Manufacturing Soft Ferrites: Pros and Cons of Pressing vs. Machining

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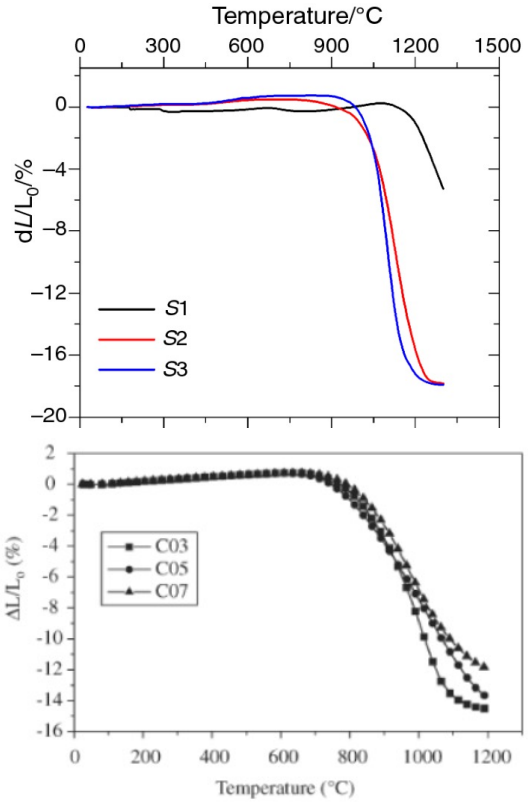
Sintering and Casting Ferrites

PROS	CONS
• Allows for complex geometries to be made • Very repeatable, fast, and cost effective in high volume	• Can cause surface defects • Can be costly in low volume • Shrinkage of up to 20% • Size restrictions of sintering furnace and parts • Improperly compressed ferrite powder can lead to porosity issues



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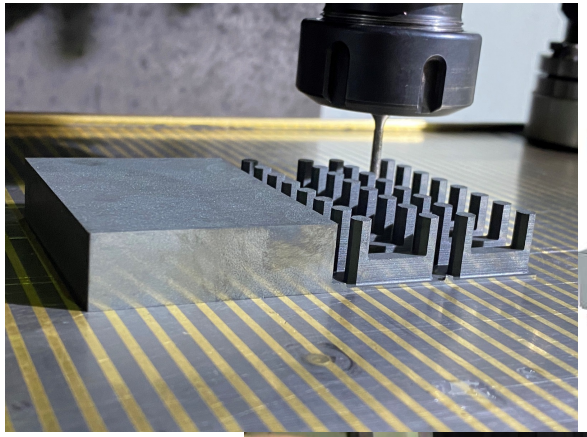
Machining Ferrites

- Because ferrites are very brittle, machining operations are limited
- Machining can be used to clean up surface defects
- Machining of ferrites can be used for the gapping of ferrite cores
- Machining can be used to obtain tighter tolerances on ferrite blocks
- Machining cores is ideal for prototyping in low-volume



