DIGITAL DENTISTRY CONSULTANCY
KNOWLEDGE TRANSFER

| What | Who | How | Why

Perfectly printed or milled?

I think I can - Part 2

I once served in the military and was given a compass and learnt to navigate from point A to B to C and onto the final destination. Interestingly the compass did a great job in guiding me but what it couldn't do was interept the contours on the map, advise on the obsticles in front of me and tell me how long it would take. So we navigate our way around one or two choices available and then maybe come up with a third that is just right.

In Part One of the article, we discussed some of the pros and cons of 3D printing. In Part Two were going to look at milling and navigate you through some of the considerations to either mill or grind a solid object with set co-ordinates.

"Every block of stone has a statue inside it and it's the task of the sculptor to discover it" Michelangelo (1475-1564) was purported to have said. Imagine what he could have done with a 5 axis mill! So whether you're sculpting a masterpiece from marble or milling a complex shape in PMMA, metal, wax or zirconia the principle is the same. You start with a solid block of material you remove the unnecessary bits until the final shape appears.

There are technical and clinical factors involved in different "subtractive" manufacturing milling techniques which influence the overall of quality, the mechanical properties of the milled parts, the costs and manufacturing time. I'm think crown and bridge, digital dentures, surgical guides, RPD's (metal, PMMA, the PEAK family), wax and more, though some applications are limited more from the CAD (parameters) or the CAM software.

Milling zirconia and glass ceramics is a given so let's have a look at the process utilising PMMA materials. There are long term results with these materials (companies utilise their existing materials with published clinical results) and at this stage, it could be the most cost effective way of producing some parts. Everybody is now talking the digital denture (PMMA) and as I utilised the 3D printed denture in the previous article we should try and compare the process.

The use of 3D milled dentures is certainly evolving. The actual mechanics also depend on which milling unit you are using or considering to buy. Milled dentures are also a meccano set of parts (essentially teeth and a base) that will need to be put together through a post processing technique (generally bonded).

When we look at the market there's a plethora of milling units that are 5-axis versus 3+2 axis. It's important to distinguish between a 5-axis machining and 3+2 machining. With 5 axis machining this can also be called continuous or simultaneous 5 axis machining. This involves continuous adjustments of the cutting tool along all 5-axis to keep the tip optimally perpendicular to the part. In contrast, the latter also called 5-sided or positional 5-axis machining (generally a cheaper unit) involves executing a 3 axis program with the cutting tool locked at an angle determined by the rotational axis. Machining involves re-orienting the tool bit along the rotational axis. Between cuts is called '5-axis indexed' though it still counts as 3+2. Other technical limitations may include the maximum rotation axis, how many axis that are available along with instrument (milling or grind bur) length.

The main advantage of continuous 5-axis machining over 5-axis indexed is SPEED, since the latter is constantly stopping and starting each reorientation of the tool whereas the former doesn't. The one limitation of continuous 5-axis milling is the CAM software. This software is more complex in its programming. It's more complex than just adding a material to mill without knowing its properties, it's not just a click of the mouse as some companies are finding out.

Spindle, chuck size and milling bur size can determine, the speed and accuracy, i.e. a 6mm chuck is better than a 3mm chuck. This equates to time. Spindles relate to torque. A 600 watt motor is not as good as 1 kilowatt motor. Some inexpensive units may only rotate an axis 20-25°, whilst other units are up to 40°. Instrument length vary from 25-40mm and with a limited rotation these milling units will not be able mill complex structures.

A quick overview in the Australian market will see the majority of units being sold having only 3mm chucks and spindle motors from 400-600 watts. These are designed for crown and bridge type products and whilst will mill PMMA type material they will not be as efficient. It's not until you move up the portfolio of mill units with a 5-6mm chuck size and a 1 kilowatt motor will you see a difference in milling PMMA (large and complex parts) that time (speed) and the resultant surface finish. These units are also substantially heavier as well as being more expensive.

So as we think about milling and 3D printing solutions both offer advantages over the other. I do think there are opportunities to design parts that couldn't be designed in the past (3D printed), but there are still parts that require subtractive machining. For example fine tight parts that require a tight circular tolerance. I look to the future where we manufacture parts utilising hybrid 3D printers and 5 axis CNC machines that use the same CAM program so that finishing is completed by a machine.

As with all things, sometimes you need just need a helping hand to understand the basics in order to decide on the digital infrastructure best suited to your situation. That is why Digital Dentistry Consultancy (DDC) is here to help you with your big picture plan. DDC can engage with you at the level matching your needs when and where you require specific advice or support. I look forward to hearing from you or where possible meeting with you to form that long-term relationship.

Cheers
Geoff

P: +61 (0)466 788 797
E: info@digitaldentistryconsultancy.com.au
W: www.digitaldentistryconsultancy.com.au

Digital Dentistry Consultancy
PO Box 1234 | Stirling | SA | 514
ABN: 60 605 212 714