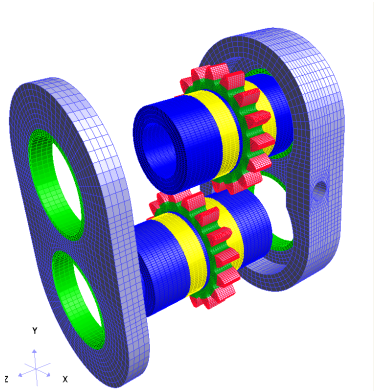

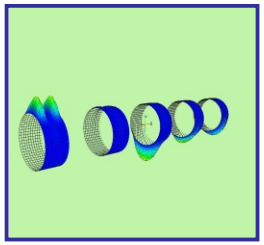

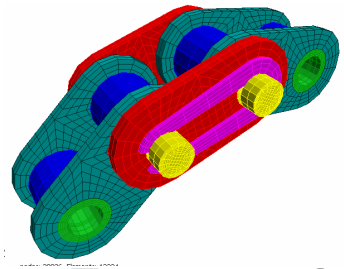

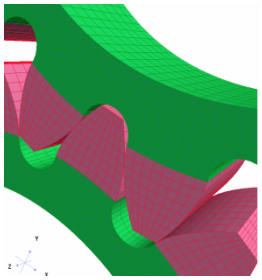

Future Trends Part - 2
Building Ball Bearings – the AIES way

Dr Ian McLuckie

April 2016

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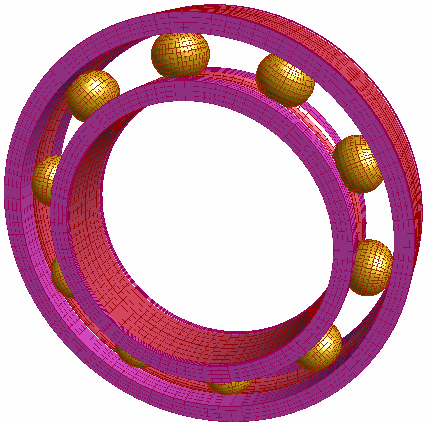
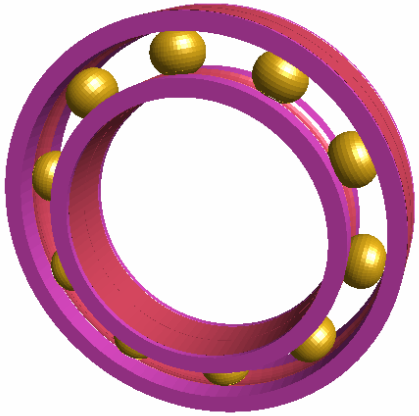
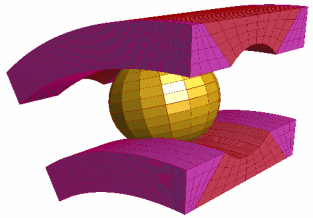
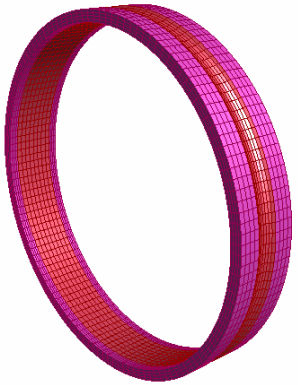
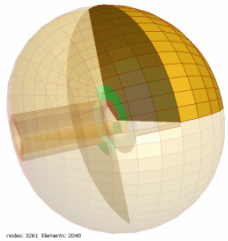
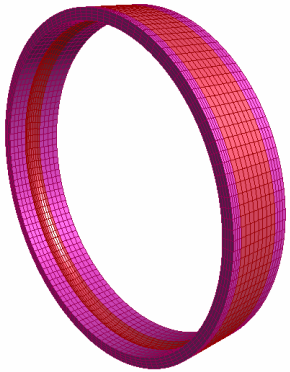


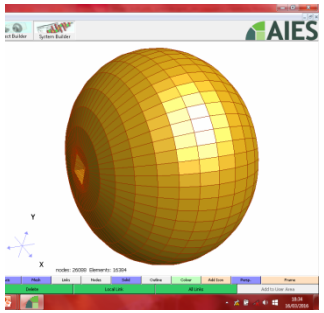












Building a Ball Bearing the AIES way

Tribology and Bearing Design – see future papers regarding Tribology Solvers

Within AIES Ltd we can already build bearings for hydrodynamic lubrication purposes and we have solvers for, Cams, Pistons and Rings. Now we can show, using our new modelling methods how we can build analysis methods for the Rolling Element Bearing (REB). To enable us to do this we would need an EHL tribology solver, (which we have) and a reliable means of generating the contact geometry of the balls plus the inner and outer raceways. Our EHL Tribology solver we currently use for cam and followers, it is generic and includes scuffing and flash temperature analyses. We can also implement our more involved solvers like EHD and TEHD as well in the future by using our generic and transferable methods .