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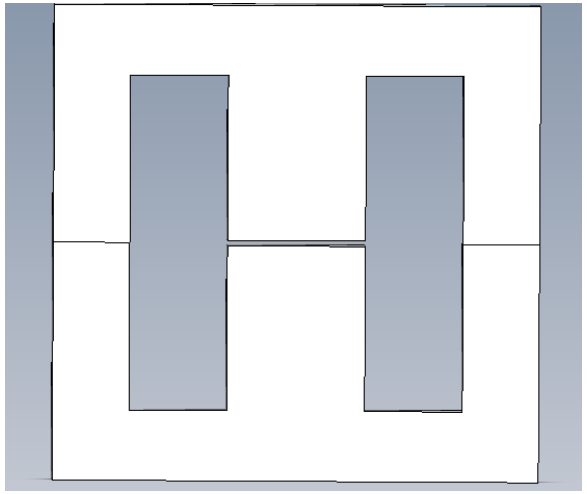
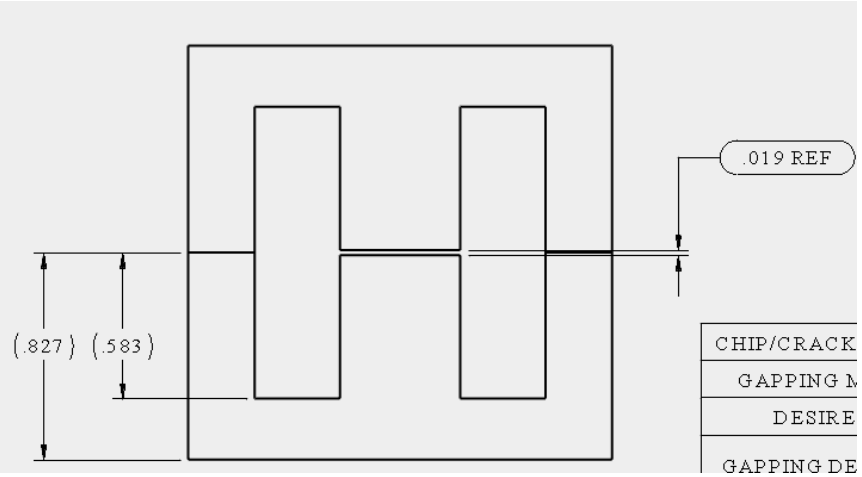
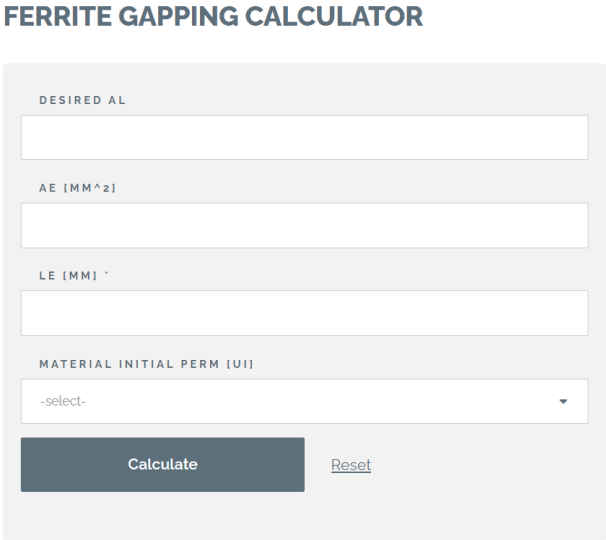
Gapping of Cores

- Gapping is the most common machining operation performed on ferrite cores
- Gapping involves removing material from a core (typically the center leg) to a specific dimensional or electrical tolerance
- Designers use gapped cores for a variety of reasons, including preventing core saturation, increasing reluctance, and controlling inductance
- The gapping calculator on Dexter's website can be used to determine gap length from desired A_L value



