ModuleWorks 5-Axis simultaneous machining technology for Aerospace applications

This article shows how SolidCAM / ModuleWorks technology is used to manufacture the aerospace component as shown below and looks at each aspect of the manufacturing process including machine tool and tooling selection, fixturing and positioning requirements and the different machining strategies required to manufacture the component.

Albatross Technologies provide hi-tech consultancy services to the manufacturing industry and specialise in 5-Axis simultaneous machining. They selected SolidCAM, powered by ModuleWorks 5-Axis machining component, as their CAM solution.

The company was formed by Doron Sashkis, a 30 veteran of the CAD/CAM and manufacturing industries. Commenting on his selection of the SolidCAM / ModuleWorks combination he states “5-Axis machining needs powerful and flexible tools for geometry manipulation and toolpath generation and SolidCAM is very strong in both areas with its SolidWorks CAD engine and the ModuleWorks machining technology and was therefore a natural choice for us given our requirements

The part was produced at Dagesh Ltd, a leading company in manufacturing who provide "turn key solutions" for: Electro optic, aircraft, aerospace, medical, and semi conductors Industries. Their customers include Applied Materials, EIA, KLA, ELOP, Elbit and Negevtech. Dagesh have a range of 3, 4 and 5-axis machines. The Flagship is the 5-axis department with 2 x DMU50, 2 x DMU70, 3 x DMU80, 1 x DMU125 and 1 x DMU 200. Six of these machines are associated with Arowa Robot systems. In the programming department of Dagesh there are 10 seats of SolidCAM.

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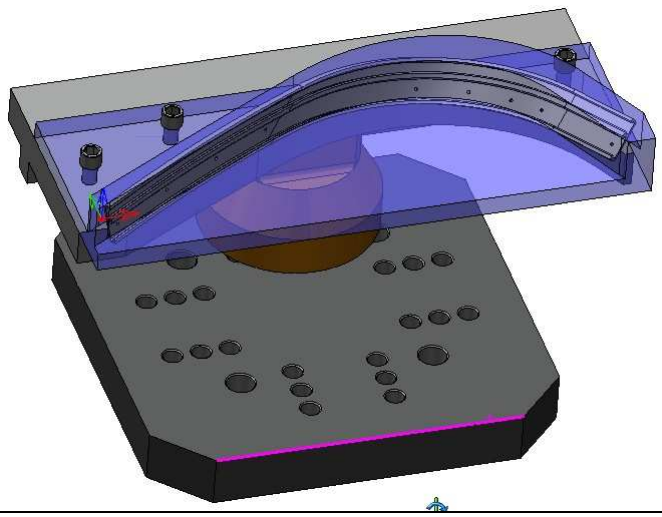
Machine Selection and Part Positioning

The first stage is to select the target machine tool, then position and fixture the stock on the machine tool table. Dagesh utilise DMG machines and have a choice of DMU 70, DMU 80, DMU125 and DMU200 machine tools. Based on the part size and machining requirements, the DMU 70 machine was chosen for this job.

In positioning the part on the component, there are a number of considerations, these are discussed below:-

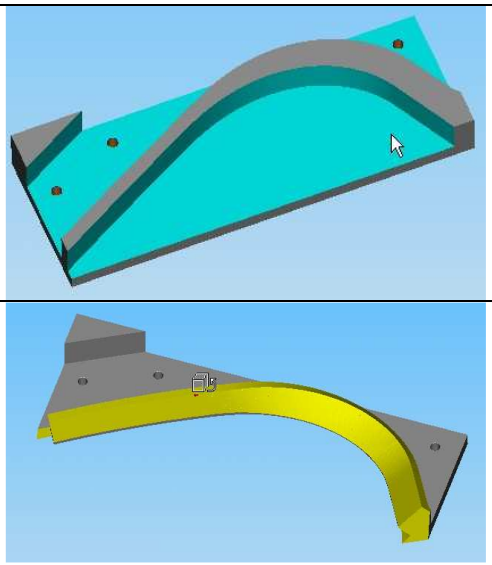
- Use the minimum amount of stock material to reduce raw material cost, particular relevant with many exotic aerospace materials which are very expensive.
- We want to minimise the amount of 5 axis rotary movement. Depending on configuration, a small change in orientation can lead to a large rotary movement – these may affect surface finish and give rise to the potential for collisions.
- Efficient fixturing to ensure all areas of the components can be reached and machined. One of the benefits with 5-Axis machining is the ability to cut the entire part in a single set up, thereby reducing lead time and improving accuracy.
- In selecting the machine, we also need to be sure that we are working within the physical limits of Machine tool movement (X, Y and Z linear axes and A, B and C rotary axes).

Having taken the above into account, we have selected the machine tool and fixtured the component on the machine tool as shown in the illustration here.	