Building a Ball Bearing Assembly

We will now discuss model generation of the ball bearing assembly . The geometry is important for contact mechanics , as the meshed geometry determines the contact stiffness and tribology contact behaviour . The lubrication aspects will be the subject of a future paper.

Lets build an Outer Race.

This geometry lends itself to construction by using an axisymmetric starting Finite Object Assembly model. If we look at a cross section of the outer race we can use this with our revolve operation and generate the Finite Object Assembly through an angle, say 360 degrees or 360/(number of balls).

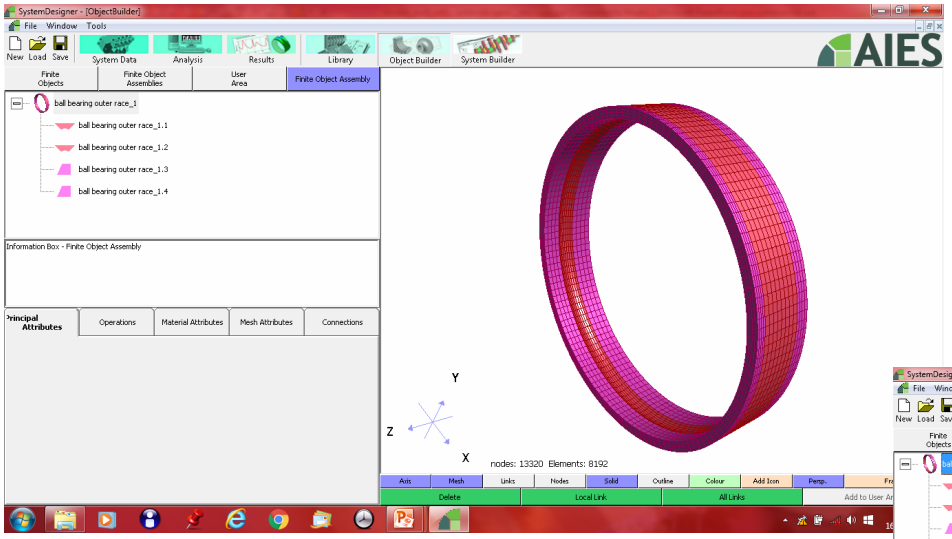
There are a number of ways to construct a ball bearing but we will discuss only two options:

1. Build a cyclic symmetry finite object assembly – this includes ball, outer race, inner race and cage which can be used to automatically generate sized and scaled complete assemblies

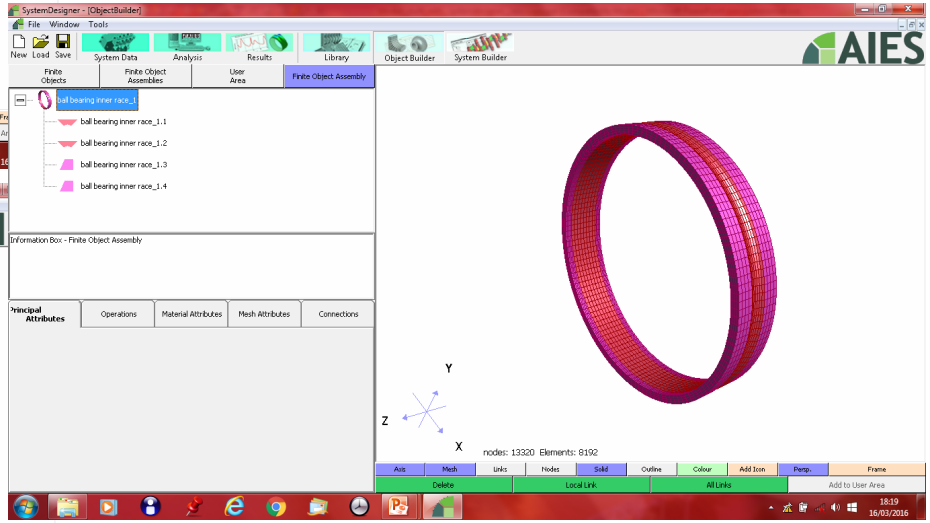
2. Build an outer race that you revolve through 360 degrees – this can be an object (totally closed)

we are going to use option 2. to show how easy it is to build a bearing. Option 1 is more useful for automatic methods of construction, and allows scaling, the building ranges of bearings, and improved mesh enhancement in the contact zones.

