

Wing

Component

Engine

Case

Blade

Landing Gear

Beam

Disk

Appendix

Workpiece

Main Rotor(Helicopter)



Size

Ø200 x 1500 mm (7.9 x 59.1 inch)

Material

Carbon Steel

Customer Request

Multi tasking

High Rigidity

High Accuracy

Solution

PUMA SMX series

Super Multi-Tasking Turning Center



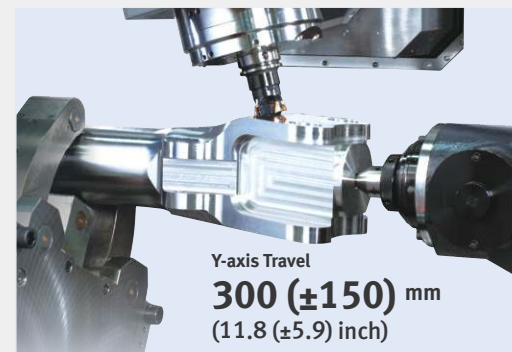
Simultaneous
5-axis

Max. Milling
Spindle Speed
12000 r/min

Left & Right
Spindles

Max.
Spindle Torque
30kW & 1203 N·m
(40.2 Hp &
887.8 ft-lbs)

Machining Process



Y-axis Travel

300 (±150) mm
(11.8 (±5.9) inch)

Ø63 mm (2.5 inch)
Face Mill

1200 r/min,
800 mm/min (31.5 ipm)

Ø25 mm (1.5 inch)
End Mill

2200 r/min,
4000 mm/min (157.5 ipm)

Solution for Productivity: Lower Turret



No. of Tool Stations	12 st
Rotary Tool Speed	5000 r/min
OD Tool Size	25 x 25 mm (1.0 x 1.0 inch)
Max. Boring Bar Size	Ø40 mm (1.6 inch)

Customer S10

Intro

Structural

Body

Tail

Wing

Component

Engine

Case

Blade

Landing Gear

Beam

Disk

Appendix

Workpiece

Rib



Size

Various

Material

Aluminum

Customer Request

Special Spec.

30000r/min High speed spindle

Solution

VC 630/5AX

Simultaneous 5-axis Vertical Machining center



30000 r/min

630mm
(24.8 inch)
Rotary Table

Chip Disposal
Solution

High Speed Built-in Spindle

Max. spindle speed

30000 r/min option

**Good for High
Speed Solution**

- Low centrifugal force
- Minimum heat generation



Response to Various size Workpieces

Max. size

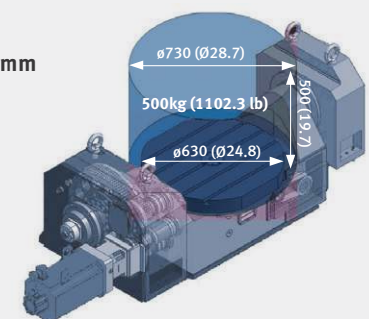
Ø730 x 500 mm
(Ø28.7 x 19.7 inch)

Max. Weight

500 kg
(1102.3 lb)

From Big to Small

- Machining a variety of workpieces by single machine



Customer S11

Intro

Structural

Body

Tail

Wing

Component

Engine

Case

Blade

Landing Gear

Beam

Disk

Appendix

Workpiece

Various Aerospace item



Size
Various

Material
Various

Customer Request

LPS 5000

Manless Automation

Machining various workpieces

Solution

DVF 6500

High Precision Vertical 5-axis Machining Center

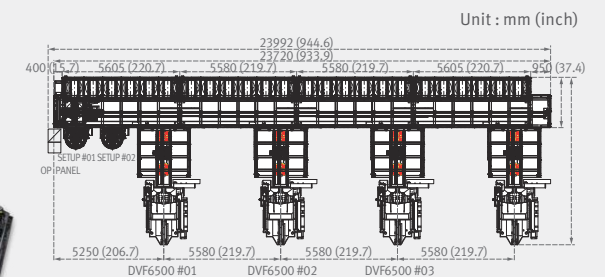


LPS 5000

**500x 500mm
(19.7x19.7 inch)
Pallet**

**Manless
Automation**

LPS 5000 System



Customer S12

Intro

Structural

Body

Tail

Wing

Component

Engine

Case

Blade

Landing Gear

Beam

Disk

Appendix

Workpiece

Wing, Rib



Size

4000 x 1500 mm

Material

Aluminum

Customer Request

High-speed Spindle

High volume chip disposal

Productivity

Solution

HFP 1540

5 Axis Horizontal Simultaneous Machining Center for aircraft profiler



4000 x 1500mm
(157.5 x 59.1 inch)
Large Tilting Table

30000 r/min

**Chip Disposal
Solution**

Spindle

Max. spindle speed

30000 r/min

Max. spindle motor power

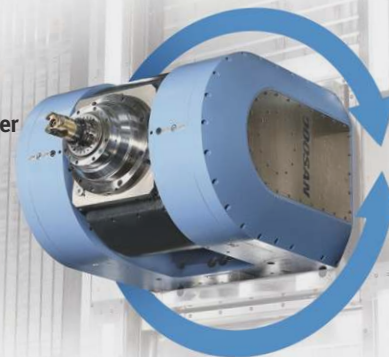
75 kW (100.6 Hp)

Tool shank

HSK A63

A-axis Tilting angle

+105° ~ -105°



360°

High-speed Scraper type Chip Conveyor

Chip conveyor width

700mm

(27.6 inch)

Max. Removal Capa.

7000 cm³/min

(427.2 inch)



Workpiece

Clip edge frame



Size Various

Material Inconel

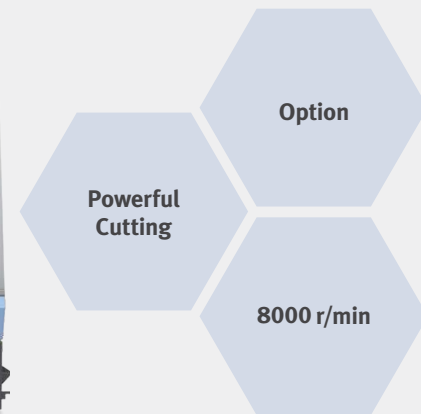
Customer Request

Hard-to-cut Material Cutting Package
Powerful Cutting
Thermal compensation

Solution

MD 6700

High Rigidity Vertical Machining Center



Machining Process

Special Modification

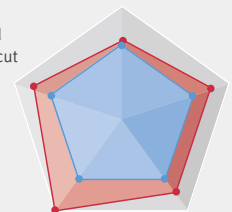
Maximized machining performance on customer request

Option

BALL SCREW / Bearing / Servo Motor

Spindle Torque

Standard
Difficult cut



Coolant(Amount, pressure)

25% Improved

Cutting(depth)

