1.2 Space Station Oct Tree Example

What will be learned:

- How to use oct-trees to accelerate execution time
- How to postprocess radk results

In this example, the use of Oct-trees in accelerating RadCAD radiation calculations will be explored. The space station model will show how changing a single oct-tree parameter can significantly decrease the amount of time required to perform radiation analyses. It is recommended that all users work through this example, even if not employed in the aerospace industry. Decreasing the computational time can be applied to any type of radiation problem.

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1. Double click on the file spaceStation.dwg located in the Tutorials\RadCAD\OctCells folder.

   Thermal Desktop opens with the spaceStation drawing on the screen.

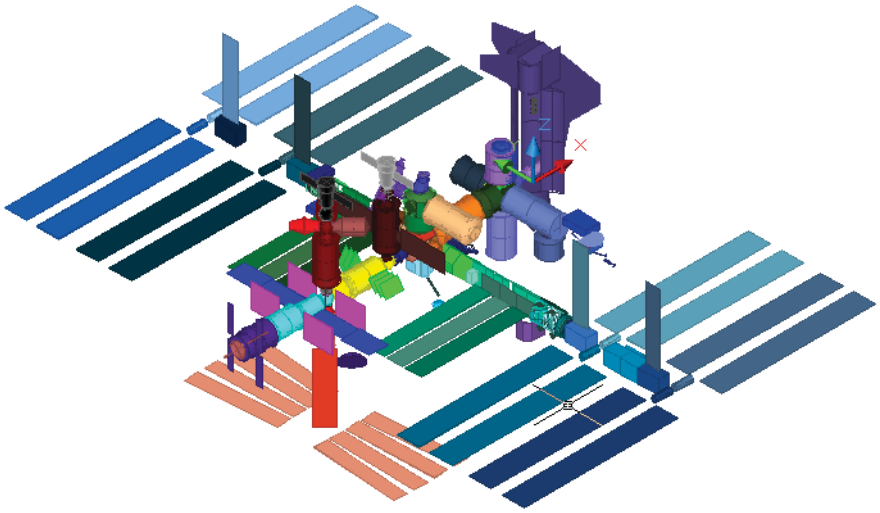

Figure 1-4: Space Station Oct Tree Initial View

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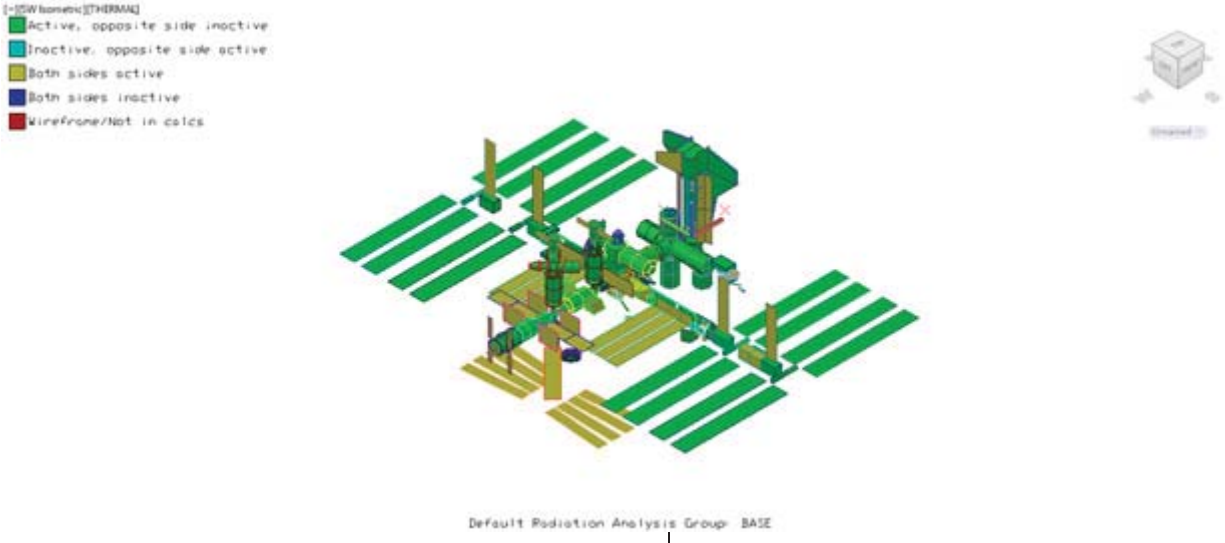
2.  or **Thermal** > **Model Checks** > **Display Active Sides**.	Verify active sides. Everything should be green and yellow. Note that some computers without a decent graphics card may show the solar panels as blue. This is an artifact of color bleeding as the solar panel has been created in this model as two surfaces, that are separated by a small amount, and are active in opposite directions.
	