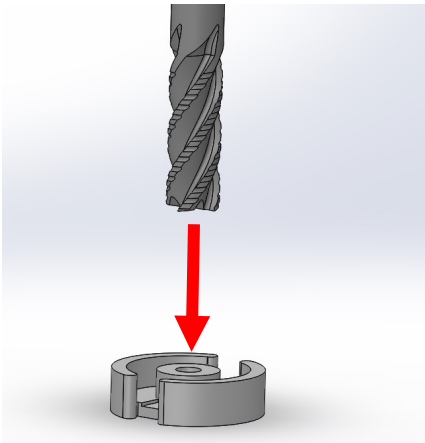


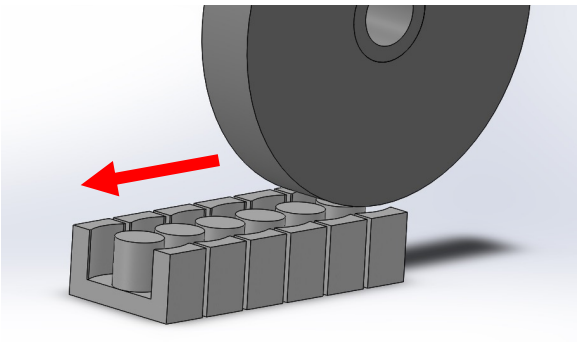


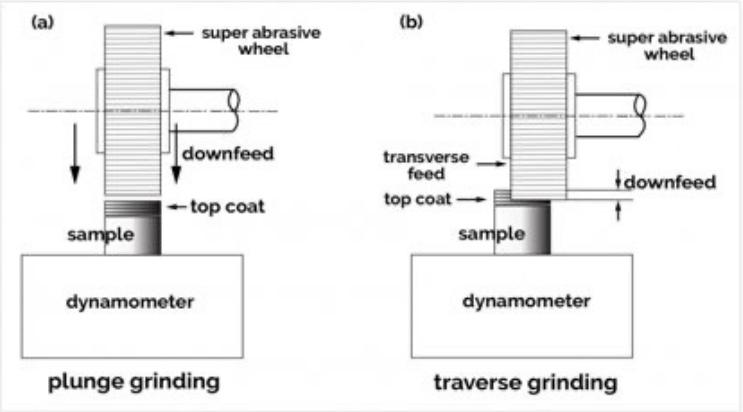
Gapping of Cores

- Gapping is done by one of two methods, either traverse (sided to side) gapping or plunge (up to down) gapping

- The diagrams to the right, show the applications of traverse gapping and plunge gapping in the case of a pot core and e-cores

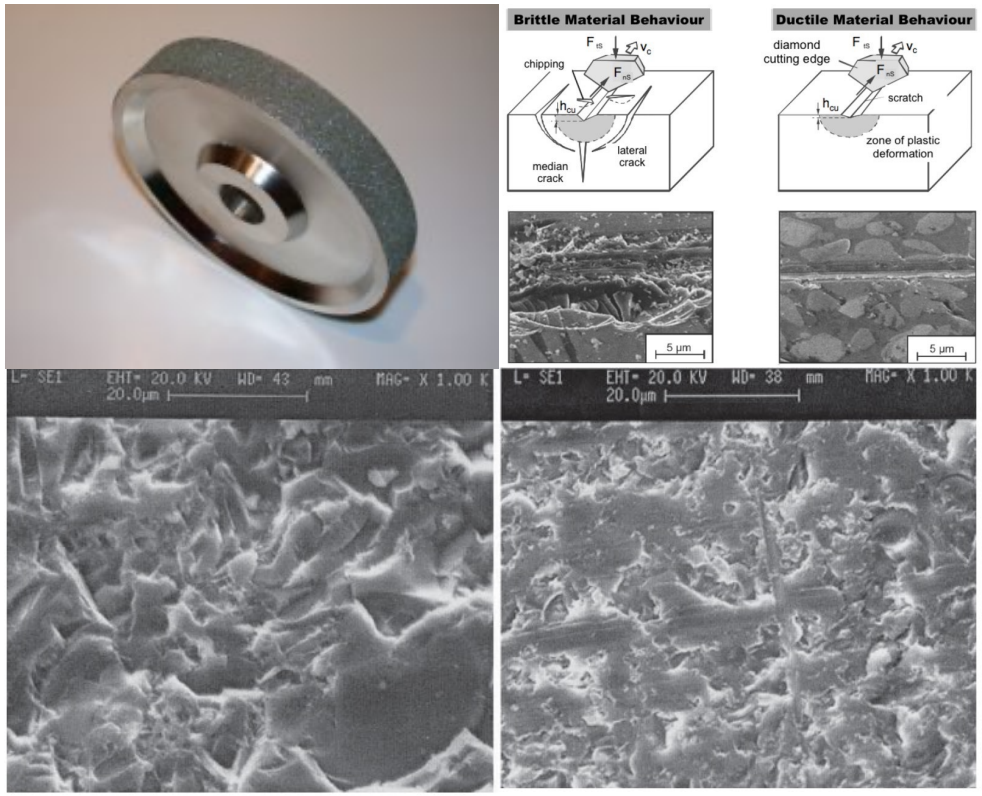






Grinding

- Grinding is one the most common and important machining operation performed on customized ferrites
- It is best to use a super abrasive grinding wheel like diamond
- Correct determination of grinding parameters is crucial and can prevent substantial damage to the structural integrity of the ferrites
- To the right are diagrams demonstrating Ductile, Fracture, and Partial Ductile modes of grinding. These grinding parameters are critical and can affect surface and sub-surface integrity