50% Improved

Axis thrust

20% Improved

Axis rigidity

23% Improved



Customer S14

Intro

Structural

Body

Tail

Wing

Component

Engine

Case

Blade

Landing Gear

Beam

Disk

Appendix

Workpiece

Large Aerospace part



Size

Various Size

Material

Various Material

Customer Request

High-speed Spindle

2-rotary table

Multi solution

Solution

VCF850LS2R

VCF Aerospace Solution

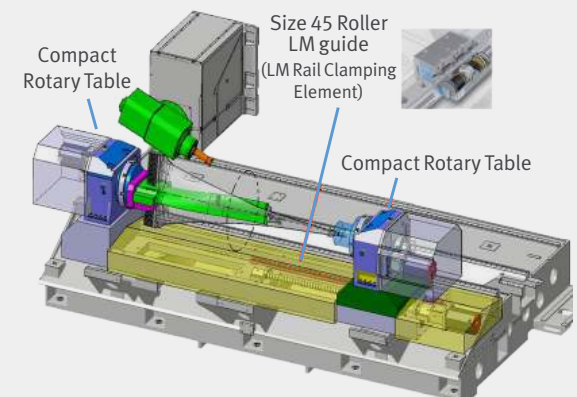


18000 r/min

2-rotary table

Multi solution

Machine Structure



Customer S15

Intro

Structural

Body

Tail

Wing

Component

Engine

Case

Blade

Landing Gear

Beam

Disk

Appendix

Workpiece

Frame part



Material

Aluminum

Customer Request

High-speed Spindle

High volume chip disposal

Productivity

Solution

HFP 1540

5 Axis Horizontal Simultaneous Machining Center for aircraft profiler



4000 x 1500mm
(157.5 x 59.1 inch)
Large Tilting Table

30000 r/min

Chip Disposal
Solution

Spindle

Max. spindle speed

30000 r/min

Max. spindle motor power

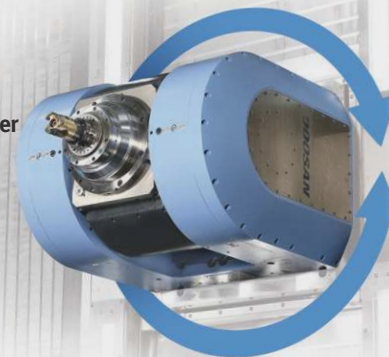
75 kW (100.6 Hp)

Tool shank

HSK A63

A-axis Tilting angle

+105° ~ -105°



360°

High-speed Scraper type Chip Conveyor

Chip conveyor width

700mm

(27.6 inch)

Max. Removal Capa.

7000 cm³/min

(427.2 inch)



Solution Engine Parts

CASE

Customer E1
Customer E2
Customer E3
Customer E4
Customer E5
Customer E6

BLADE

Customer E7
Customer E8
Customer E9
Customer E10



Workpiece

Engine Case



Size

Ø1000 mm (Ø39.4 inch)

Material

Inconel

Customer Request

High Productivity

High Rigidity

Strong RAM head

Solution

PUMA VTR series

Large Vertical Turning Center with Rigid Ram Spindle

High
Productivity

High Power /
High Torque

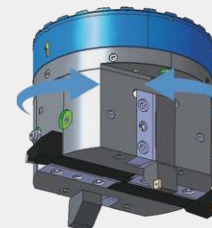
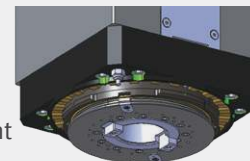
Strong Ram
Head



Unique Solution for Productivity of PUMA VTR series

Quad Tool Indexing

- 4 direction rotating head
- DMT have the patent
- Reduce tool change time



Strong RAM head of PUMA VTR series

Clamping Force
8 ton
(17636.7 lb)

Indexing
90 deg.

Max. Tool Length from Ram
180 ~ 200 mm
(7.1 ~ 7.9 inch)



"Inconel is one of the most difficult material to cut. But It's easy to cut Inconel if you have PUMA VTS Series. I will seriously consider further purchase more PUMA VTS Series."

-Engineer of E company

Customer E2

Intro

Structural

Body

Tail

Wing

Component

Engine

Case

Blade

Landing Gear

Beam

Disk

Appendix

Workpiece

Engine Case



Size
Ø800 mm
(Ø31.5 inch)

Material
Inconel

Turbine Disk



Size
Ø800 mm
(Ø31.5 inch)

Material
Titanium

Customer Request

High Accuracy

High Productivity

Large Capacity

Solution

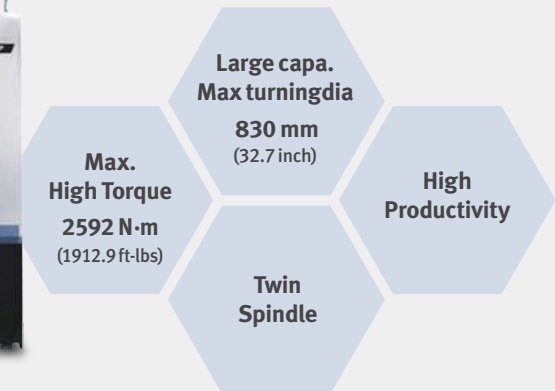
PUMA V8300-2SP

2 Spindle Vertical Turning Center



PUMA V8300-2SP key Strengths in Turning Process

- Strong machine rigidity supports stable fixation despite long working hours, and can handle items with a diameter as long as 830mm (32.7 inch)
- PUMA V8300-2SP have independent motor systems in each of its spindles, so productivity can be enhanced by operating two spindles at once.



Productivity Improvement

A Maximum ~50% in Cycle Time was Shortened **50%↓**

A Company	5 hours
PUMA V550	2.5 hours

← -50%

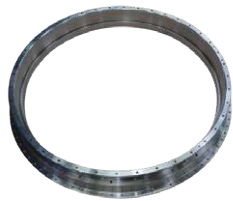
As much as 40% Cut in Turning Costs **40%↓**

A Company	\$20k
PUMA V550	\$12k

← -40%

Workpiece

Engine AFT Inner



Size
Ø700 mm
(Ø27.6 inch)

Material
Inconel

Engine Case



Size
Ø700 mm
(Ø27.6 inch)

Material
Titanium

Customer Request

Large size Workpiece

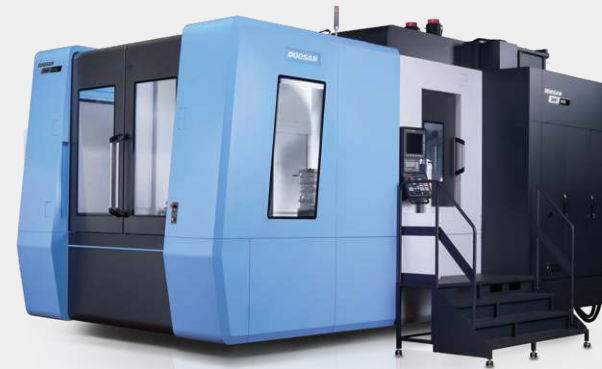
ComplexShaped Workpiece

Difficult-to-cut Material Solution

Solution

DHF 8000

Simultaneous 5-axis Horizontal Machining Center



Large
Workpiece
1400 x 1400 mm
(55.1 x 55.1 inch)

High
Torque
960 N·m
(708.5 ft-lbs)

Simultaneous
5-axis

Machining Process

Upper Side Hole Drilling

- Ø6.7 mm (0.3 inch) drill
- 50mm/min (2.0 ipm), 700 r/min

Slope Side Boss part Surfacing

- Ø6.95 mm (0.3 inch) Row end mill
- 30mm/min (1.2 ipm), 200 r/min

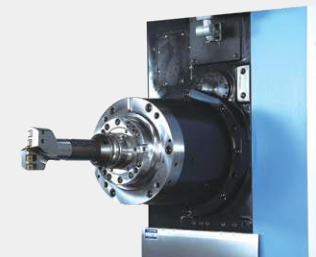


High Power Spindle Option for Difficult-to-cut Material

Torque
960 N·m (708.5 ft-lbs)

Power
35 kW (46.9 Hp)

