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# CAD AND FEA SOLID MODEL GEOMETRY INPUT INTERFACE FOR MCNP

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## ABSTRACT

In recent years it has become industry practice to directly transfer CAD geometry from native CAD program directly into FEA codes to perform structural and thermal analyses. Many CAD interfaces and FEA programs also have the capability to export geometry into standard MCNP file format. This paper explores the process of exporting geometry for CAD and FEA programs and the benefits and limitations of the process.

## INTRODUCTION

In recent years it has become industry practice to directly transfer CAD geometry from native CAD program directly into FEA codes to perform structural and thermal analyses. Many CAD interfaces and FEA programs also have the capability to export geometry into standard MCNP [1] file format. This is a very useful tool, considering that creating one CAD model can potentially generate the geometry for any necessary structural, thermal, criticality, and shielding analyses necessary for a package. The capability to make this conversion between coding platforms can reduce the duplication of efforts in creating the same geometry multiple times for different codes. Adding to this convenience is the fact that the process is very automated as long as a certain set of rules are followed through the process.

## CONVERSION PROCESS

Through this process Autodesk Inventor [2] can be used to efficiently create an MCNP geometry using the geometry capabilities available in CAD, including the efficient creation of 3D objects, the ability to create copies of CAD bodies, and the 3D display of CAD geometries.

The first step in this process is to use Autodesk Inventor or some other CAD program to generate a CAD geometry. An example a CAD geometry for a drum created in Autodesk Inventor is shown below in Figure 1.

**Figure 1. CAD Model generated using Autodesk Inventor**

This CAD geometry can be directly transferred into an FEA code such as ANSYS Workbench [3] for thermal and structural analysis. ANSYS Workbench can import Autodesk Inventor solid model CAD files and convert CAD files to an ANSYS Neutral File (ANF) format. At this point the regions in the model should be defined Solid model CAD files can be modified to conform to the more restrictive constraints of an MCNP geometry. The CAD model shown in Figure 1 is converted into the ANSYS solid model format as shown below in Figure 2.

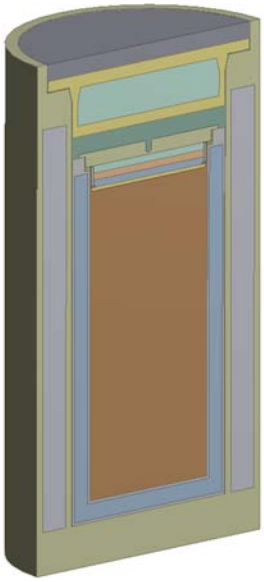

**Figure 2. ANSYS Workbench Model converted from Autodesk Inventor CAD Model**

The ANSYS solid model can then be exported to a Monte Carlo N-Particle (MCNP) input file format. Visual Editor for MCNP [4] can be used for and graphically displaying visually editing input files for MCNP. The MCNP input file that is generated will include all of the surfaces and

defined cells for this geometry. All that is let to do in order to visualize the 3D model in MCNP Visual Editor is define the materials of each of the cells. Figure 3 below shows the image from MCNP Visual Editor of the geometry model generated by ANSYS Workbench.

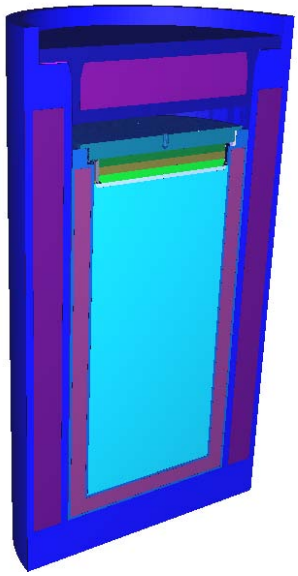

**Figure 3. MCNP Model converted from ANSYS Workbench Model**

This CAD conversion process can be effectively used by any MCNP users developing new MCNP geometries from scratch and by users who have a currently existing CAD model that was not initially developed for export to MCNP. The only issue with using a CAD model that was originally developed for purposes other than creating MCNP geometry is that it may not follow the rules necessary for a simple conversion. The advantage of this approach is to streamline the cask licensing process by generating models that are capable of being used as both shielding and thermal mechanical models.

## RESTRICTIONS

There are certain rules that must be followed when models are being converted into MCNP files. These rules are due to the modeling restrictions of MCNP. The first rule that must be followed when creating CAD geometry for conversion to MCNP is: there cannot be any splines in the model (each CAD surface must be expressed as a general second order quadratic). MCNP also will not allow a rotated torus to be included in the geometry. If there is a Torus in the model it must be perpendicular to the X, Y, or Z axis. There also cannot be any regions of the model that are undefined or double defined. Also, regions in the CAD model can't be too complex, such that they cannot be created as an MCNP cell. Such complex regions must be split up into simpler regions. Finally, only a limited number of unions and intersections are allowed for this conversion.

## MCNP VISED CONVERSION

There is also a tool incorporated in MCNP Visual Editor that offers the ability to convert cad files to an MCNP input format [4]. For this tool the CAD model should be exported as a *.SAT

file, which can then be read into the Visual Editor [5] and be converted. This tool does not seem to work as reliably as the conversion tool included in ANSYS Workbench, however it is an option to consider. The Visual Editor is distributed by the Radiation Safety Information Computational Center (RSICC) as part of the MCNP6 package [1].

## REFERENCES


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