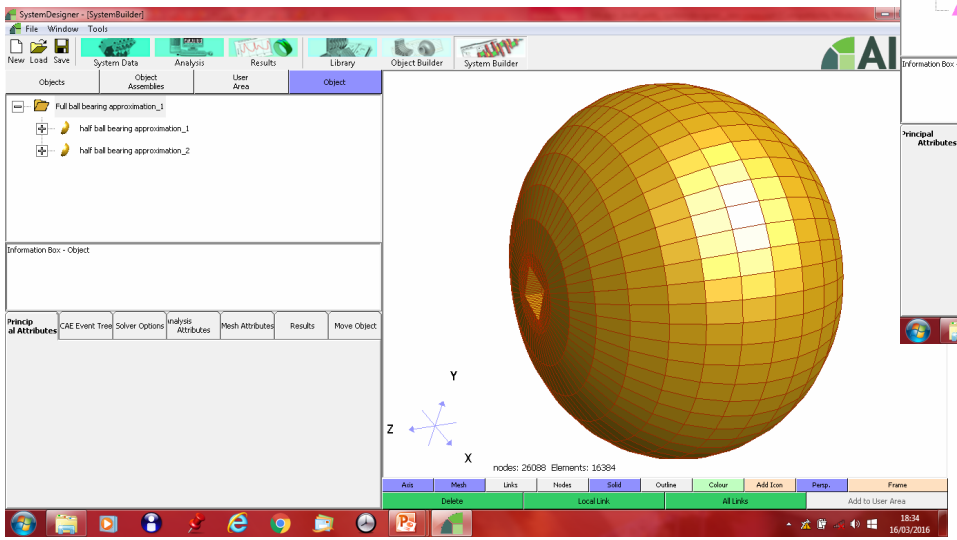
Ball Bearing - Objects



Outer race built with finite objects



Inner race built with finite objects



Ball built with finite objects

Ball Bearing Sector Finite Object Assy

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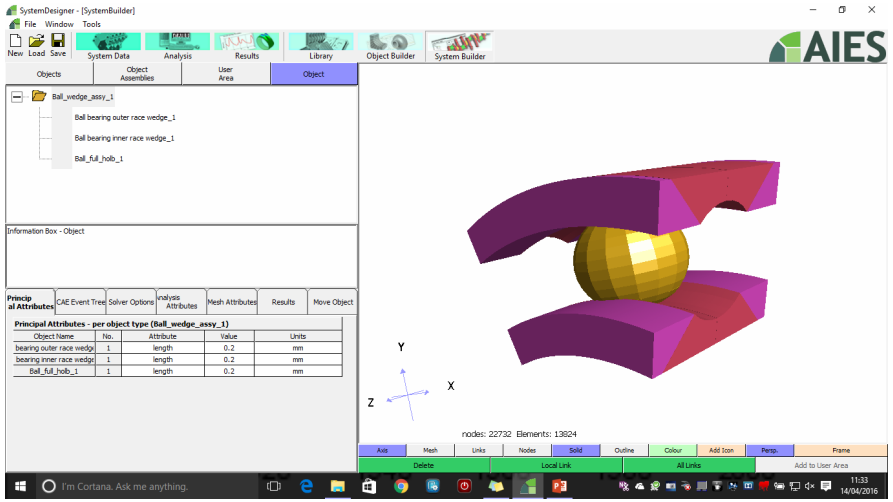
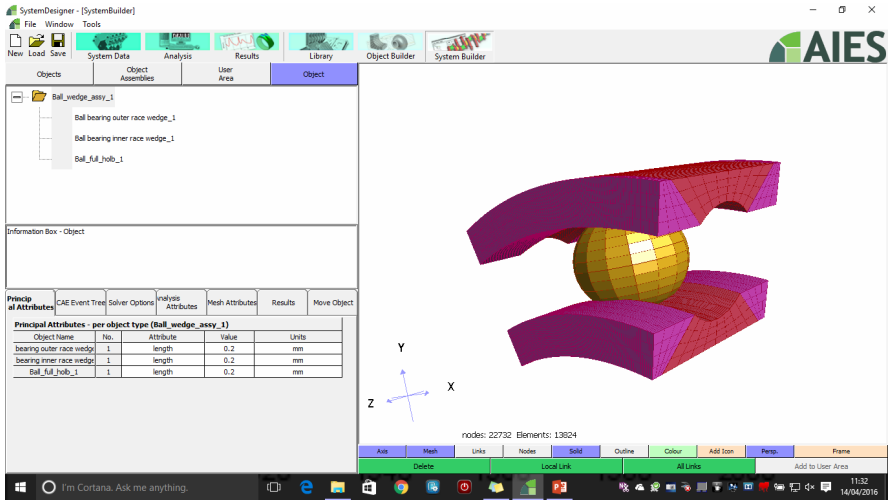
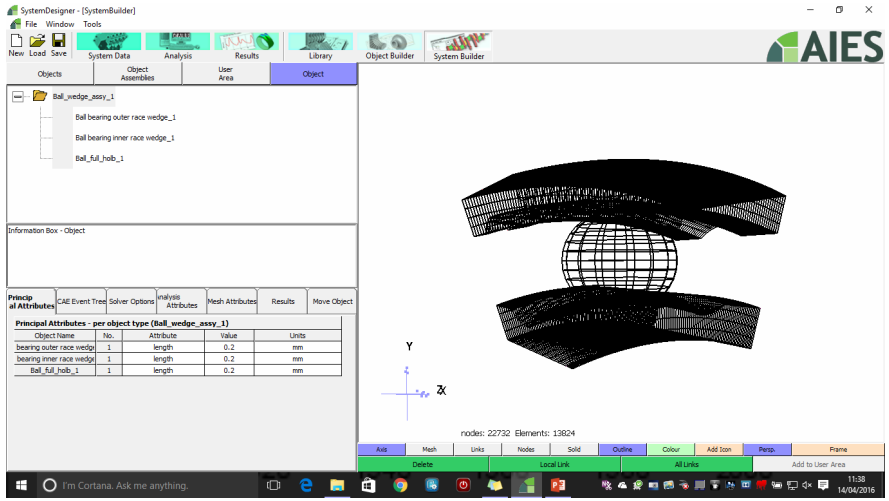


