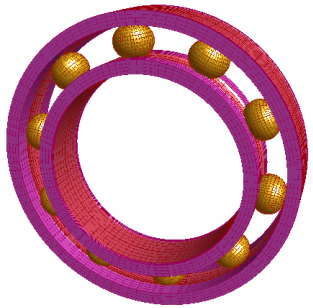

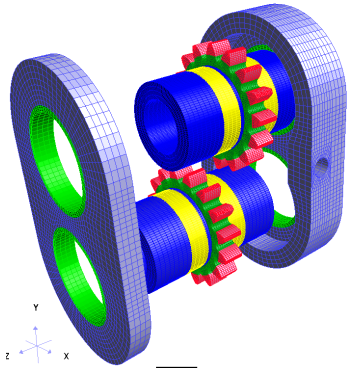

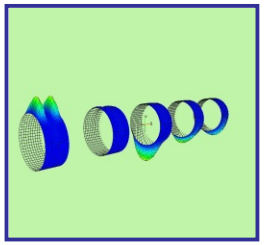

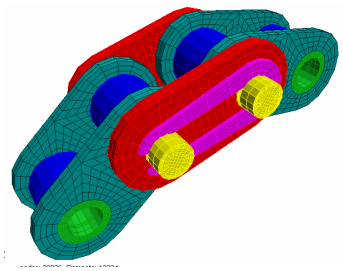

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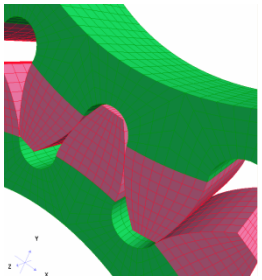
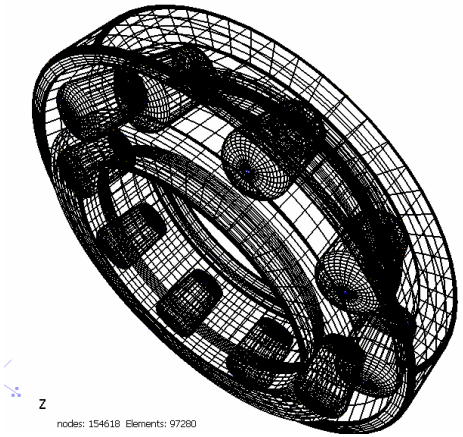


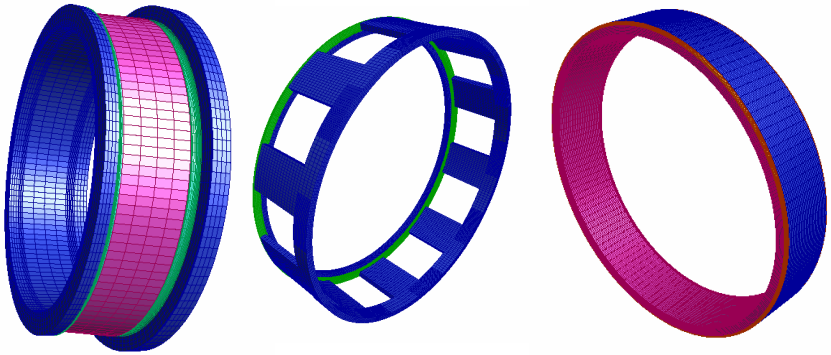
Future Trends Part – 3
Building Taper Roller Bearings – the AIES way