3. Select **Thermal** > **Radiation Calculations** > **Set Radiation Analysis Data**. The Radiation Analysis Data dialog box appears. 4. Select the Control tab if not already displayed. 5. Highlight the value in the Rays per node field and type 500 if the current value is different.	Set the number of rays to 500 and note the number of Oct-tree subdivisions.
6. Select the Advance Control tab. Notice the Max oct-tree subdivisions: field is set to 6. 7. Select the Radk Output tab. 8. Clear Generate SINDA/FLUINT input after calculations. 9. Select OK to close the Radiation Analysis Data dialog box.	Remove the option to generate the SINDA/FLUINT input.

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10. Select **Thermal > Radiation Calculations > Calc Radks Ray Trace**. A Thermal Desktop/AutoCAD dialog box asking for confirmation to continue appears. 11. Select OK to close the dialog box. 12. Press <F2> to find the time to calculate the radks. 13. Press <F2> to close the text window.	Calculate radiation conductors. The default analysis group and the currently loaded optical properties will be used to calculate radks. Record the amount of time required to perform the radk calculations. This is most easily done by hitting the <F2> function key. The text window will appear. The amount of time to calculate the radks is needed. That value can vary based on CPU speed, the number of CPU's available and the number of other applications running.
14. Select **Thermal > Radiation Calculations > Set Radiation Analysis Data**. The Radiation Analysis Data dialog box appears with the Radk Output tab displayed. 15. Select the Advanced Control tab. 16. Highlight the current value in the Max oct-tree subdivisions field and type 7. 17. Select OK to close the dialog box.	

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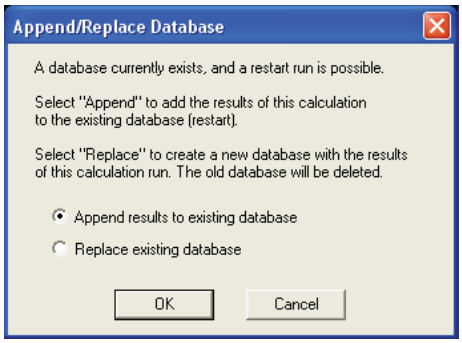
18. Select **Thermal > Radiation Calculations > Calc Radks Ray Trace**.

    A Thermal Desktop/AutoCAD dialog box asking for confirmation to continue appears.

19. Select OK to close the dialog box.

    The Append/Replace Database dialog box appears.



20. Select the desired option.
21. Select OK.
22. Press <F2> to find the time to calculate the radks.
23. Close the text window when finished reviewing.

Since the database from the previous run already exists, the program asks if the user wants to “append” or “replace” the existing database.

Appending will add 500 more rays to the existing database, making it 1000 total rays. Replacing will replace the database. For this example, either selection is sufficient.

Record the amount of time required to perform the radk calculations. This run should be about 30% faster.

Note: The times are clock times, so the time required to respond to the Append/Replace Database form will affect the results. If your new time is slower, try again, but respond more quickly to the form that appears.

Each run shot 500 radk rays, and only one parameter was different, the Max oct-tree subdivisions. Please keep in mind that the oct-tree does not affect the answers, but only the speed at which they are arrived. The oct-tree breaks the model into smaller regions, and limits the amount of intersection tests performed.

Every model has an optimal number of Max oct-tree subdivisions and Max surfaces per cell that will calculate the radiation job the fastest. CRTech has found that the subdivisions parameter affects the results much more drastically than the surfaces per cell. Some models will run 10 times faster by changing the subdivision setting. In other models, the subdivision setting does not affect the CPU time. Some models may run fastest with subdivisions equal to five, while others may require subdivisions equal to 9. In conclusion, the user should run test cases to find the optimal parameters.

An easier method to determine the optimum Oct-Cell settings is to use the Optimize Cells command as described below.

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24. Select **Thermal** > **Radiation Calculations** > **Optimize Cells**.

    The Optimize Cells form opens.