Ball bearing sector finite object assembly - mesh



Ball bearing sector finite object assembly - solid



Ball bearing sector finite object assembly - outline

Building the Outer Race – solid + mesh

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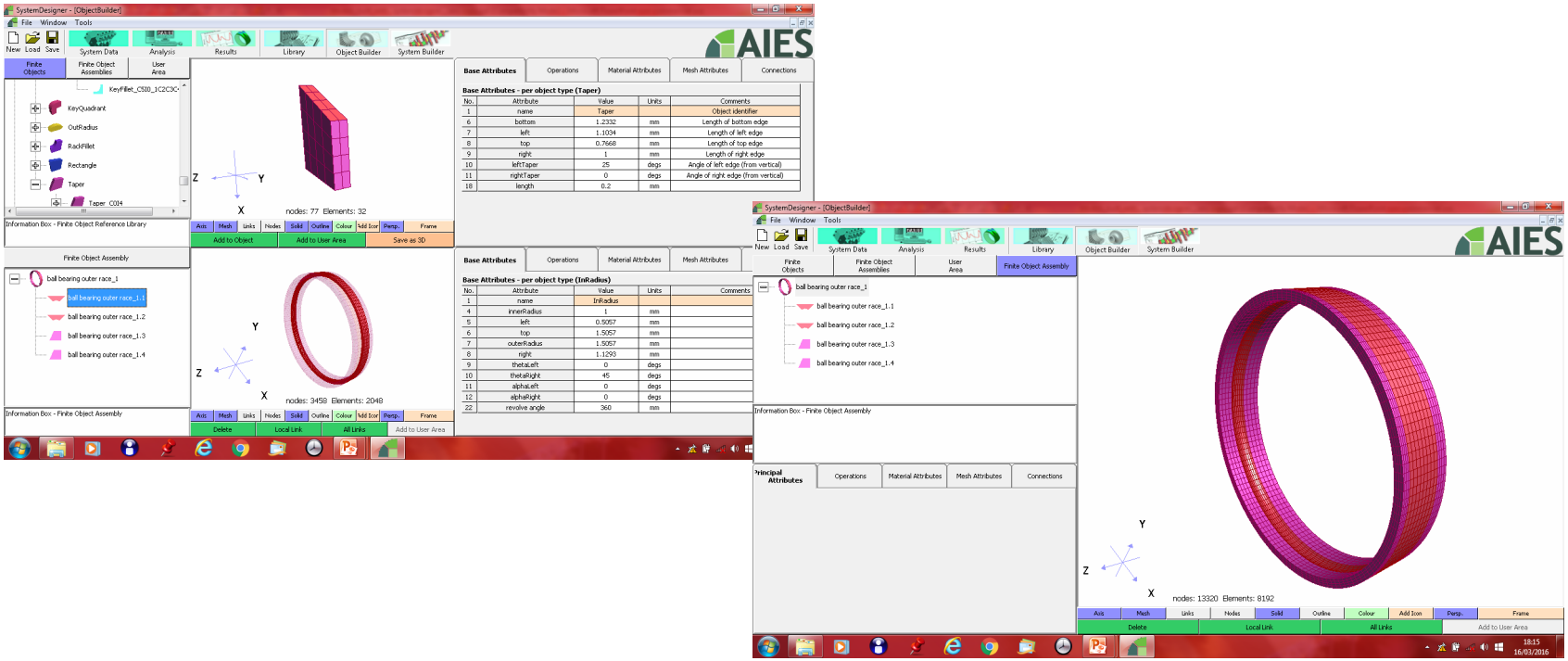
Building the outer race of the bearing requires four finite objects. The figure below shows the 4 basic building blocks. We could make the profile have fillet radii on the edges.

But at this stage we are showing the philosophy of the building approach.



We connect the basic finite objects together to form the cross section of the bearing outer race.

We then use the revolve operation and choose an angle of 360 degrees. We chose to close off the section. We could leave it open if we were modelling say a cracked through raceway for example.