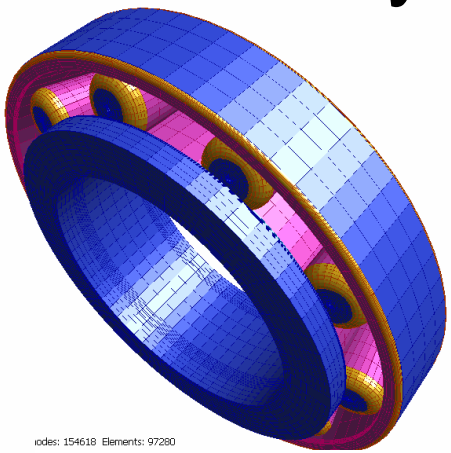
Dr Ian McLuckie

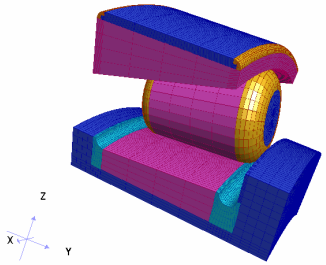
April 2016

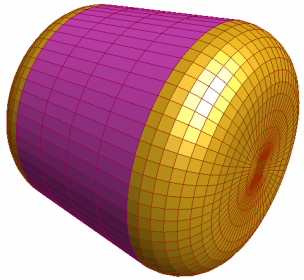
ian.mcluckie@aiesl.co.uk











Taper Roller Bearings 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. We can show using our new modelling methods how we can start building analysis methods for Rolling Element Bearings (REB). To enable us to do this we need a EHL tribology solver (which we already have), and a reliable means of generating the contact geometry of the Taper Roller Bearing. Our EHL tribology solver is used 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 in the future by using our generic transferable methods

Building a Taper Roller Bearing Assembly

We will now discuss model generation of the taper roller bearing assembly . The geometry is important for contact mechanics , as it determines the contact stiffness and tribology contact behaviour. The lubrication aspects will be the subject of a future paper, and will include Gas Turbine SFDs.

Lets Build an Outer Race

This geometry lends itself to construction by using an axisymmetric starting Finite Object Assembly model. We use the cross section of the outer race with our revolve operation generate the Finite Object assembly through an angle, say 360 degrees or 360/(number of rollers) for a cyclic symmetry model.

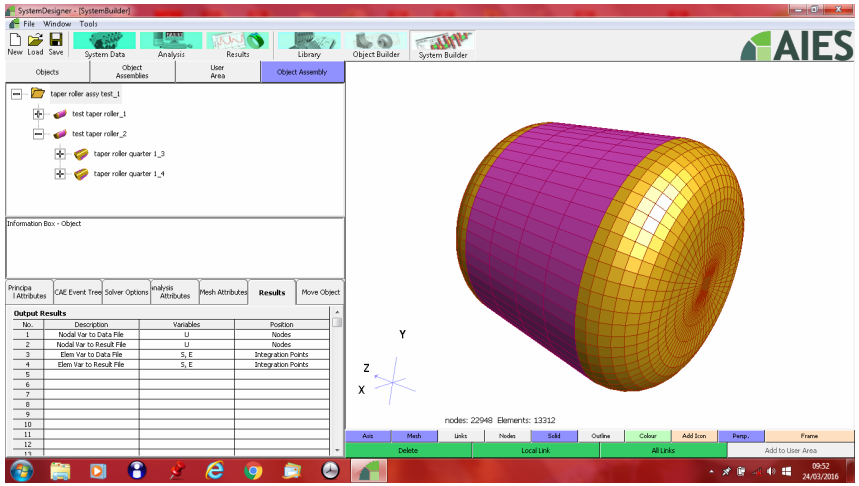
There are number of ways to construct a taper roller bearing but we will discuss two options:

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

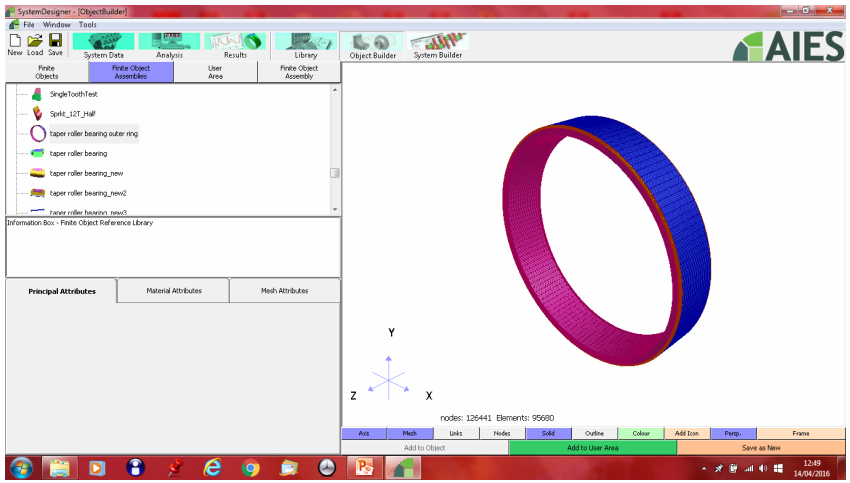
2. Build an outer race that you revolve through 360 degrees – this can be an object (totally closed)

we are going to use 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 of ranges of bearings and improved mesh enhancement in the contact zones.