Speed
6000 r/min



“DHF8000 is optimized to cut inconel and titanium.”
- General Manager of Equipment management team

“This machine have enough power to machining difficult-to-cut material with tilting function”
- General Manager of Production team

Customer E4

Intro

Structural

Body

Tail

Wing

Component

Engine

Case

Blade

Landing Gear

Beam

Disk

Appendix

Workpiece

Engine Forward Case



Size
ø800 mm
(ø31.5 inch)

Material
Inconel

Blisk



Size
ø800 mm
(ø31.5 inch)

Material
Titanium

Customer Request

Complex and Curved Workpiece

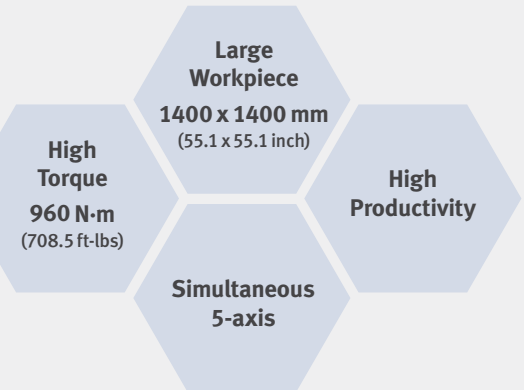
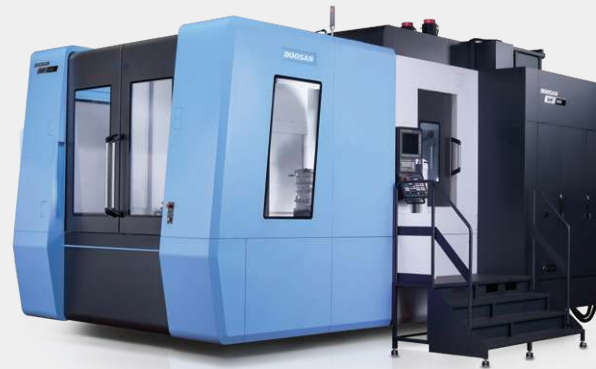
Shorten Cycle time

High Torque Spindle

Solution

DHF 8000

Simultaneous 5-axis Horizontal Machining Center



Machining Process (Forward Case)



Roughing	795 r/min, 450 mm/min (17.7 ipm)
Semi-finishing	1910 r/min, 500mm/min (19.7 ipm)
Semi-finishing Blade	1425 r/min, 278mm/min (10.9 ipm)
Finishing	970 r/min, 70mm/min (2.8 ipm)

High Power Spindle for Difficult-to-cut Material

Torque
960 N·m
(708.5 ft-lbs)

Power
35 kW
(46.9 Hp)

Speed
6000 r/min



Tilting Angle
-100 ~ 60 deg

Workpiece

Engine part



Size
Ø500 mm (Ø19.7 inch)

Material
Inconel

Customer Request

- Complex Shaped Workpiece
- High Rigidity
- Precision parts

Solution

VC 630/5AX

Simultaneous 5-axis Vertical Machining Center



20000 r/min

High
Rigidity
Design

Simultaneous
5-axis

High Speed Built-in Spindle

Max. spindle speed
12000 r/min
(20000r/min **option**)

Good for High Speed Solution

- Low centrifugal force
- Minimum heat generation



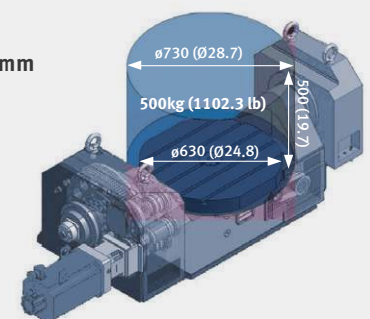
Response to Various size Workpieces

Max. size
Ø730 x 500 mm
(Ø28.7 x 19.7 inch)

Max. Weight
500 kg
(1102.3 lb)

From Big to Small

- Machining a variety of workpieces by single machine



Customer E6

Intro

Structural

Body

Tail

Wing

Component

Engine

Case

Blade

Landing Gear

Beam

Disk

Appendix

Workpiece

Engine casering



Size

Ø800 mm (Ø31.5 inch)

Material

Inconel 718

Customer Request

High productivity

High accuracy

Strongram head

Solution

PUMA VTR1012F/1216F

Large Vertical Turning Center with Rigid Ram Spindle

High
Productivity

High Power /
High Torque

Strong Ram
Head



Option

Fixed column

Full cover

Linear scale

Work & Tool Measuring

Calibration Unit

High pressure coolant 70bar

Spin Window

Strong RAM head of PUMA VTR series

Clamping Force

8 ton

(17636.7 lb)

Indexing

90 deg.

Max. Tool Length from Ram

180 ~ 200 mm

(7.1 ~ 7.9 inch)



“Inconel is one of the most difficult material to cut. But It's easy to cut Inconel if you have PUMA VTS Series. I will seriously consider further purchase more PUMA VTS Series.”

-Engineer of E company

Intro

Structural

Body

Tail

Wing

Component

Engine

Case

Blade

Landing Gear

Beam

Disk

Appendix

Workpiece

Aerofoil (Engine Blade)



Size

50 mm (2.0 inch)

Material

Inconel

Customer Request

Special Quotation

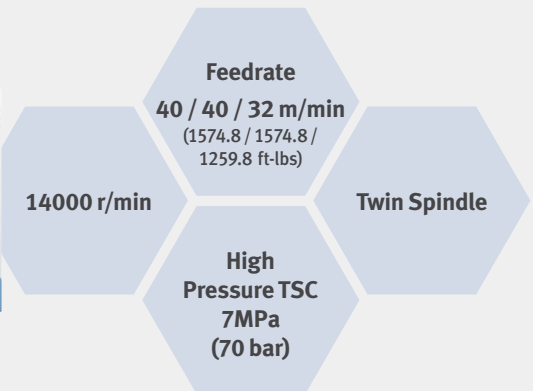
High Rigidity

Guarantee Productivity

Solution

VC 510

High Productivity Twin Table Vertical Machining Center



Machining process

Special Modification

Machine ATC guard modified to take over size tool Ø200mm (Ø7.9 inch) required for some components.

Filtration

Drum filtration coolant system added to filter particles created by Grinding wheel.



Customer E8

Intro

Structural

Body

Tail

Wing

Component

Engine

Case

Blade

Landing Gear

Beam

Disk

Appendix

Workpiece

Engine Fan Blade



Size

300 x 700 mm (11.8 x 27.6 inch)

Material

Aluminum

Customer Request

Guarantee Accuracy

High Rigidity

Curved Shape

Solution

VC 630/5AX

Simultaneous 5-axis Vertical Machining Center



High Speed Built-in Spindle

Max. Spindle speed

12000 r/min

(20000r/min **option**)

Good for High Speed Solution

- Low centrifugal force
- Minimum heat generation



Rotary Table type 5-axis Machine

Travels

A axis **+30 ~ -120°**

C axis **360°**

Rapid traverse

A axis **20 r/min**

C axis **30 r/min**



Customer E9

Intro

Structural

Body

Tail

Wing

Component

Engine

Case

Blade

Landing Gear

Beam

Disk

Appendix

Workpiece



Size
750 x 180 mm (29.5X 7.1 inch)

Material
Inconel

Customer Request

Special Spec.