Building the Inner Race – solid + mesh

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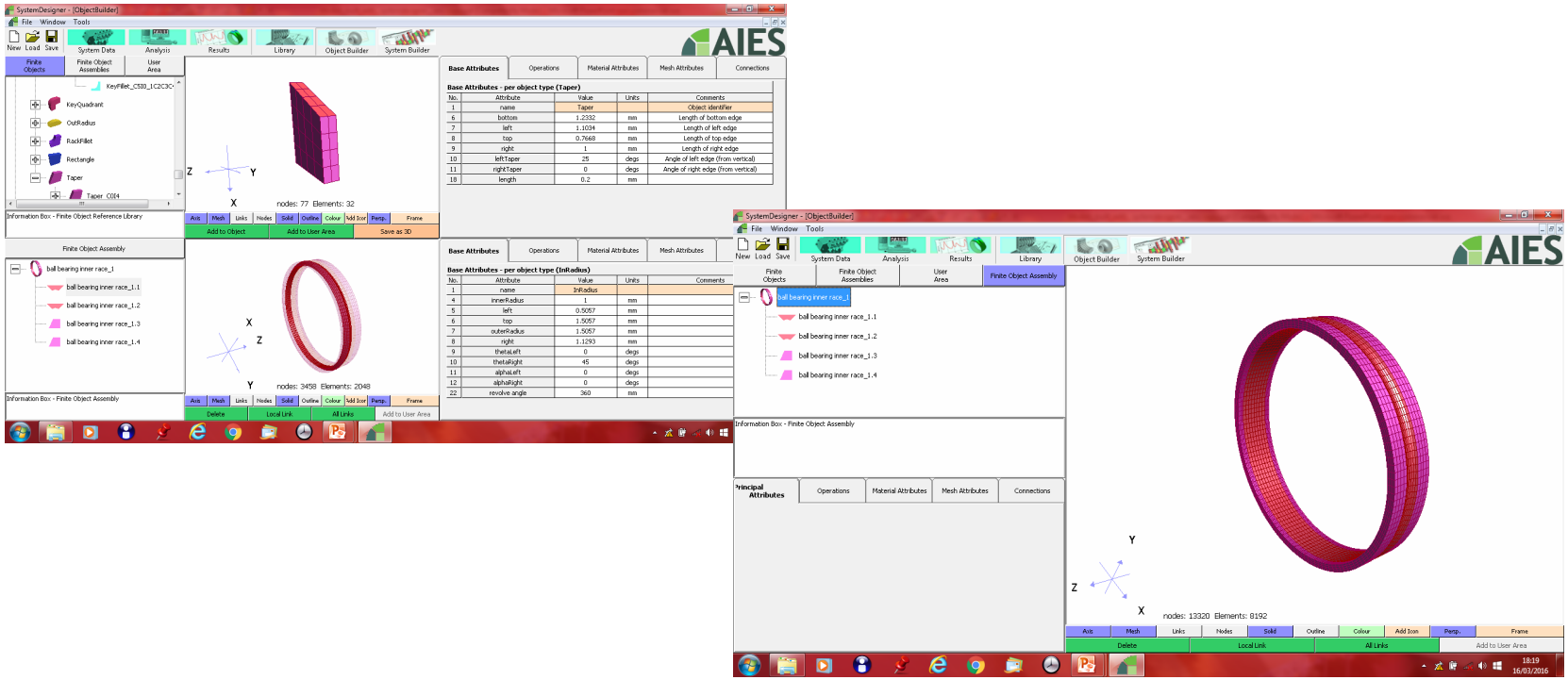
In the process of revolving you will find that you have to increase the number of elements in the revolve direction. This is easily done. *Note if you wish to know more detail please enquire through our website or contact me directly. You will need to sign an NDA as this information is confidential at the moment.* www.aiesl.co.uk or info@aiesl.co.uk

Building the Inner Raceway.

Next is the construction of the inner race way. This is quite easy to do, in fact you could do the same as the outer raceway and construct a cross section of the bearing inner race and revolve through 360 degrees, and you can also see the ball track in the outer surface of the ring.



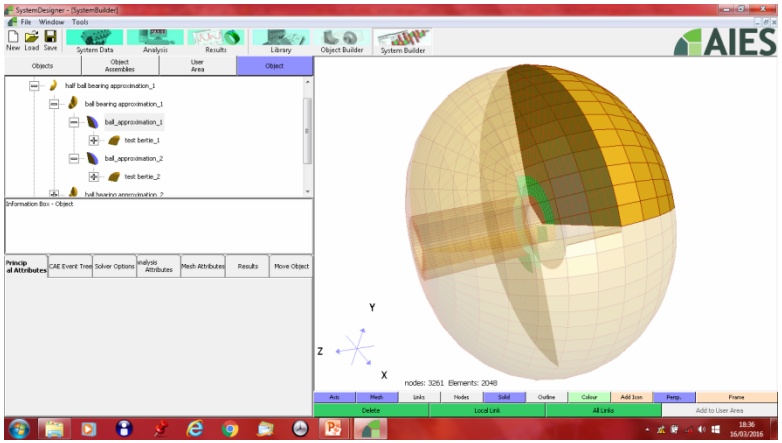
Building the ball – solid + mesh

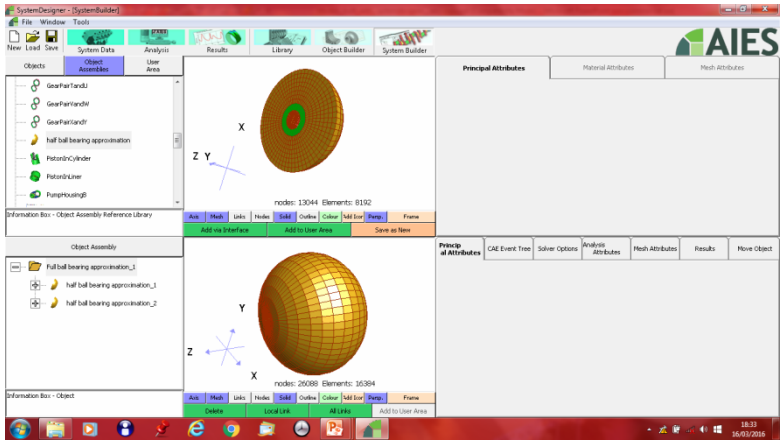
Building the Ball Object

This is a slightly more protracted compared to the building of the inner and outer raceway.