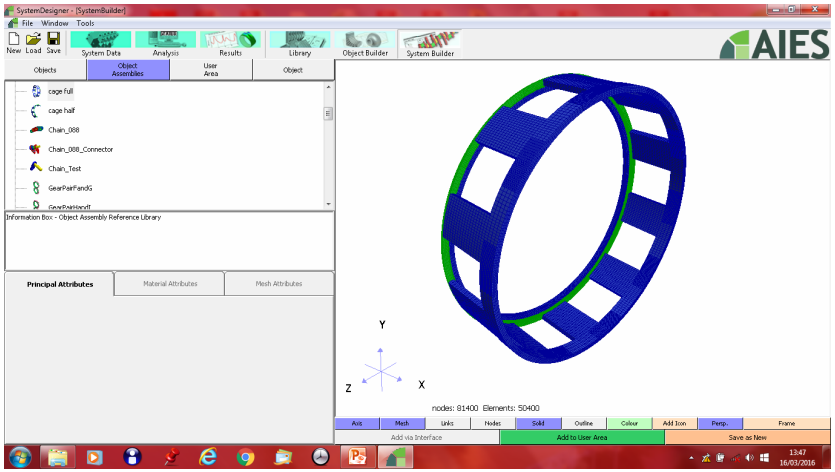
Taper Roller bearing - objects



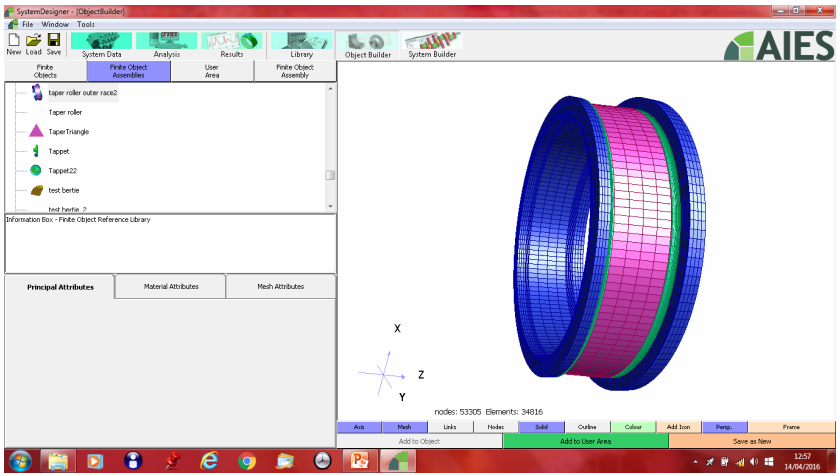
Taper roller built with finite objects



Outer race built with finite objects

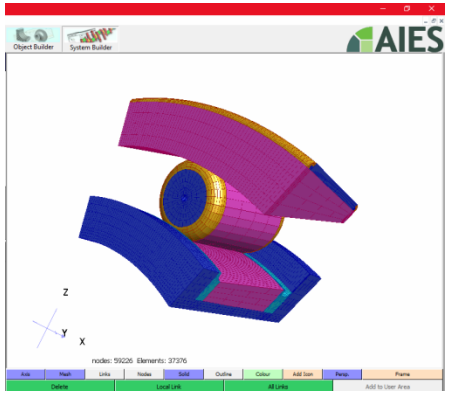


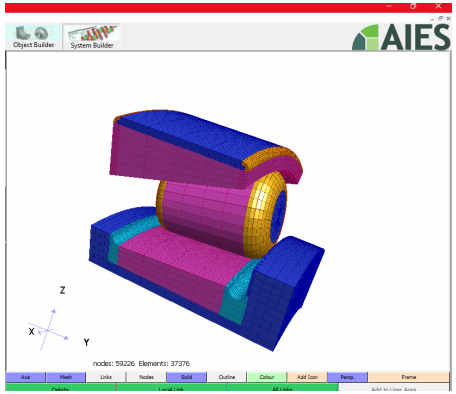
Cage built with finite objects