Continuous Operation

Auto Compensation

Solution

BM 1530M

Bridge type machining center



Angle Head

800mm
Rotary Table

High Productivity

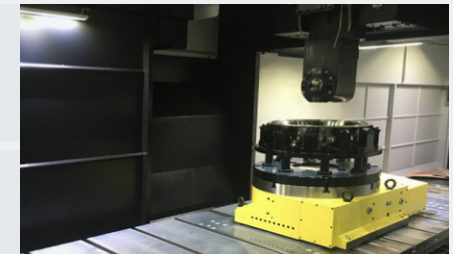
Machining process

Customized

Custom machining of up to 800mm workpieces for special workpiece

Option

Angle Head / Rotary table
HSK-A63 / 100 tools



Customer E10

Intro

Structural

Body

Tail

Wing

Component

Engine

Case

Blade

Landing Gear

Beam

Disk

Appendix

Workpiece

Split Engine Case



Material

Titanium

Customer Request

Total solution

Additional C-axis option

Tolerance between hole 0.05mm
(DOOSAN Measuring Macro P/G)

Solution

BM 1530 / DHF 8000 / PUMA VTR1216

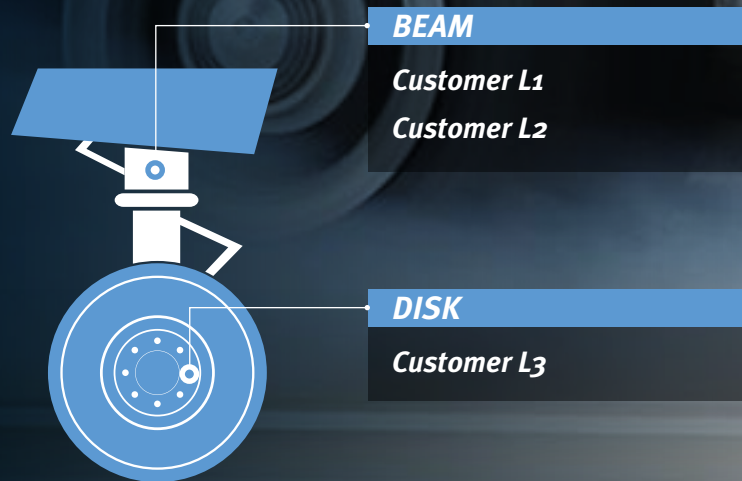
Special solution for engine case machining



Customer Site

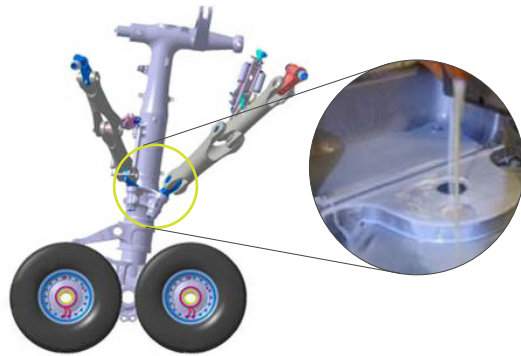


Solution Landing Gear Parts



Workpiece

Landing Gear Pylon



Size
Ø380 mm (Ø15.0 inch)

Material
Titanium

Customer Request

High Accuracy

Heavy Duty Machine (High Torque)

High Productivity & Rigidity

Solution

Mynx series

Heavy Duty Vertical Machining Center



Machining Process

Initial
Machining
Condition

Speed
34 r/min

Feedrate
60 mm/min (2.4 ipm)

Required Torque
450 N·m (332.1 ft-lbs)

- Tool: Ø380mm(Ø15.0 inch) slotting cutter

On the
Cutting Trial

- Raise RPM to 55 and decrease feed per tooth
- Enough Torque:
Max. torque of Mynx is over 450N·m (332.1 ft-lbs)

Test
Result

- Comparable cycle time with reducing spindle load
- Get the additional order for other type of machine



Customer L2

Intro

Structural

Body

Tail

Wing

Component

Engine

Case

Blade

Landing Gear

Beam

Disk

Appendix

Workpiece

Support



Size

800 x 800 mm (31.5 x 31.5 inch)

Material

Titanium

Customer Request

Guarantee Rigidity

High Productivity

Heavy Duty Cutting

Solution

NHP/NHM series

Horizontal Machining Center



High
Rigidity
Design

Heavy
Duty Cutting
(NHM)

High
Productivity
(NHP)

High Power, High Torque Spindle



NHP

Torque

600 N·m (442.8 ft-lbs)

Power

45 / 25 kW (60.3 / 33.5 Hp)

Speed

10000 r/min



NHM

Torque

1732 N·m (1278.2 ft-lbs)

Power

22 / 35 kW (29.5 / 46.9 Hp)

Speed

6000 r/min

Workpiece

Brake Disk



Size
ø500 mm (ø15.0 inch)

Material
Carbon Steel

Customer Request

Better Accuracy
Automation Application
Raise Productivity

Solution

PUMA V8300-2SP

2 Spindle Vertical Turning Center



Better
Rigidity

Automation
Application

Twin
Spindle

Automation Solution



PUMA V8300-2SP
(Brand New Model of PUMA V550-2SP)

+



DNM 6700
(Brand New Model of DNM 650II)