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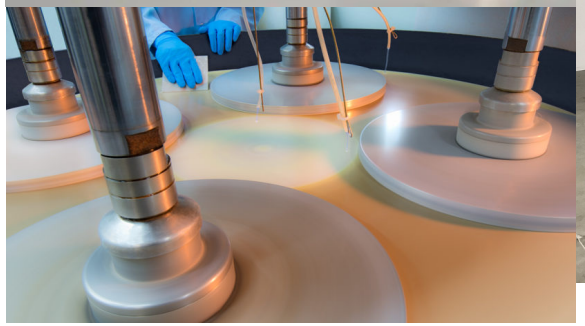
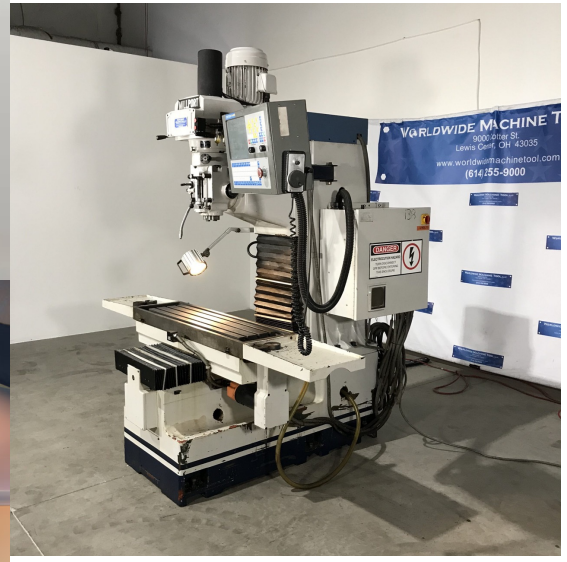
Other Operations

- In addition to grinding, CNC mills and centerless grinders may be used as well
- It is important use coolant in order to remove significant differential thermal expansion which causes spalling/fracturing
- A goniometric head may be utilized to achieve non straight cuts on ferrites
- Lapping, can be used to obtain a better surface finish at the mating surfaces, yielding better magnetic performance of ferrite cores





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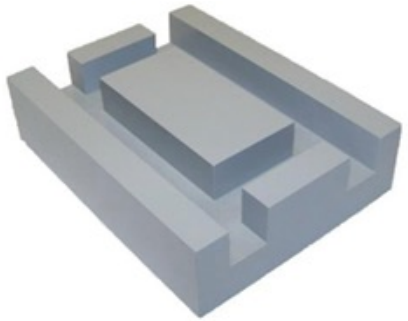
Special Core Shapes

- Special or customized cores are usually implemented in the case in which standard core shapes cannot achieve mechanical, magnetic, or aesthetic specifications
- Special core shapes can be manufactured to accommodate special air gaps or the insertion of steps, pitches, slants, caps, slots etc. to influence the modulation or allow space for mechanical/electrical components