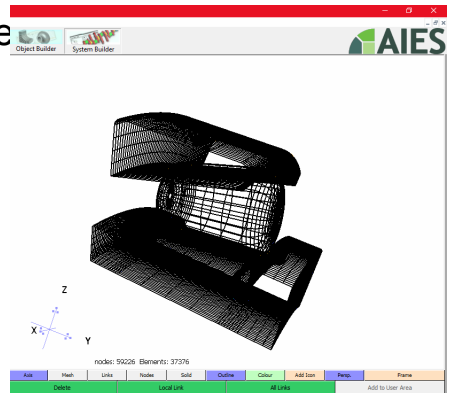
Inner race built with finite objects

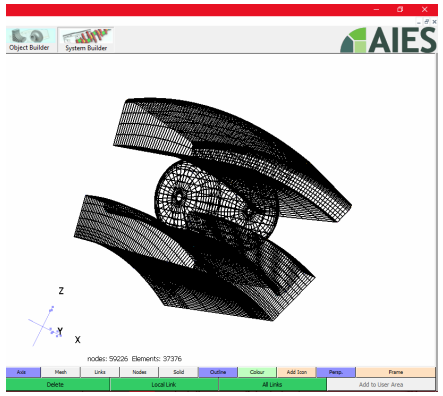
Taper roller sector finite object assy



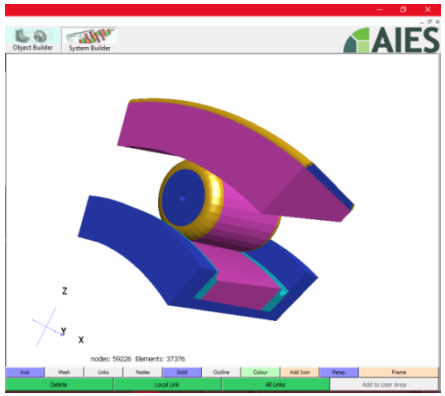


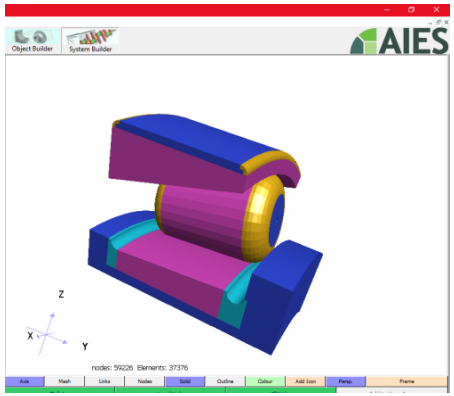
Taper roller bearing sector finite object assembly - me