25. Under Vary the Subdivisions, enter 6 for From and 9 for To.

26. Under Vary the Surfaces Per Cell, enter 8 for **From** and 8 for **To** and 1 for Increment.

27. Enter 1000 for Number of Rays.

28. Select **OK** and confirm any dialogs that appear.

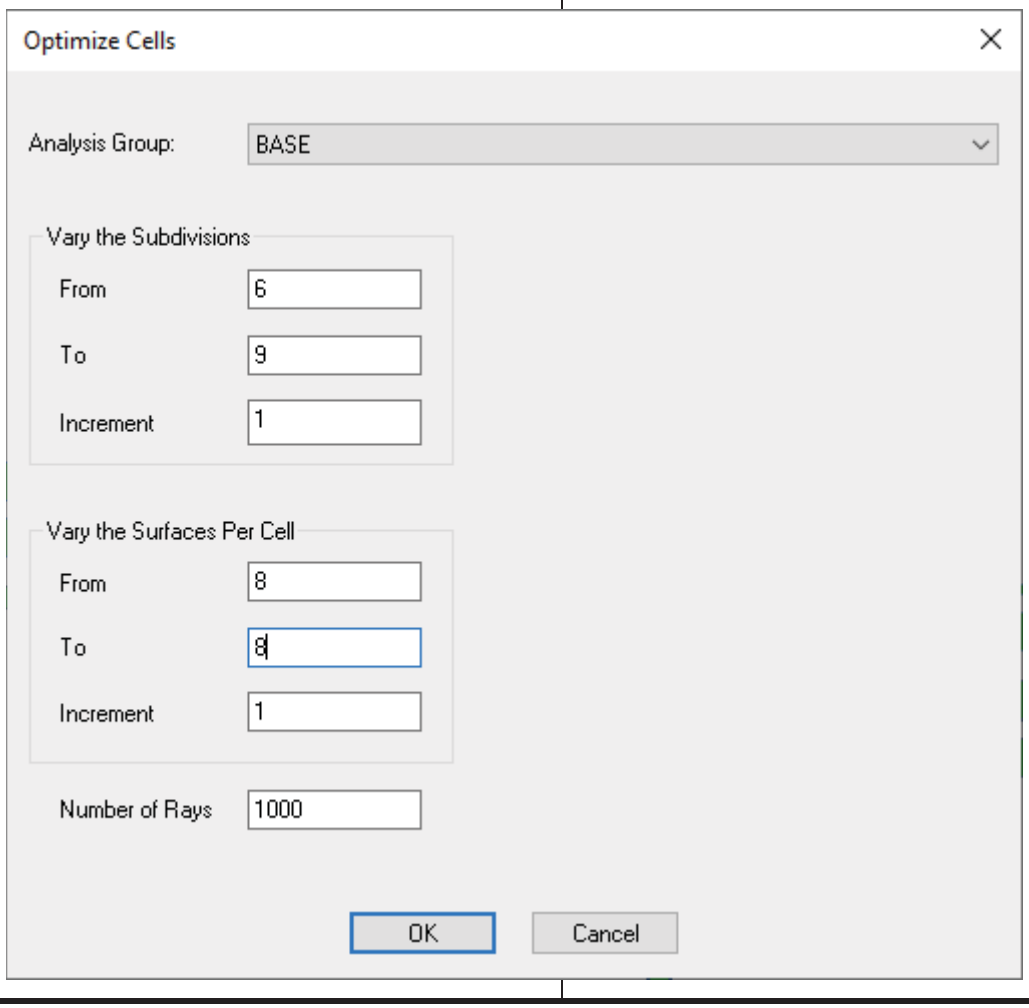
    After the calculations are completed, a document called OptimizeCells.txt is opened.

29. Close OptimizeCells.txt and AutoCAD Text Window.

The Optimize Cells command runs a small radiation calculation using a variety of settings for the Oct-Cells. Each run uses the same random seed number to minimize the differences between the runs.

The stronger variation in run time is usually caused by the number of subdivisions. For time reasons, we will only change subdivisions for this tutorial.

It is important that the amount of time required for each test is substantial enough to see true run time changes, and not just CPU or operating system effects. Ideally, each setting should run for at least 30 seconds of CPU time. This can be controlled by the number of rays shot per run.



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Examining the document, you will see at 3 main sections. The first section is the OctCell generation time. The second section is the maximum number of surfaces in any one cell. The third section Provides the ray tracing time.