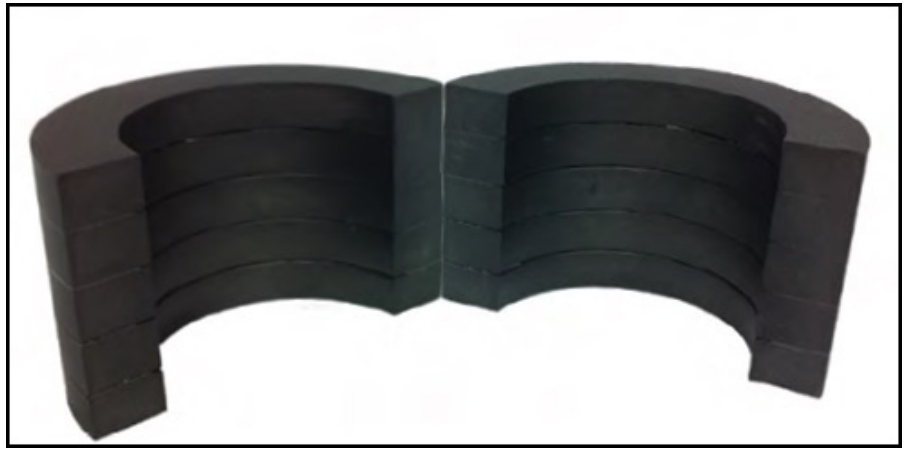


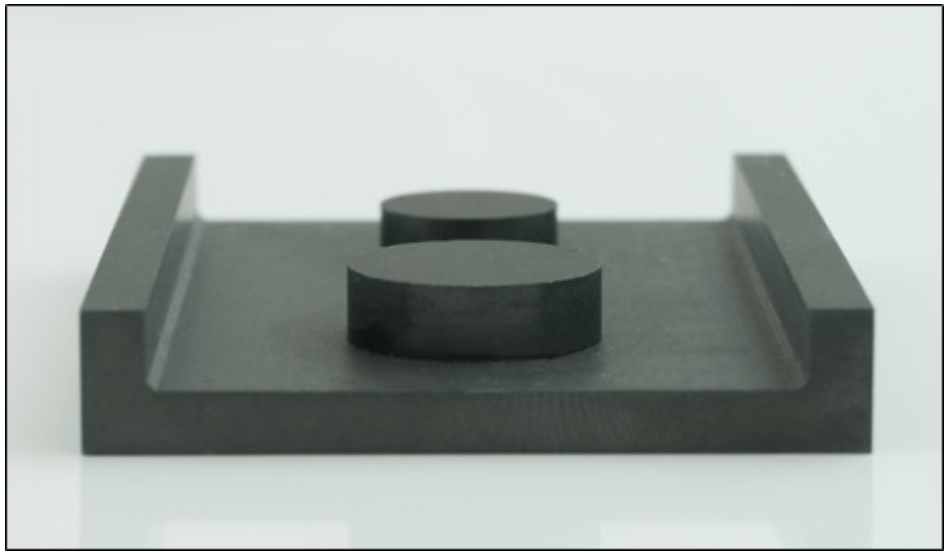
Special Core Shapes: EXAMPLE 1

- Ferrite assembled, glued and cut in half to be used as a snubber on a power cable

- Machined ferrites for use in a PLANAR application

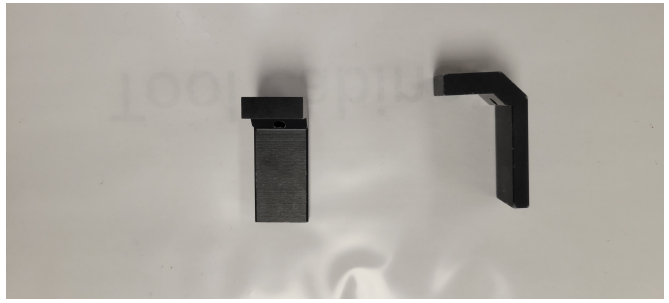
- Prior to Dexter's addition of the HAAS, this design would need to have been made from 3 pieces, causing an unwanted gap at the joint lines



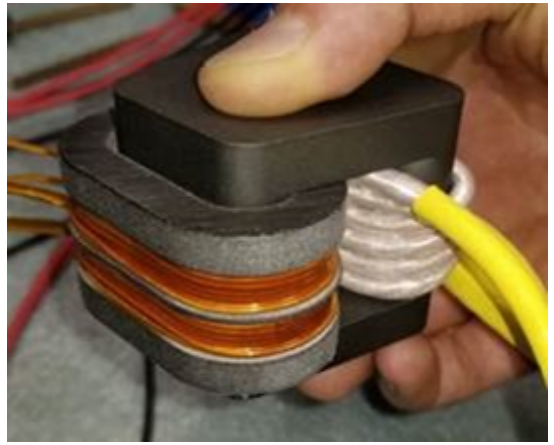


Special Core Shapes: EXAMPLE 2

- Photos of machined ferrites from blocks and windings used in a deflection assembly



