TopAct: Automated Translation from CAD to Combinatorial Geometry

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INTRODUCTION

Modeling of complex three-dimensional engineered systems in the standard radiation transport tools MCNP and TART has traditionally been inhibited by geometry concerns. Most of these systems are designed in the framework of a commercial Computer Aided Design (CAD) package, but the geometrical paradigms used in these products are fundamentally different from the Combinatorial Geometry (CG) framework used in the radiation transport codes. Engineers at Raytheon Missile Systems have developed an automated system for bridging the gap between CAD and combinatorial geometries called TopAct, for “Translation Optimization for Part-wise Adaptive Combinatorial Transport”. TopAct has been demonstrated to provide highly accurate, efficient CG representations of real-world parts designed in the ProEngineer CAD system. TopAct thus enables substantial cost savings in the production of radiation transport geometry models, along with attendant benefits in the complexity and accuracy of these models.

TOPACT CAPABILITIES

TopAct provides an end-to-end translation capability. It accepts as input part files in the standard STEP format common to most of the popular CAD products. Using a pre-processor developed as a part of the Adaptive Modeling Language (AML) development environment licensed by Technosoft, Inc., STEP files are read in and analytical surface data are extracted. TopAct uses this data to compute an efficient zoning statement for part geometry and any void space in the model. The final optimized form of the zoning statement and surface prescriptions are output in both MCNP and TART formats; tools exist in either code system to validate the model by inspection.

A demonstration of the accuracy of TopAct translations is shown in Figure 1. For this example, the secondary mirror part depicted in the inset was translated into MCNP format, and the MCNPX code was used to trace rays through the part. The path length data generated by MCNPX were used to compute the total material volume of the part. Using the specified density of the material, the total weight of the part was computed. Figure 1 compares this Monte Carlo weight approximation to the deterministic computation performed by ProE on the original CAD part. It is observed that the error in the weight decreases log-linearly as the number of samples increases. This is consistent only with geometrical representations of the part that are identical to within the lowest error projection of the curve. Therefore in this case the translation is accurate to at least one part in one thousand, and very probably one part in ten thousand.

The ultimate capability of TopAct is emergent; it allows radiation transport analysts to fully participate with mechanical designers as a system design is evolved. When translations are performed by hand, detailed transport models are typically produced only very late in the cycle, as cost precludes multiple iterations. This frequently leads to inelegant design patches when transport calculations reveal system shortcomings. Because TopAct reduces translation time by as much as three orders of magnitude, it allows designers and analysts to evolve their high-fidelity models in parallel, and to discover weaknesses early in the design phase. This cooperative arrangement often leads to more elegant, efficient, superior delivered components and systems.

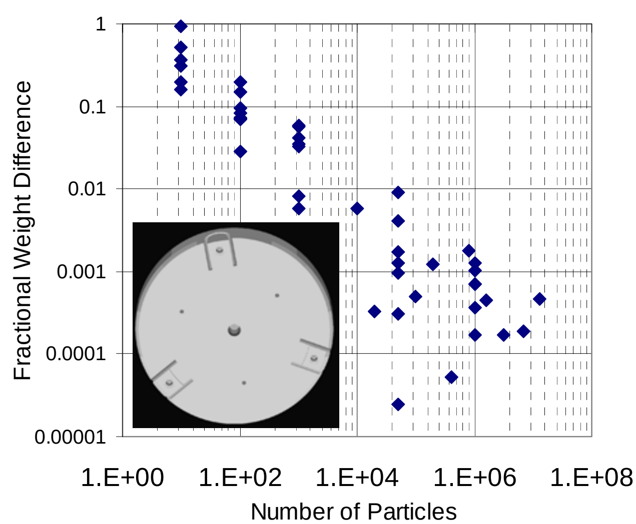

Fig. 1. Weight computation error as a function of number of samples.

CONCLUSIONS

The TopAct code is an accurate and efficient means of computing CG representations of engineered parts, components and systems. TopAct translations have been demonstrated to achieve accuracies of better than 99.9% of net part weight. Implementation of the TopAct software can result in cost-savings and design improvements stemming from interdisciplinary collaboration throughout the design cycle.

REFERENCES

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