With a large change in the values in the second section, as seen from 6 to 7 subdivisions, a large benefit can be realized. With a smaller change in Surfaces per Cell, as seen from 7 to 8 subdivisions or 8 to 9 subdivisions, a smaller benefit will be realized.

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```
[ AutoCAD - Sun Mar 31 16:20:40 2019  ]-----------------------------------

Results for Oct-tree cell optimization for analysis group 'BASE'

     Database setup I/O time = 0.034000
     Ray tally I/O time      = 0.238000
     Total I/O time          = 0.272000


     OCT-TREE GENERATION TIME

          Max Surfaces Per Cell
    Levels         8
         6      0.08
         7      0.13
         8      0.31
         9      1.07



     ACTUAL MAX SURFACES PER CELL

          Max Surfaces Per Cell
    Levels         8
         6       217
         7        75
         8        50
         9        34



     RAY TRACING TIME (1000 rays)

          Max Surfaces Per Cell
    Levels         8
         6      6.35
         7      3.92
         8      3.03
         9      2.61



Notes:

1) Database setup I/O time, Ray tally I/O time, and Oct-tree generation
   time are all independent of the number of rays shot.

2) Ray tracing time scales with the number of rays shot.

3) Time for a different number of rays can be estimated from the results:
      Estimated ray time = ray tracing time * desired rays / rays shot
      Total time = Total I/O time + Oct-tree time + Estimated ray time

4) An actual number of surfaces per cell greater than the desired number of
   surfaces per cell indicates that the max number of subdivision levels was
   reached before the maximum surfaces per cell condition was met.