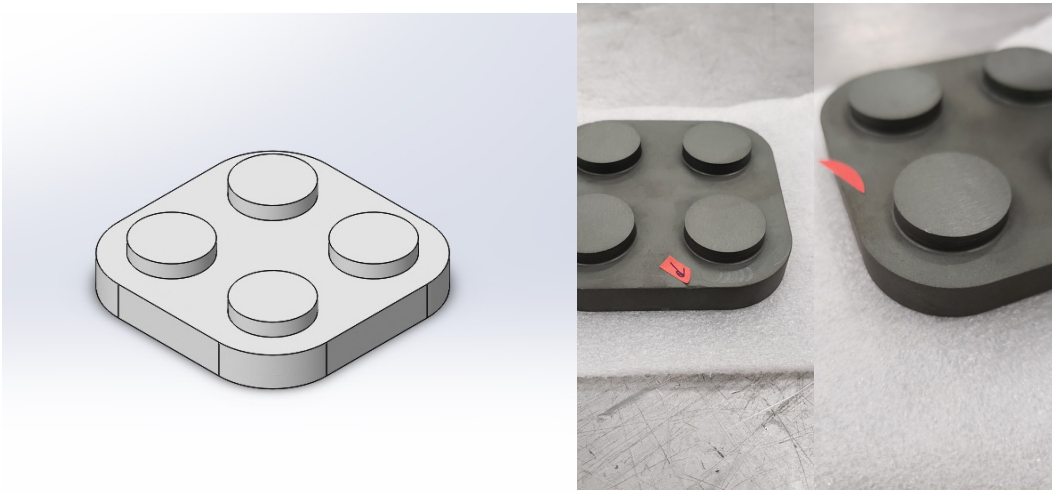
- Machined ferrites being for use in unique power supply designs – one showing turning single phase core into three phase cores, the other displaying further use of CNC



Special Core Shapes: EXAMPLE 3

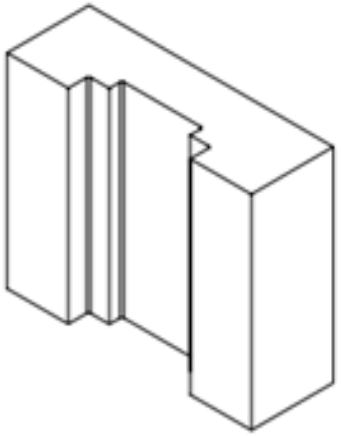
- Ferrite for Hall Effect current sensor where a standard ferrite toroid has a cut taken out so fringing lines of magnetic flux can be measured

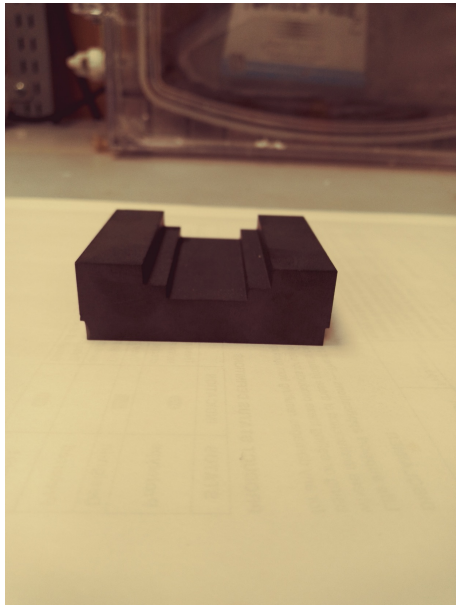
- Machined ferrites developed for a high current, low profile inductor
- This design could not have been made by Dexter prior to the addition of the HAAS