+



Robot Cell



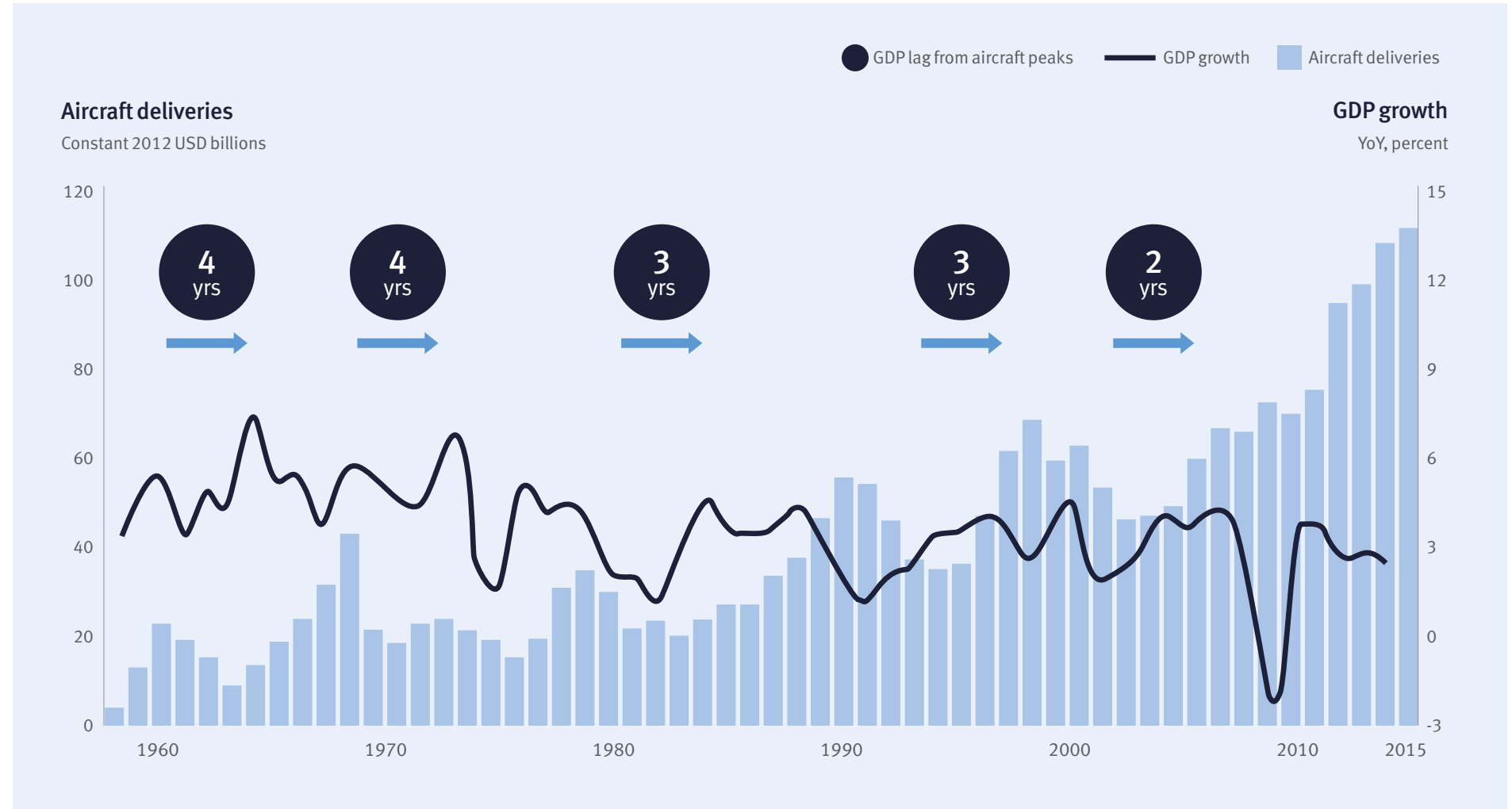
Appendix

Aircraft demand
forecasts

Analysis on
Aerospace parts
machining

Supply Chain of
Aerospace
Industry

Aircraft deliveries have risen steadily for the past 50 years, reaching the historical peak in 2015



Note: Includes regional aircraft
SOURCE: Teal Group; OECD; EIU; IHS Global Insight; McKinsey

Order books are completely full – with a backlog of 10 years' production (12,900 aircraft)

Commercial aircraft backlog (Airbus, Boeing, and Bombardier)

'000 aircraft

● Backlogged years of production



SOURCE: Company data; McKinsey

Most of the backlog is for Boeing and Airbus aircraft; Bombardier is a distant third, although they scheduled an entry into the narrow-body market in 2016