5) The following is a summary of the submodels used in the last cell that
   calculations were made.
        Submodel Count
        N2SCBM   30
        ALENIA   2
        JEM      2
```

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30. Select OK to close the dialog box. A Thermal Desktop/AutoCAD dialog box asking for confirmation to continue appears. 31. Select OK. 32. Press <F2> to view test progress and results. 33. Close the text window when finished reviewing.	

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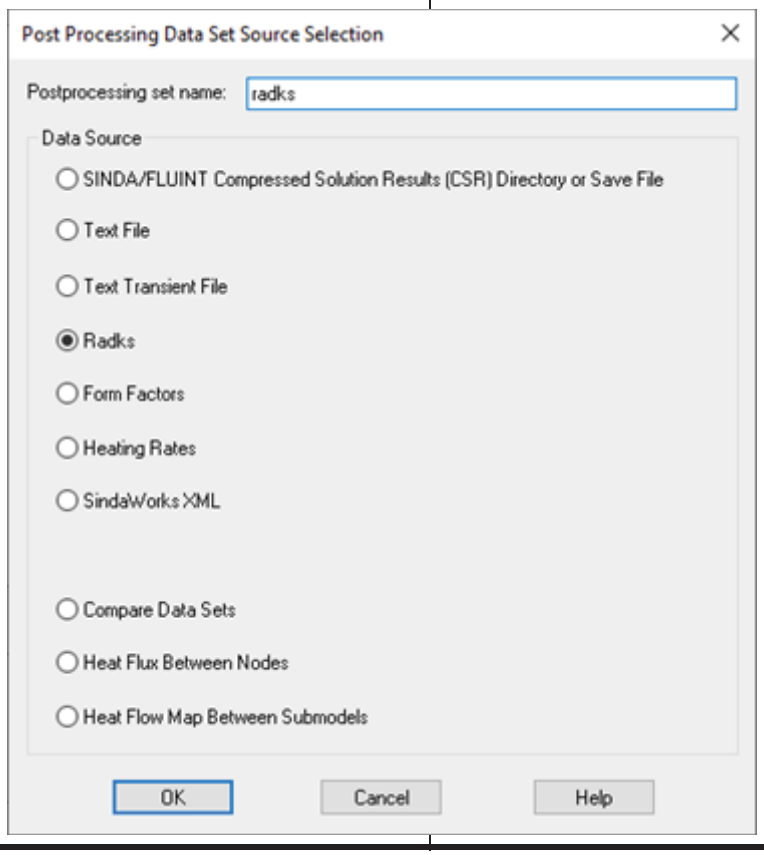
34. Select **Thermal** > **Post Processing** > **Manage Datasets**. The Postprocessing Datasets dialog box appears. 35. Select Add New. The Data Set Source Selection dialog box appears. 36. Type radks in the Postprocessing set name field. 37. Select the Radks option button. 38. Select OK to close the dialog box. The Directory Select dialog box appears.	Create a new radks post-processing dataset named radks.



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39. Select OK.

    The Set FF/Radk Dataset Properties dialog box appears.

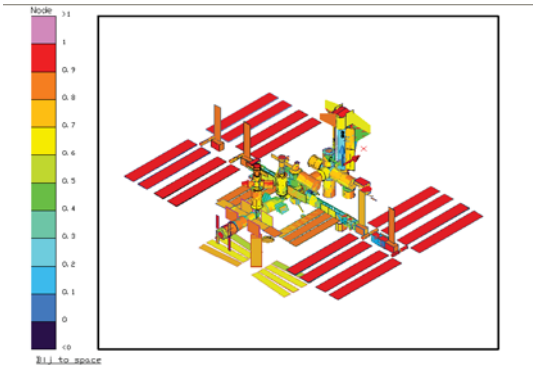
40. Select OK.

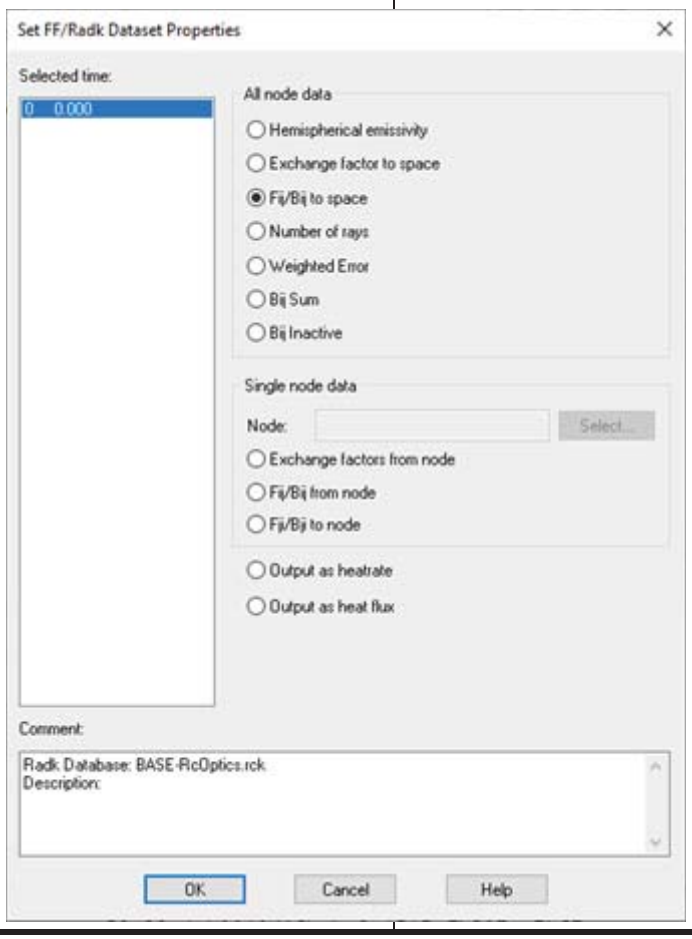
    The Postprocessing Datasets dialog box appears with radks displayed in the Current Data Set field.

41. Select Close.

View the calculated data using a color map. Enter a descriptive comment for the post-processing dataset if preferred. Click directly in the edit field to enter the comment.

A lower value for the radk to space for the interior or shuttle payload bay should be seen.





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42.  or **Thermal** > **Postprocessing** > **PostProcessing off**.	Return to the normal display mode. **Note:** The drawing may be left in postprocessing mode when exiting if desired. It will be reloaded in post-processing mode when the session is resumed. 
43. Select **File** > **Exit**. A Thermal Desktop/AutoCAD dialog box appears asking to save the drawing changes. 44. Select Yes.	Exit Thermal Desktop and save as prompted.

Additional practice:

Use the **Model Checks** > **Check Overlapping Surfaces** command to find the surfaces that might be overlapping in the same plane. Surfaces that overlap in the same plane will most likely cause problems with radiation calculations. Once the overlapping surfaces are found, use the **Model Browser** to isolate the overlapping nodes and try to determine what is wrong with the geometric model. In the Model Browser, select List > Groups to see groups of overlapping surfaces.

Overlapping surfaces can be corrected by offsetting the surfaces slightly.