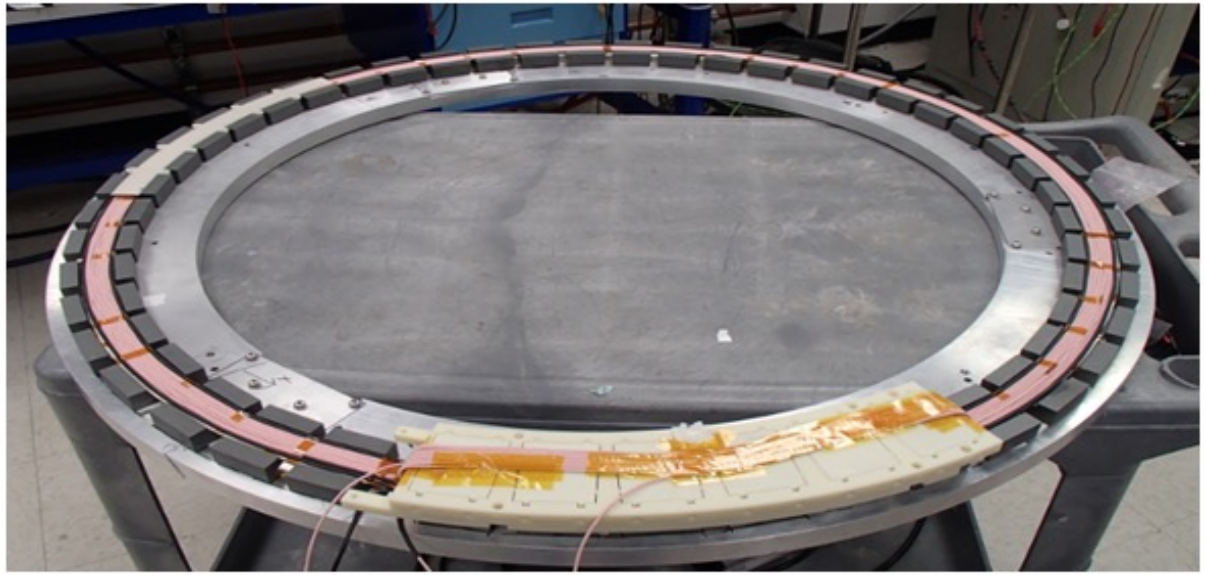


Special Core Shapes: EXAMPLE 4

- This is an example of a core machined completely from a ferrite block
- Because of their relatively simple geometry and tight tolerancing, they were best manufactured using machining operations
- Project for 3-D scanners to give TSA agents a clearer view of potential problems in bags, including explosives, and designed to go twice as fast checking carry-on bags