We start by building a very close approximation to the ball, where the contact mechanics is correct.

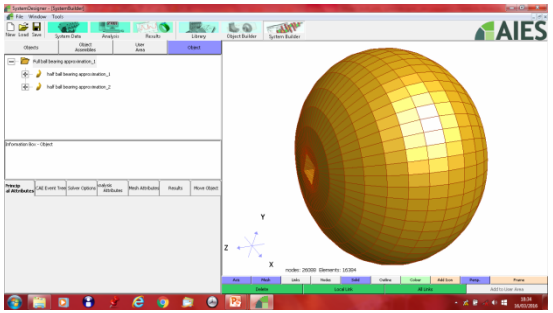
What we do here is revolve the finite objects through 90 degrees in order to have a well ordered mesh pattern in this instance to fill the centre of the ball with a rectangular prism (not shown here). We then save this finite object 1/8th of the ball, so we can reuse it to build the whole ball in hex.



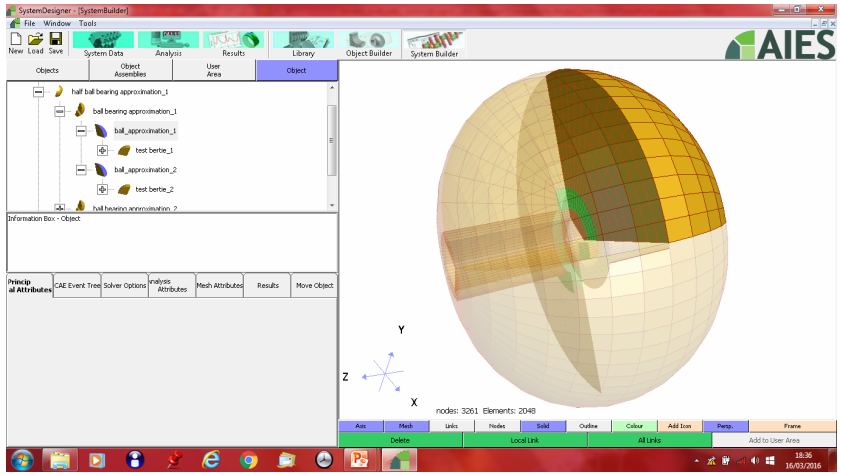


The completed ball (minus closing rectangle) is shown on the RHS

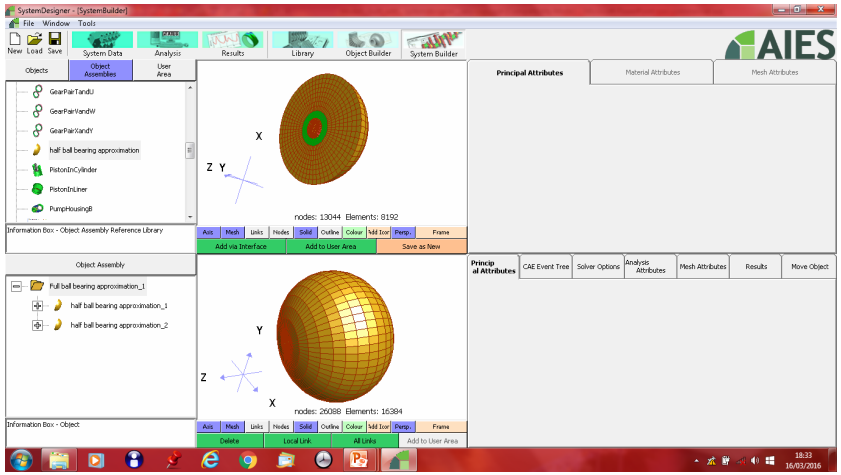
In the mesh enhancement stage the mesh can be biased with greater mesh density in the contact zones.