Roughing and finishing the outline shape

The first stage is to rough the blank to approximate size. This operation is carried out using conventional 3-Axis roughing. Next we carry out our first 5-Axis machining to generate the outline shape of the final component. The following 5-Axis cuts are required:-

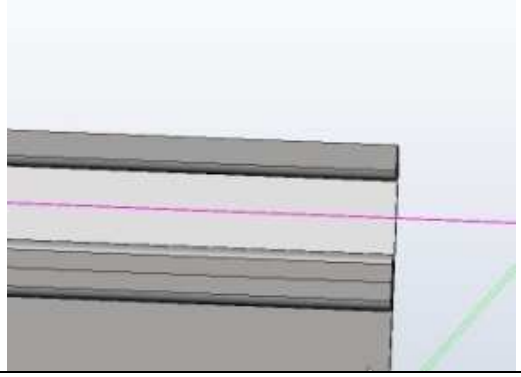
- Clean the top face with face machining – the tool is tilted over to form the shape of the top face.
- Clean the front wall with SWARF machining. This is a popular technique and is an abbreviation for Side Wall Angle Relief machining – the tool is tilted over and the shape cut using the side of the tool and allows the component to be machined with very few cuts.
- Clean the left side with SWARF milling.
- Clean the right side with SWARF milling.
- Clean the bottom Face with SWARF milling



With very cuts we now have the outline form of the finished component. We know need to finish the detail of the slot and undercut areas; this is most demanding aspect of the machining.

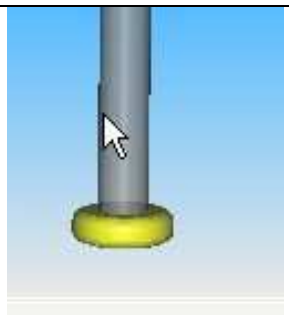
Forming the Slot and undercut areas

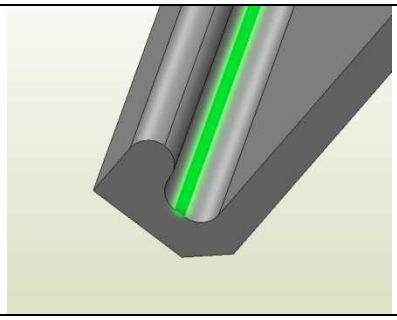
To machine the slot we use an End Mill and position it normal to the bottom of the slot. A small 1 degree lag angle is employed and this will improve the overall surface finish as the centre of the tool is above the part and machining takes place with the front of the tool. Two operations are required, one for the each side of the slot.



Having cut the slot, the next operation is to rough the undercut area. For this, we have used a small diameter T-Slot cutting tool with separate operations for each side of the slot.

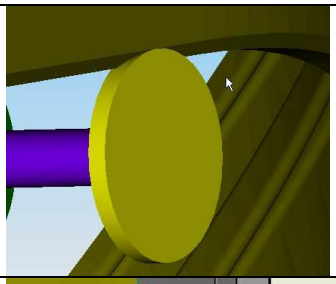
For finishing an undercut tool with the same diameter as the external fillet is used.

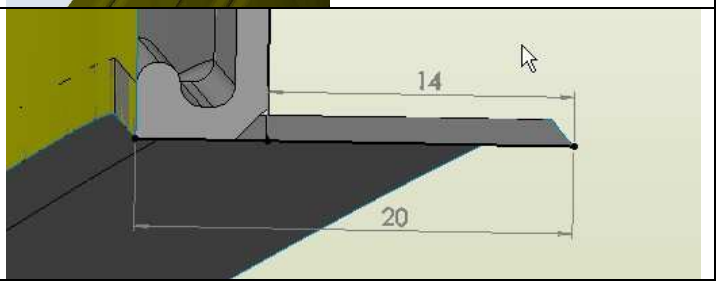




Machining the Bottom Chamfer

The chamfer is 45 degrees to the bottom and is equal all along the edge of the component. To machine this, a T-Slot cutter is again used to follow the bottom face so that the tip of the tool is collinear to the back face. Following this, we move into the material with a 1.5mm offset from the part. The chamfer is then machined by following the back wall with the angle of the tool ensuring the right form is produced. As can be seen in the picture, the tip face ends coincident to the back face and the diameter of the tool is tangential to the edge of the chamfer.





Finish the back and cut off

To complete the machining of the component we need to finish the back side and cut the part off using SWARF milling. A roughing tool is used first with a 4mm offset, followed by a finish cut with the same offset. The final operation to cut the part off - again SWARF cuts are used but with a lower feedrate and spindle speed to minimise vibration.

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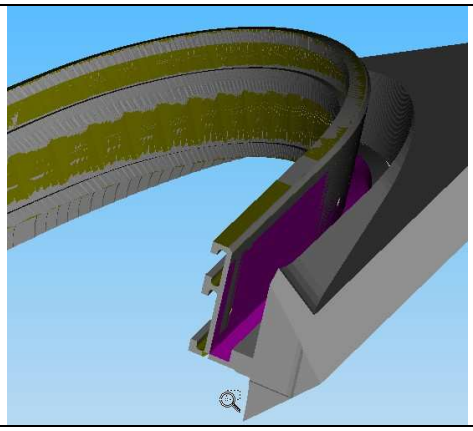

Summary

The brief article shows some of the capability of the ModuleWorks 5-Axis machining kernel. This shape requires a range of powerful and flexible machining strategies with tight control of tool positioning and movement.