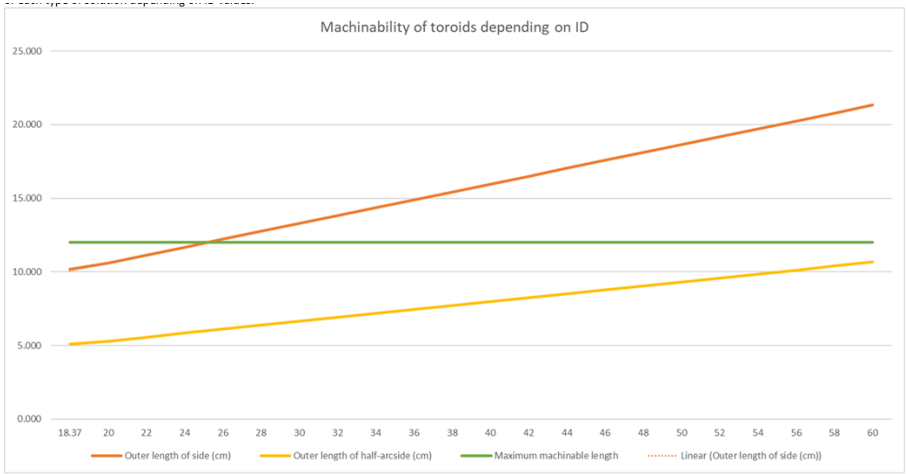


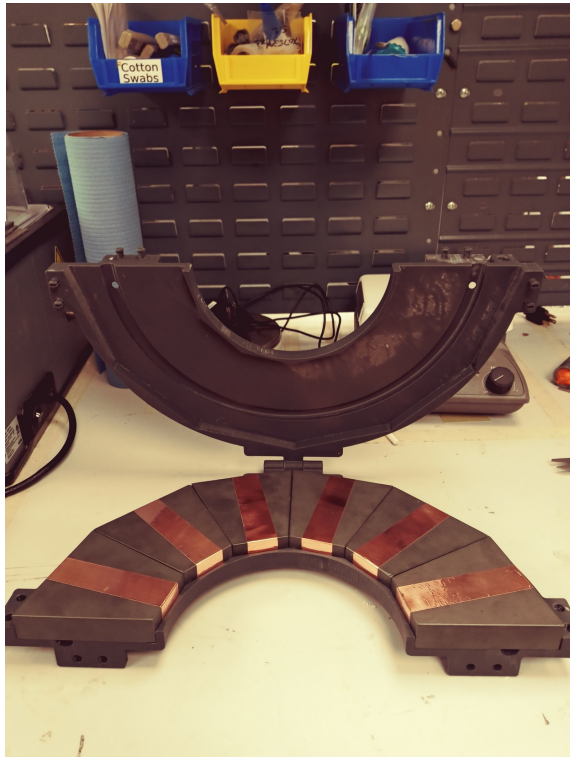




Special Core Shapes: EXAMPLE 5

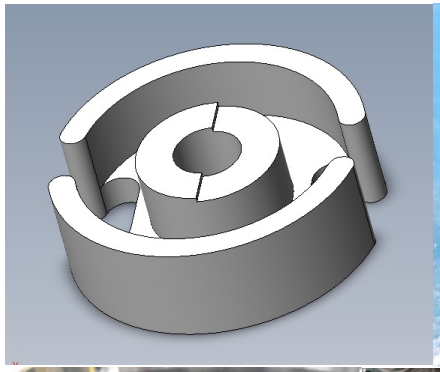
- To the right, a prototype for a polygonal ferrite toroid can be seen
- This custom toroid had to be machined and assembled due to the size limitations of a sintering furnace. Calculations and analysis were performed in order obtain the feasibility of machining different sizes of toroids
- 12 3C95 grade trapezoidal ferrite blocks were machined using a diamond wheel to grind them to size. They were then assembled using structural adhesive

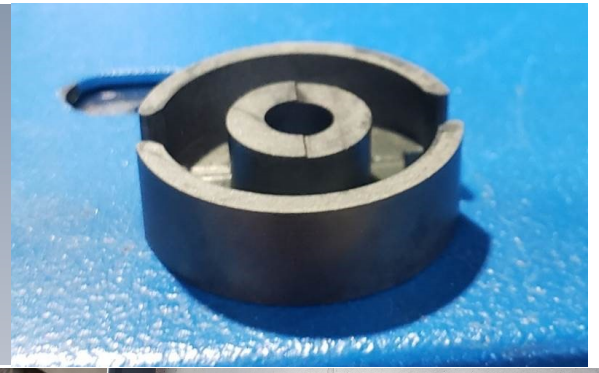


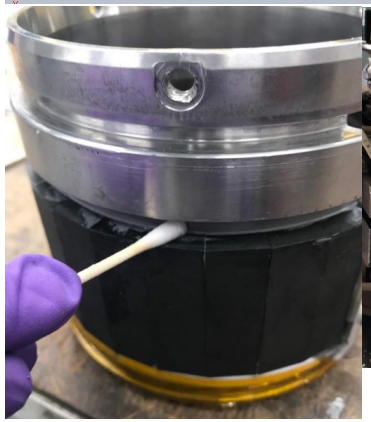


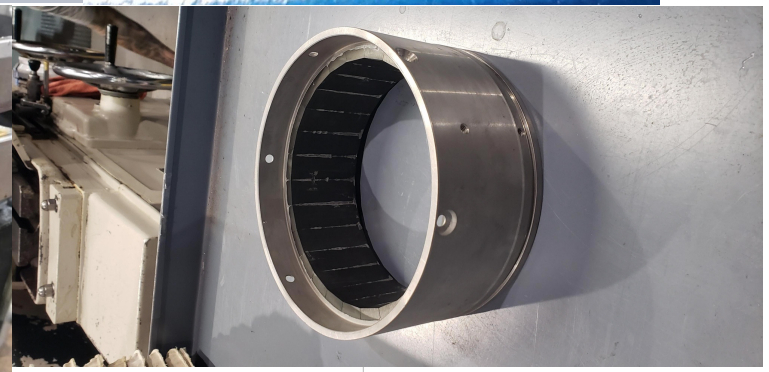
Special Core Shapes: EXAMPLE 6

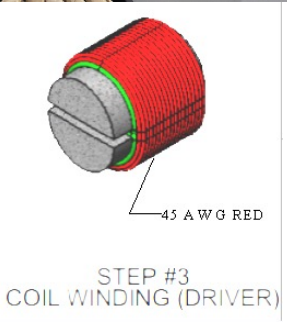
- Firstly, we see a pot core with a custom gap. It is step-gapped, as can be seen in the pictures
- The next pictures show custom machined arc ferrites glued to the ID and OD of a housing. When assembled, these parts create a down-hole rotational transformer
- Lastly, a picture of a custom ferrite winding used in a rechii rotor is shown











Conclusion

KEY TAKEAWAY: Depending upon application and quantity there are trade-offs when determining whether to use a sintered core or a machined core. It is important to consider critical aspects of end use in this determination.

Special Thanks To:

- Ivan Ambriz
- Chuck Wild