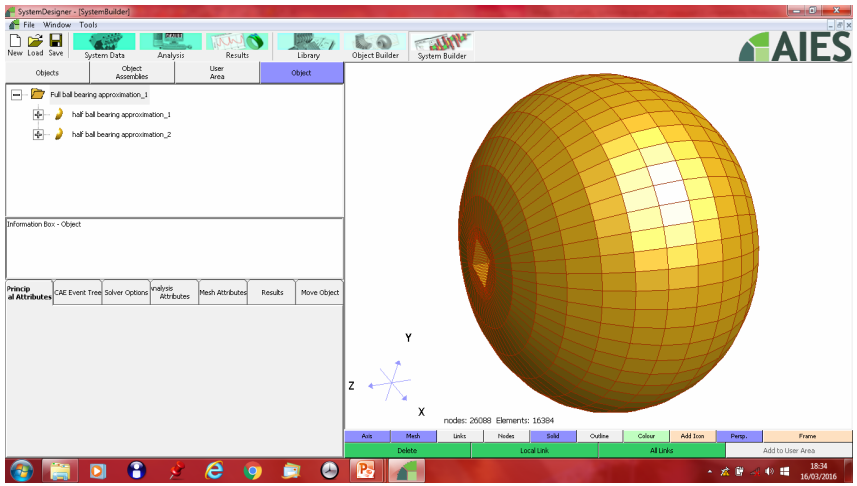


Building a Ball Object



Ball bearing showing one of 8 finite objects





Ball bearing showing one of finite object halves

Ball built with 2 half ball finite objects

Building a Ball Bearing Assembly

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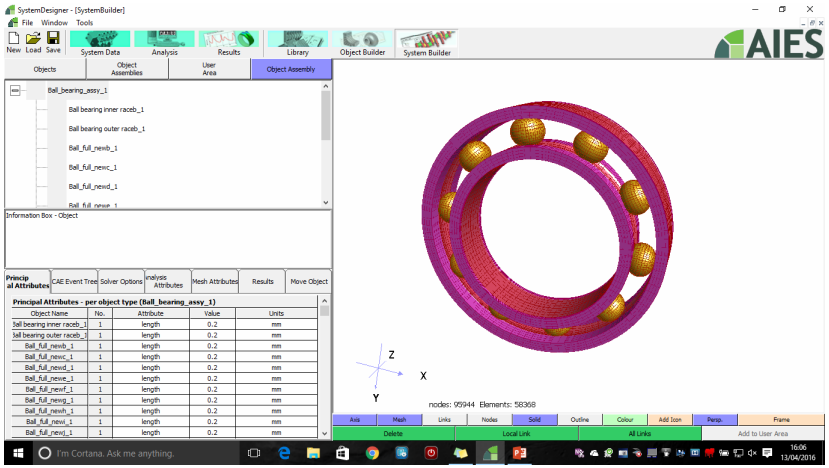
Building the ball bearing object assembly

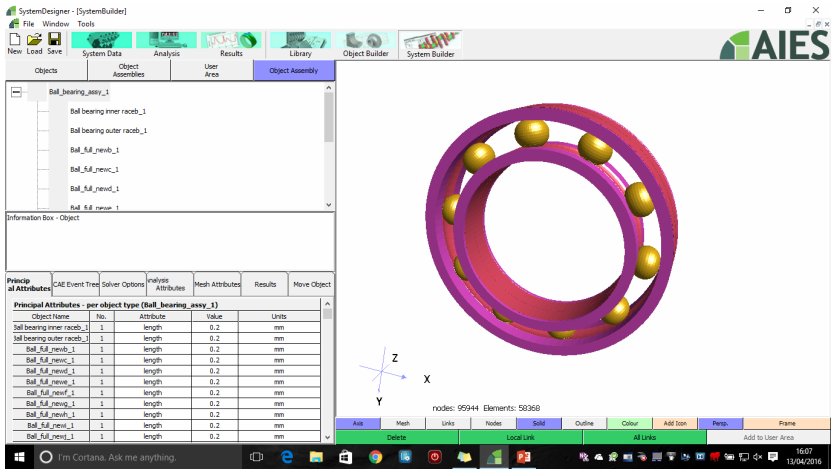
Building the ball bearing assembly involves assembling the object together in position and connecting objects via interface objects.

Which in this case would be through **EHL tribology objects** which model the films between the ball and outer and inner race contact tracks.

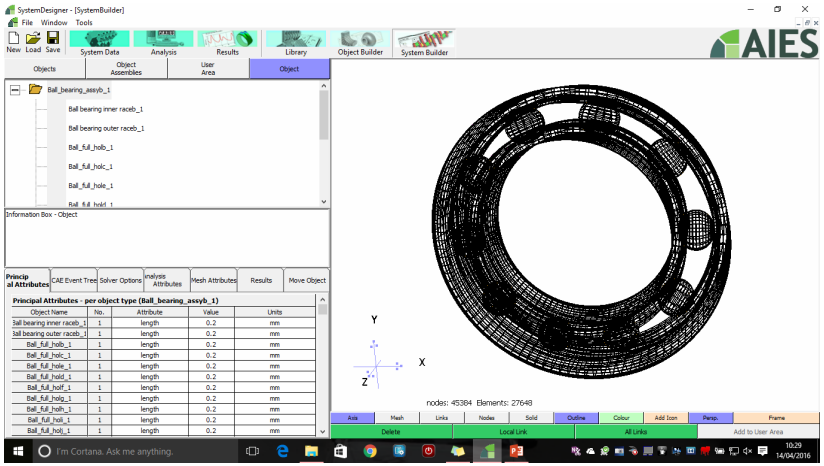
These models are fully parameterised



Ball bearing assembly with balls, inner race and outer race - meshed



Ball bearing assembly with balls inner race and outer race - solid



Ball bearing assembly with balls inner race and outer race – outline with auto contact surfaces