Ball bearing sector finite object assembly - outline





Taper roller bearing sector finite object assembly - solid

Building the Outer Race – solid + mesh

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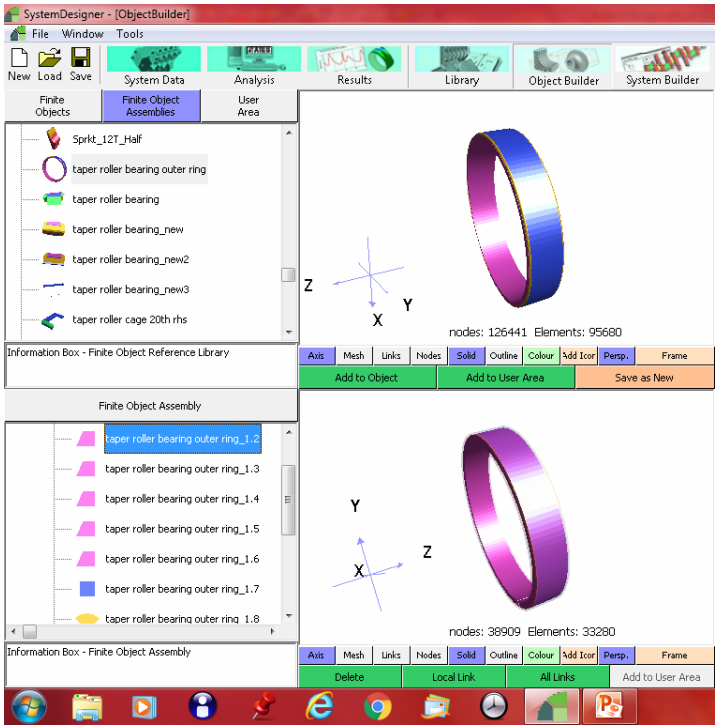
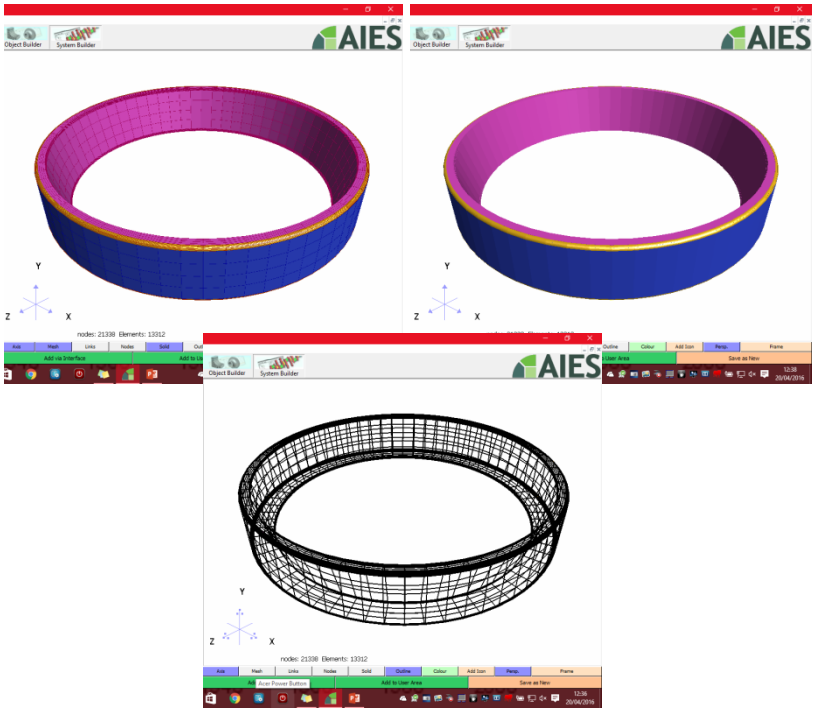
Building the outer race of the bearing requires a number of finite objects. The figure below shows the basic building blocks. We also include fillet radii on the edges, and at this stage we are showing the philosophy of the building approach.





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 close off the section.

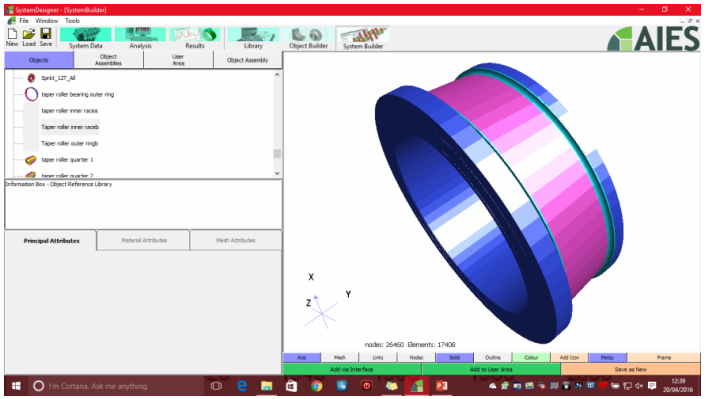
We could leave it open if we were modelling the effect of a cracked through raceway for example.

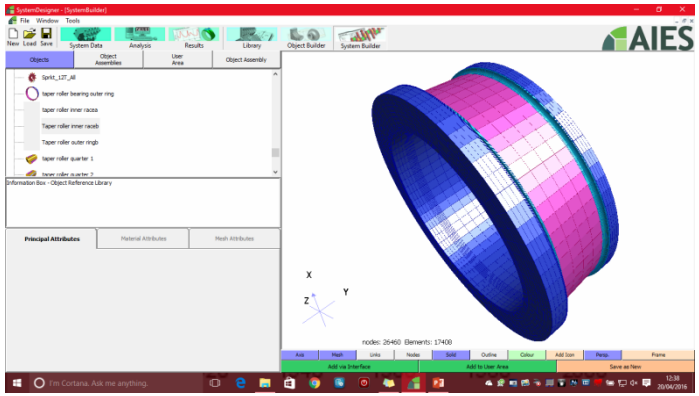
Building the inner race – solid + mesh

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.

