

# Design and build of an ultra-precision diamond machining system

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## Task

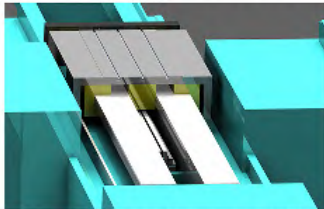
- Define a specification of a diamond machining system capable of producing aluminium parts for the Meso scale machine system.
- Perform necessary design and procurement.
- Build and commission the system.
- Process an aluminium frame getting 25 nm RMS roughness and flatness of less than 5  $\mu\text{m}$ .
- Commercially machines get flatness around 15-20  $\mu\text{m}$  in metre-scale workpieces.

## Pre-existing system



- Pre-existing structure**
- Three pneumatic feet support.
  - Cast Iron Base.
- Vibrations damping performance.**
- Old 7-axis Grinding Machine.

## Sliding Table

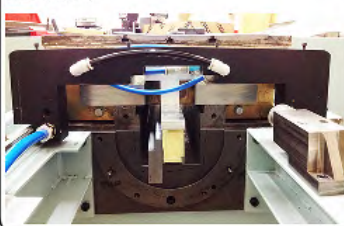


### Purpose of Sliding Air Bearing Table

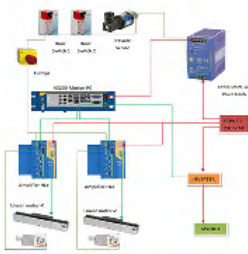
- Moving the frame from a position to another.
- Holding the frame in the right position during processing.
- Having a smooth motion to avoid defects on the machined surface.
- The table has to be perfectly flat and parallel to the rails to produce a perfect surface.
- Provides very high motional accuracy
- Generates a frictionless motion
- 14  $\mu\text{m}$  air gap
- Acceptable Slideway's motion errors

### Motor: Aerotech BLMC-142

- Continuous force (120 N) for fast travels
- Heat generated (calculated with Aerotech's Motor Sizer)



## Electrical



### Controller

- Aerotech A3200 computer with 4-axis-cnc operator:
- rugged, compact panel-mount
- Space saving multiple wiring option

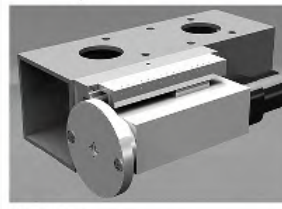
### Amplifier

- Aerotech Ndrive Hle
- Linear power stages
- Digital current, velocity and position loops
- Improved motion stability
- Encoder feedback

### Encoder

- RENISHAW Linear Encoder
- TRACK optical 30 $\mu\text{m}$ : pitch absolute track
- self-adhesive - dirty immunity
- READHEAD 5nm resolution
- 100m/s max reading speed
- $\pm 40$  nm sub-divisional error
- <10 nm RMS jitter

## Spindle



### Spindle

- Radial Stiffness: 2917 N/ $\mu\text{m}$
- Integrated Cooling System
- Output Power: 900 W
- Max Rotational speed: 5500 RPM
- 3 Phase Power Supply 380 V

### Fly-cutter

- 290 mm in Diameter Aluminium Disk
- Steel tool-holder
- Single Point Diamond
- Counterbalance slots

### Y-axis Motor

- Aerotech BLMC-142
- Maximum force: 120 N
- Peak Force: 480 N
- 300 mm stroke in Y-axis
- Needle bearing slideway
- Absolute encoder



## Safety

### Purpose of the Safety Covers

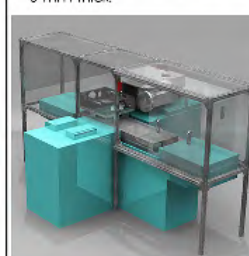
Prevent from approaching moving parts (spindle and table) during the machining.

Protect the operator from the fly cutter in case of a failure. Contain metallic chips.

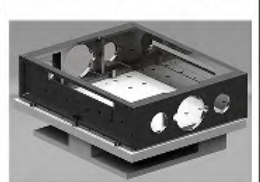
Allow the operator to safely see the machining.

Enable the operator to load and unload the product easily using a door.

Transparent, resistant, stable, easy to use solid polycarbonate sheet - 8 mm thick.



## Platform



### Platform

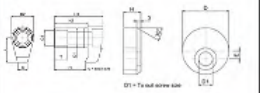
- Allow frame regulations.
- Help clamping system.
- Fit the frame in the correct position

### Clamping

- Three points system.
- Hooks keep the frame steady.

### Frame

- Four surface to machine
- Positioning with eccentric jigs



## Outcome

Every component of the machine has been designed, purchased, delivered and at the moment of poster printing (15-04-2014 10 of 12 weeks) the assembly stage is in progress following an accurate assembly plan. All the setting and alignment features have been designed and tested. The electrical components are ready to be integrated on the structure.