Other Object Assembly's @ AIES

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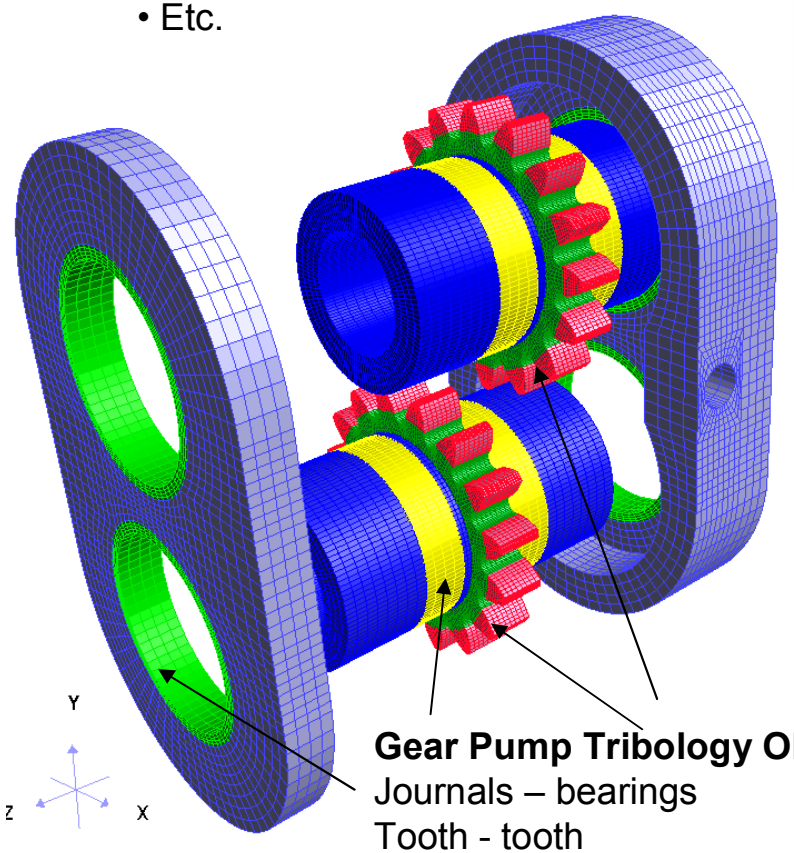
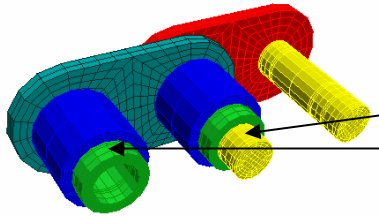
Tribological Interface Objects

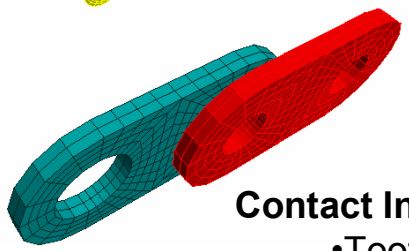
- Journals – bearings
- Pins – bushes
- Bushes – rollers
- Tooth – tooth
- Etc.



Gear Pump Tribology Objects
Journals – bearings
Tooth - tooth

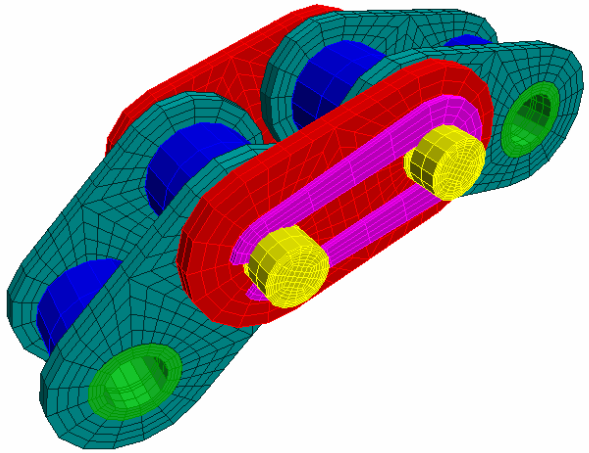


Chain Tribology Objects
Pins – bushes
Bushes - rollers



Contact Interface Objects

- Tooth – tooth
- Pin – sideplate
- Circlip – pin & sideplate
- Sprocket tooth - roller



Conclusions

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I hope I have given you some food for thought. Something you may have thought hypothetical is now achievable and becoming a reality.

Thank you for your kind attention

Dr Ian McLuckie

April 2016

If you have any questions or want to know more please contact us on Tel. +44 (0) 1858 414854 Mob. +44 (0) 7801 575725 or on info@aiesl.co.uk and sales@aiesl.co.uk or to me on ian.mcluckie@aiesl.co.uk

Note if you wish to know more detail about our processes please enquire through our website or contact me directly. You will need to sign an NDA as this information is confidential at the moment. www.aiesl.co.uk or info@aiesl.co.uk