Intro

Structural

Body

Tail

Wing

Component

Engine

Case

Blade

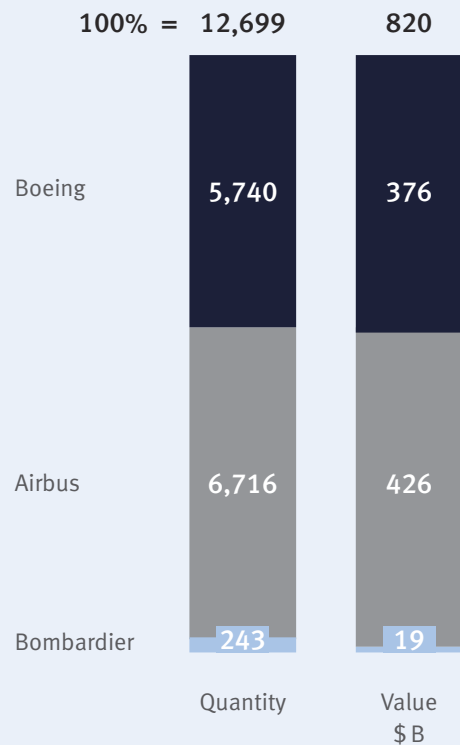
Landing Gear

Beam

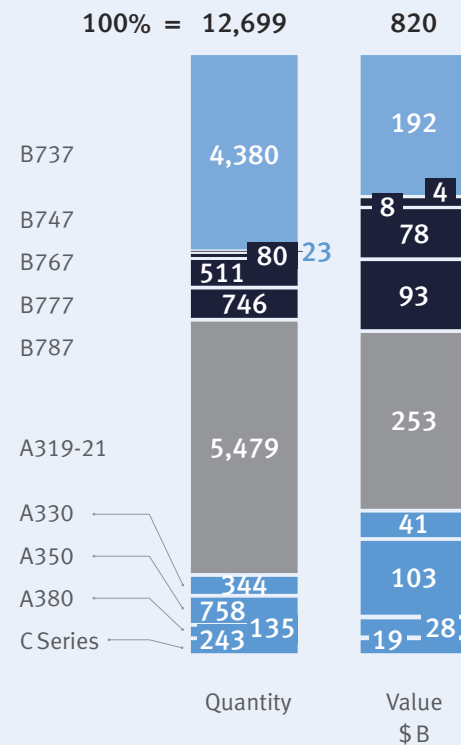
Disk

Appendix

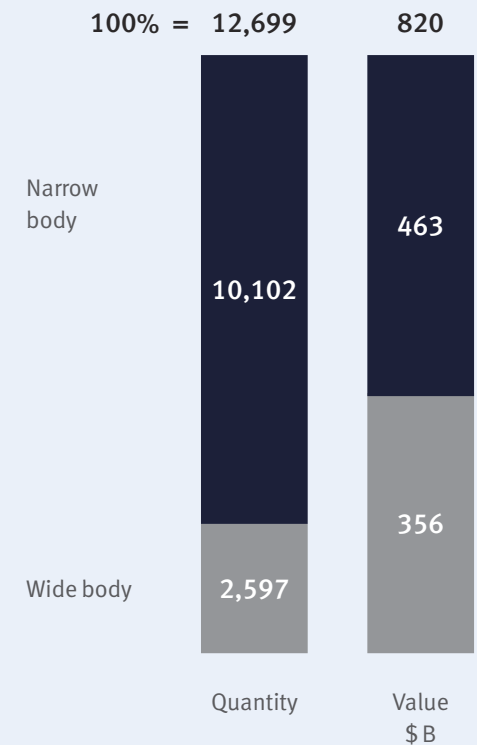
Backlog by **OEM**¹



Backlog by **Model**



Backlog by **Type**

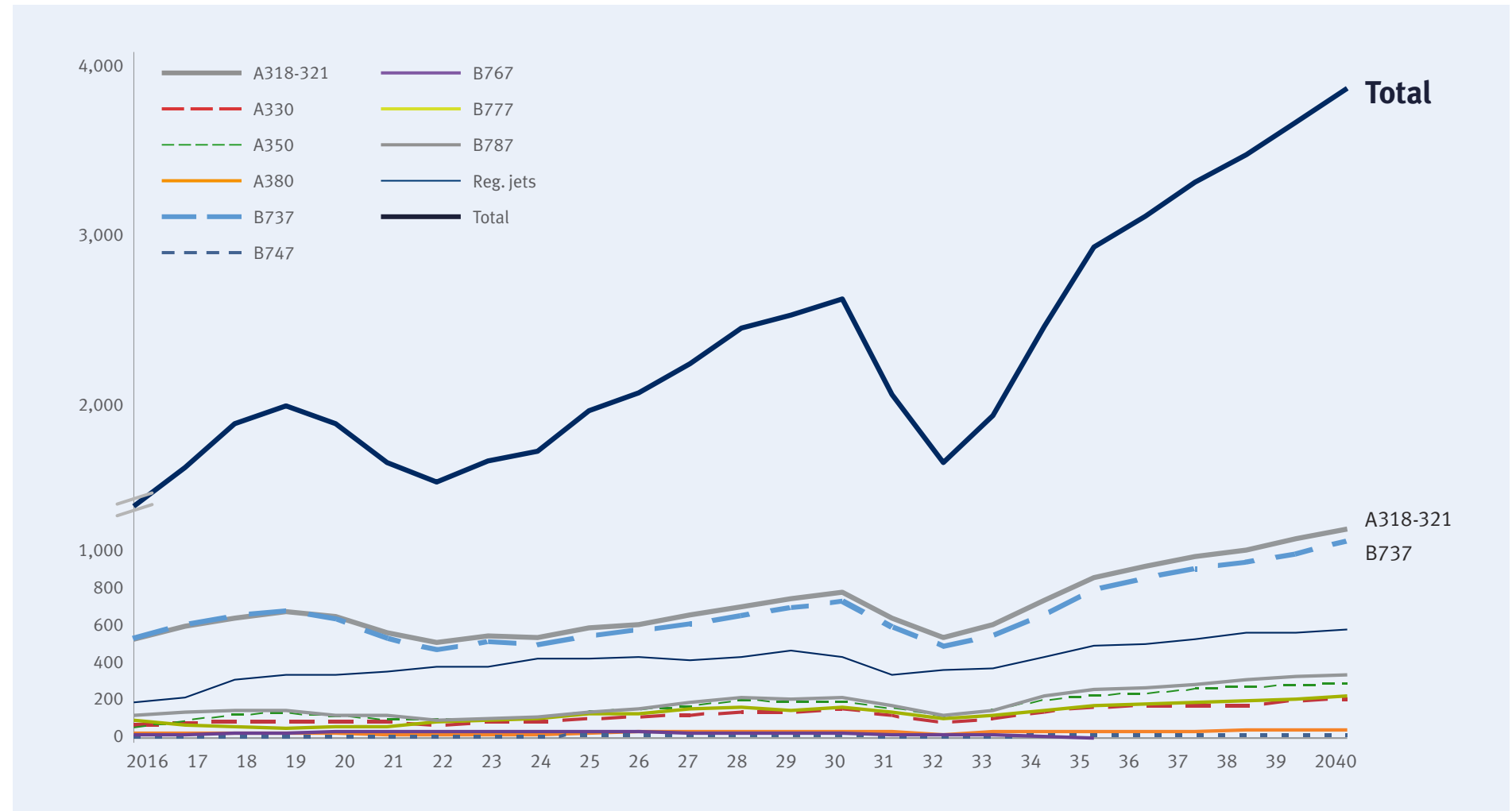


¹ Figures as of April 2016

² Does not include Regional or Business Jet business

SOURCE: Company website, TEAL

Projected aircraft deliveries, 2016 to 2040



1 Assuming titanium is acquired three years prior to aircraft delivery

2 Estimate – includes Russian, Chinese and Japanese aircraft

SOURCE: Airline Monitor June 2016

Intro

Structural

Body
Tail
Wing
Component

Engine

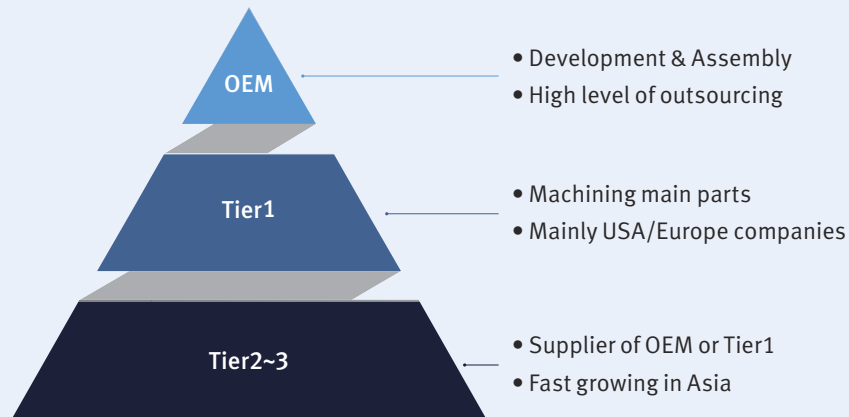
Case
Blade

Landing Gear

Beam
Disk

Appendix

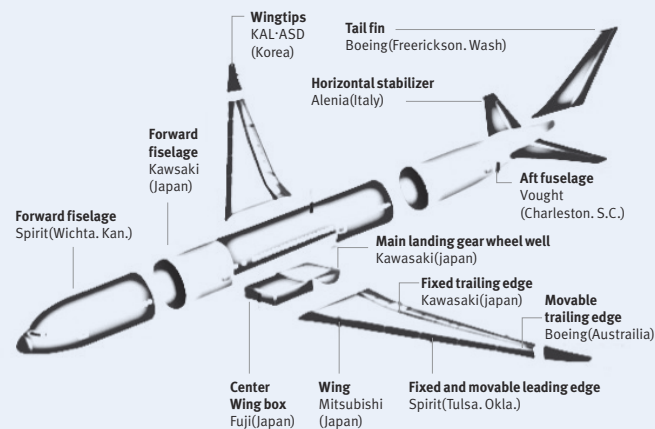
Aerospace Industry Structure



Aerospace supply chain latest trends

- Direct cooperation between MTB and OEM or Tier1
- Supply chain is expanded to developing countries

Boeing Parts Sourcing



Parts not shown

Landing gear: Messier Dowty (England)

Wing/body fairing: Boeing (Canada)

Landing gear doors: Boeing (Canada)

Cargo access doors: Saab (Sweden)

Passenger entry doors: Latecoere (France)

Engines: GE (Evendale, Ohio)

Engines: Rolls Royce (England)

Engines nacelles: Goodrich (Chula Vista, Calif)

Aerospace Industry Trend in Machining

Increasing Use of Hard-to-cut Material: Need for Solutions

- Aluminum alloy, Titanium: External parts of Aircraft
- Heat-Resistance material: Engine
- Machine tool concept, tooling, CAM, etc.



Aluminum



Inconel



Titanium

Composite Material(ex: CFRP)

- Partially applied buy price issue
- Metal is still main material in the industry



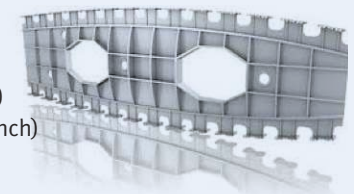
Need for Better Chip Disposal

- 90% of raw material is removed as chip
- Horizontal structure for chip disposal
- + Universal head for 5-axis machining



Machine classification for frame/skin by size(table)

- Small size aircraft: 500~700mm (19.7~27.6 inch)
- Middle size aircraft : 800~1300mm (31.5~51.2 inch)
- Large size aircraft : 2000mm~ (79.7 inch~)

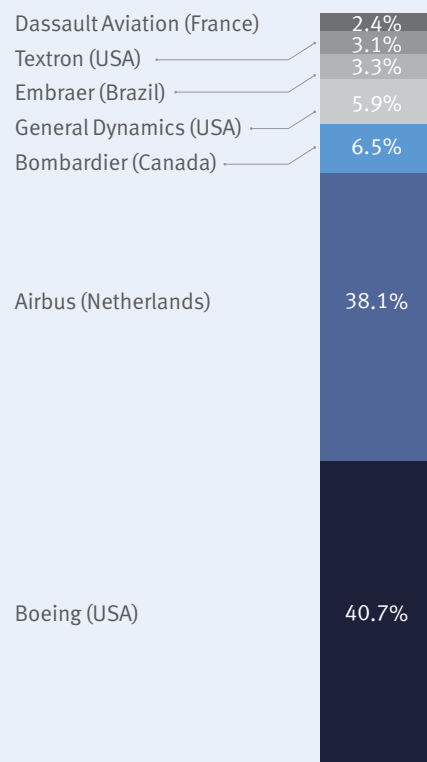


The industry is quite consolidated in the Engines segment, but this has not yet occurred in the Aero-structure one