Building the inner raceway.

Next is the construction of the inner race way. This is quite easy to do in fact you can 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 see the roller track on the outer surface of the ring.

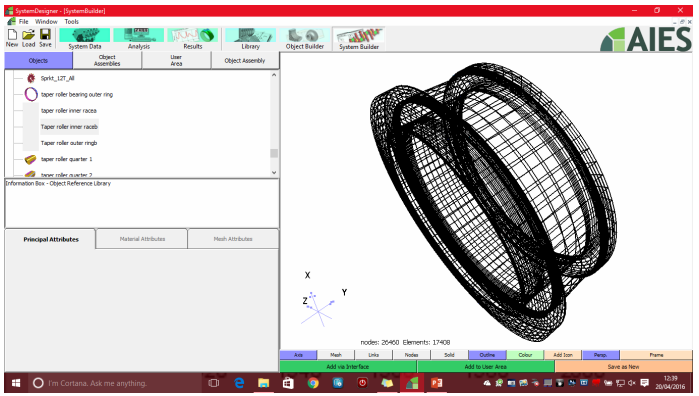




LHS top shows solid of inner race

RHS top shows meshed inner race

RHS bottom shows outline surfaces and mesh of the inner race.

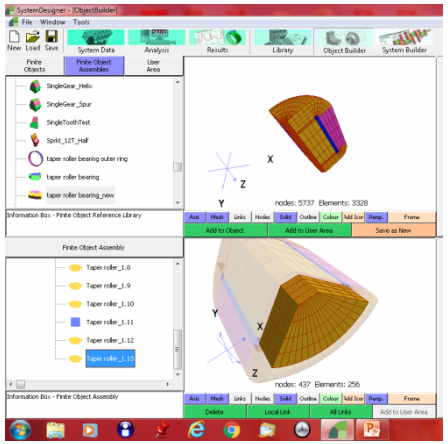


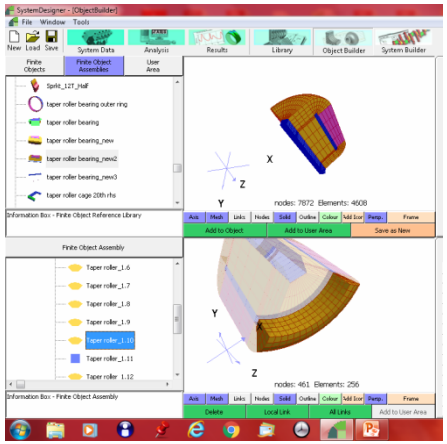
Building the ball – solid + mesh

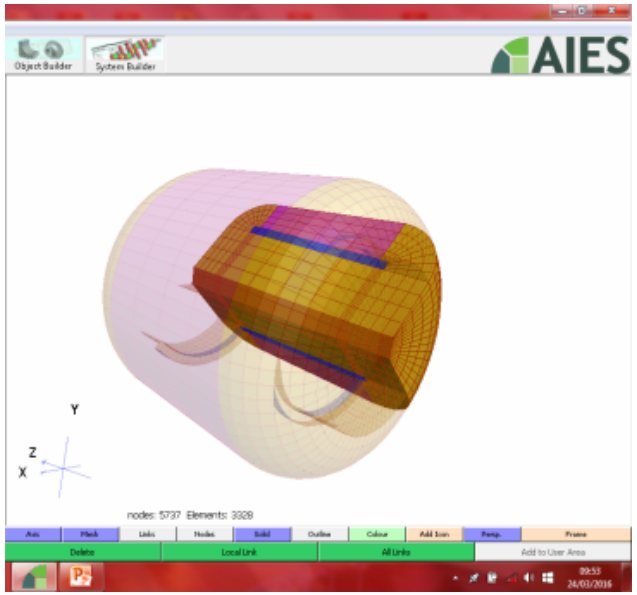
Building the taper roller

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

We start by building the tapered roller, the tapered face is straight, but we can make it, curved, or may have a profile. 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 quarter roller without closing rectangle is shown on the LHS, and quarter with closing Rectangle is on RHS.