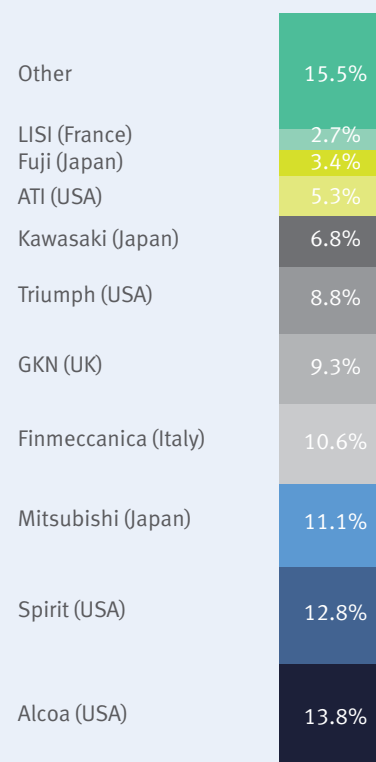
Share of revenues within top players from 100 aerospace suppliers¹

2014, Unit : Percent

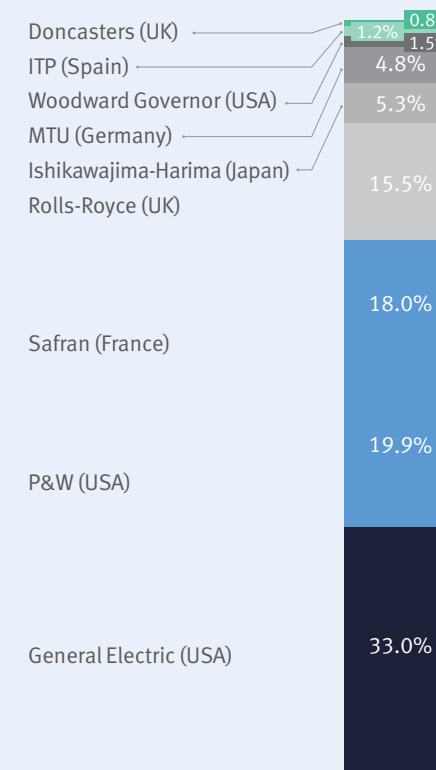
Aircraft OEMs



Aerostructure suppliers



Engine suppliers

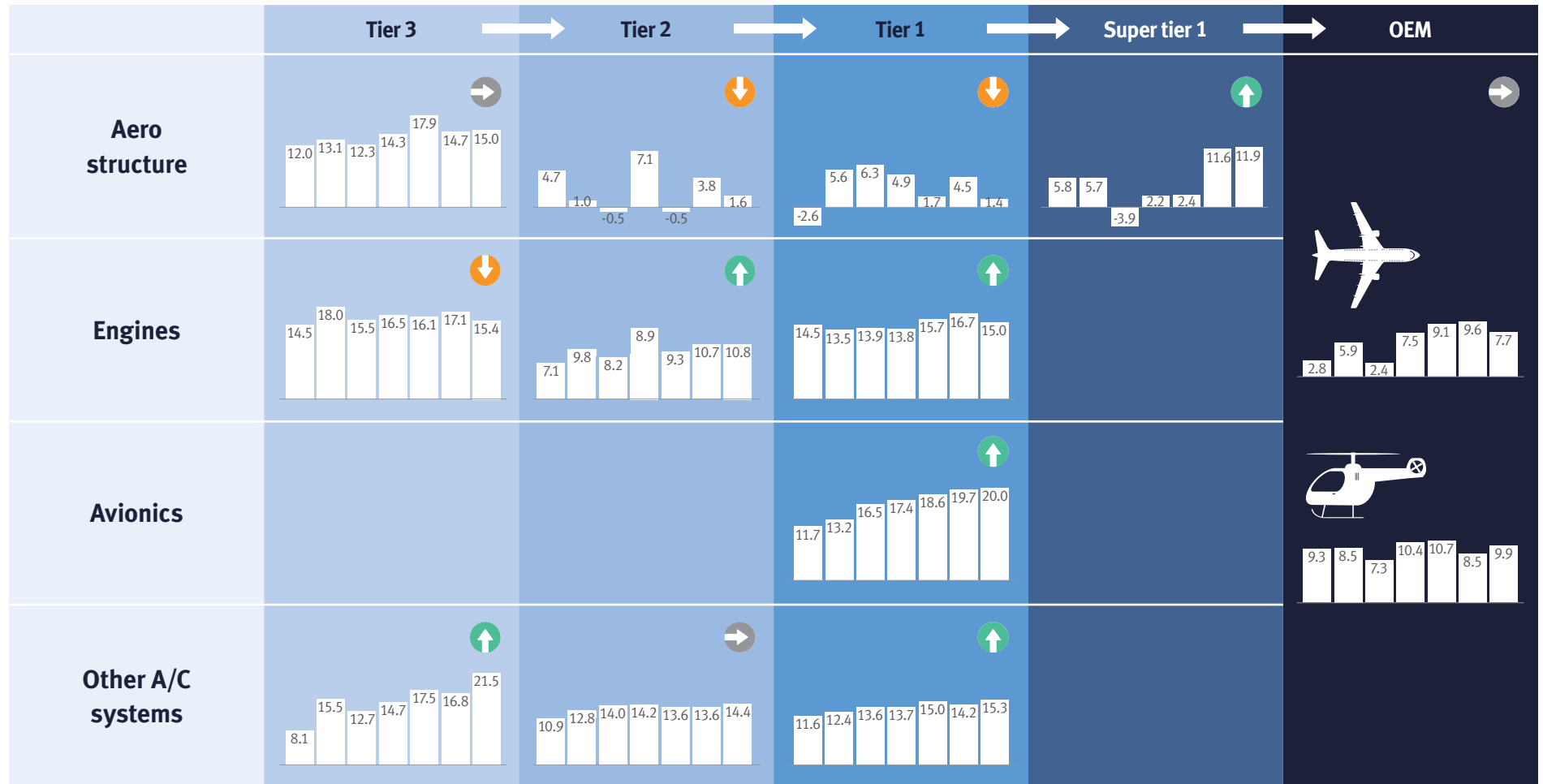


Note: Reflects database and not the entire industry as small players are not covered
¹ If available, the data reflects the business division concerned, otherwise the whole company
 SOURCE: Company data, McKinsey analysis

The production ramp up in commercial aviation results in diverse margin trends with 2015 being tough for OEMs

Average operating margin

Unit : Percent



- ↑ Increased margin more than 1 percentage point since 2012
- Stable margin (-1 < X < 1) since 2012
- ↓ Decreased margin more than 1 percentage point since 2012

NOTE: Reflects database and not the entire industry; figures corresponding to commercial aircraft specific division whenever possible
SOURCE: McKinsey profit pool database

Intro

Structural

Body

Tail

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Component

Engine

Case

Blade

Landing Gear

Beam

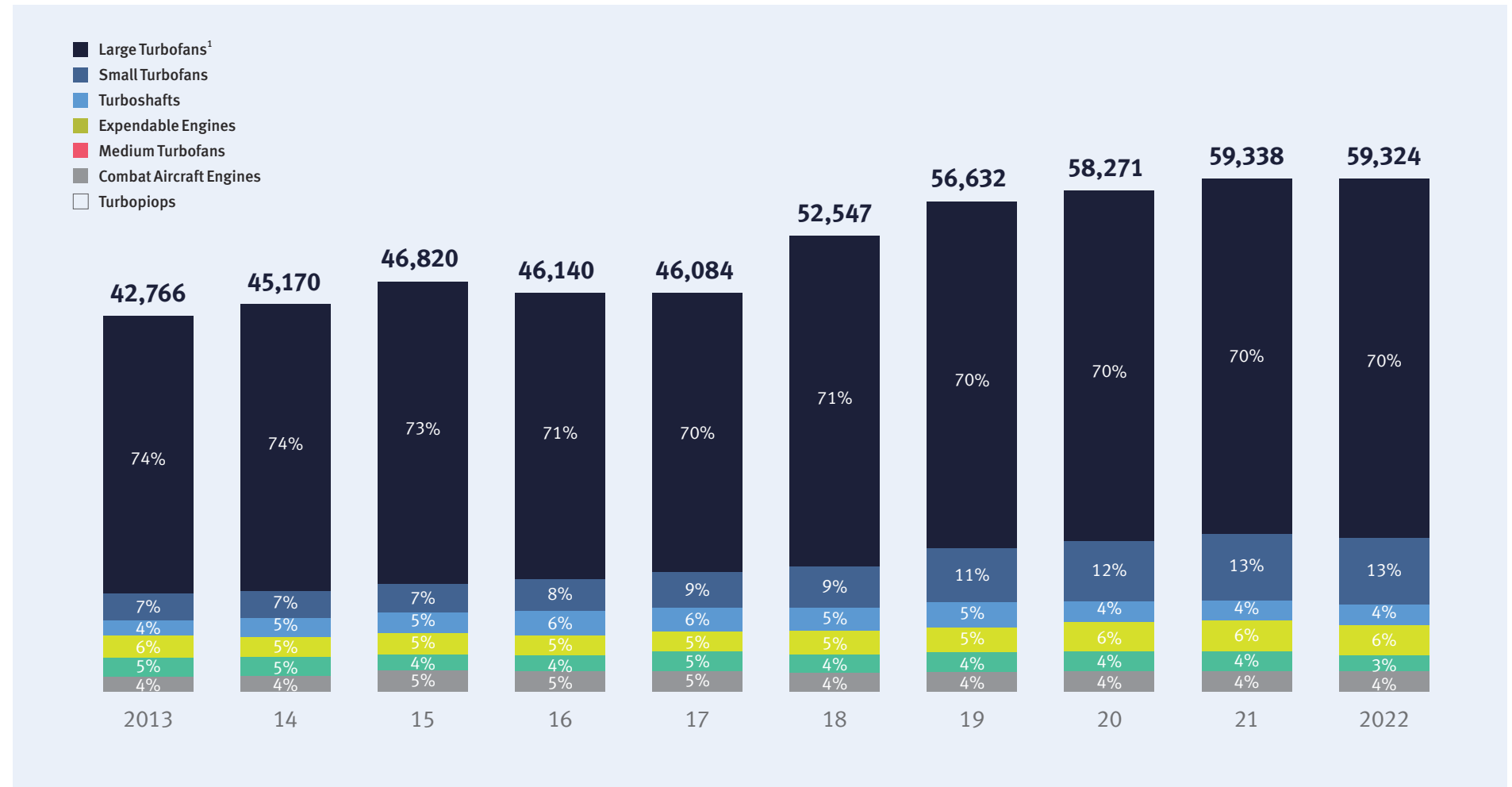
Disk

Appendix

The aero engine market is growing, driven primarily by medium-to-large turbofan engine developments

Value

2016, Unit: \$ Millions



1 Engines for narrow-body and wide-body commercial jets

SOURCE: Teal Group

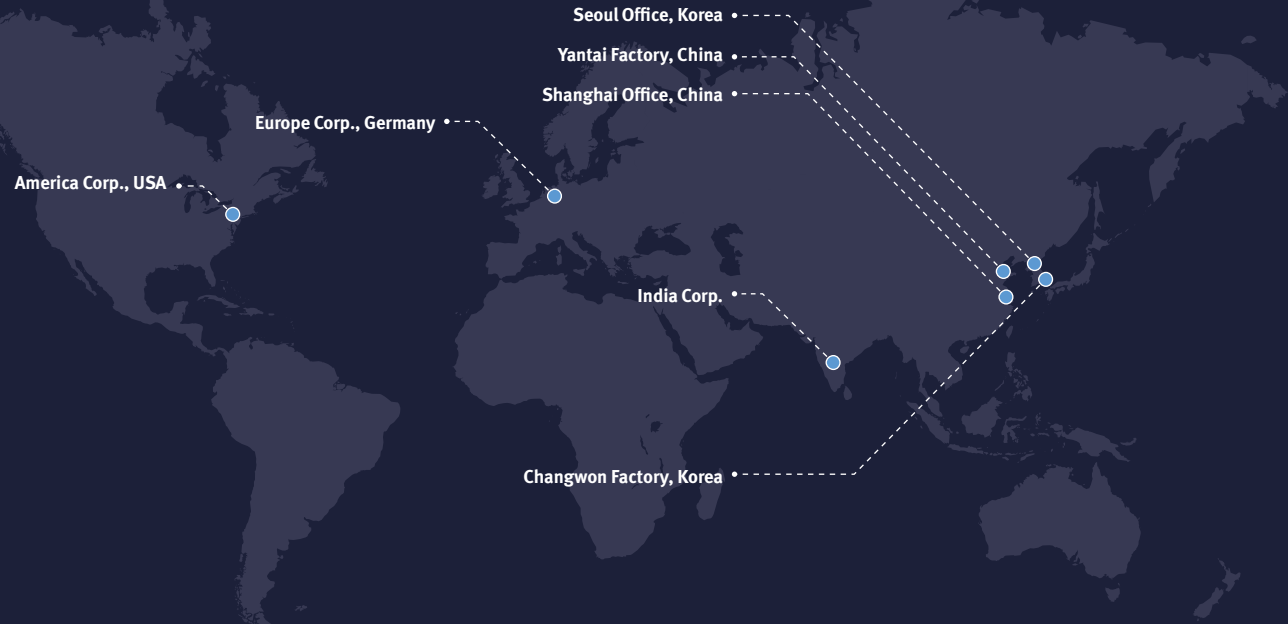
Doosan Machine Tools in the World

In an effort to provide solutions that fit each partners' unique needs, we constantly innovate our thinking, processes, and the way we do business. These optimal solutions lay the foundation for the success of our partners, which adds value to our partners' businesses.

Global Sales and Service Support Network

4 Corporations
167 Dealer Networks
51 Technical Centers
200 Service Post
3 Factories

Technical Center: Sales Support, Service Support, Parts Support



Supplying Parts

- Supplying parts without charges
- Supplying parts with charges
- Parts repair



Field Services

- On-site services
- Installment and trials
- Scheduled maintenance/ Preventive maintenance
- Repairs with/without charges



Technical Support

- Supporting machining technology
- Responding to technical inquiries
- Providing technical materials



Training

- Programming / Machine operation
- Maintenance
- Application engineering

Doosan Machine Tools

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Fax +86-21-6405-1472



Fire Safety Precautions

There is a high risk of fire when using non-water-soluble cutting fluids, processing flammable materials, neglecting use coolants and modifying the machine without the consent of the manufacturer. Please check the SAFETY GUIDANCE carefully before using the machine.

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