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

Building a taper roller bearing

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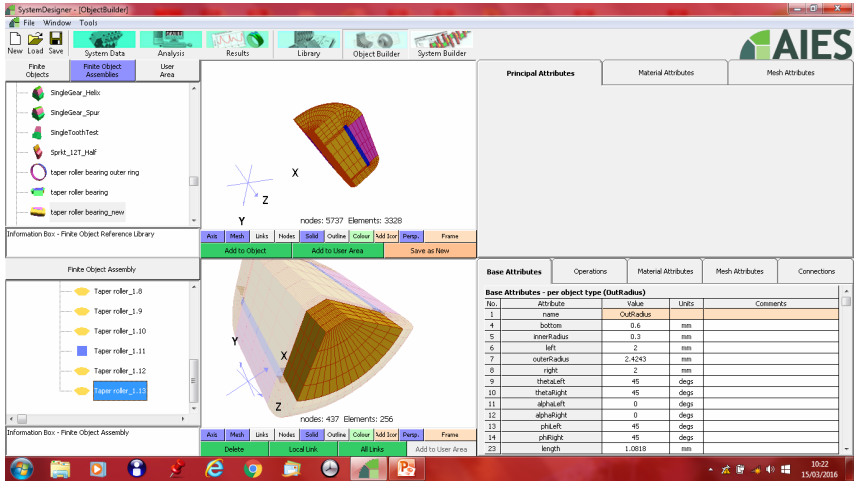
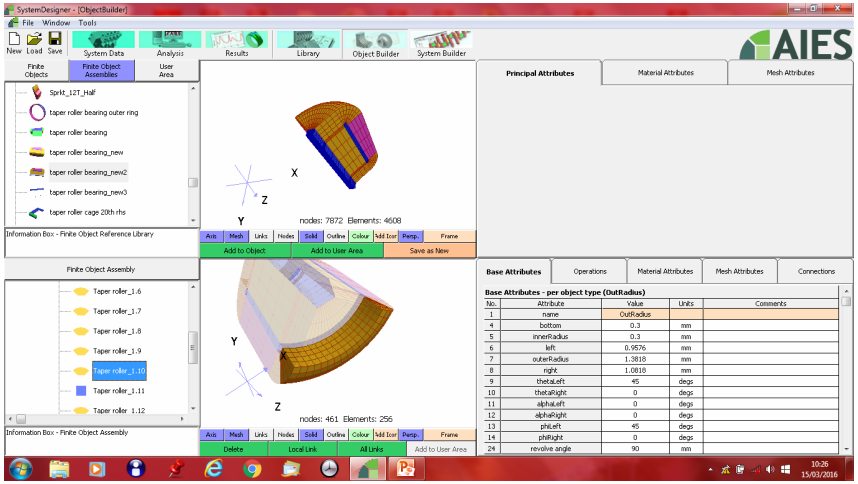
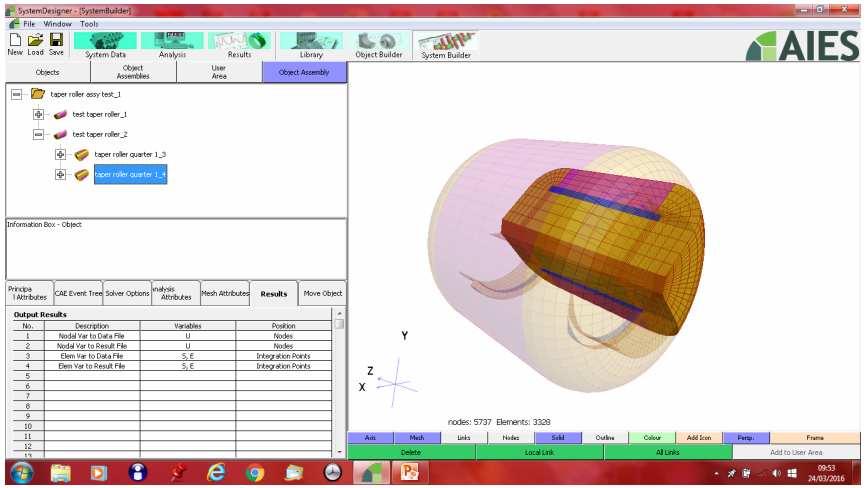


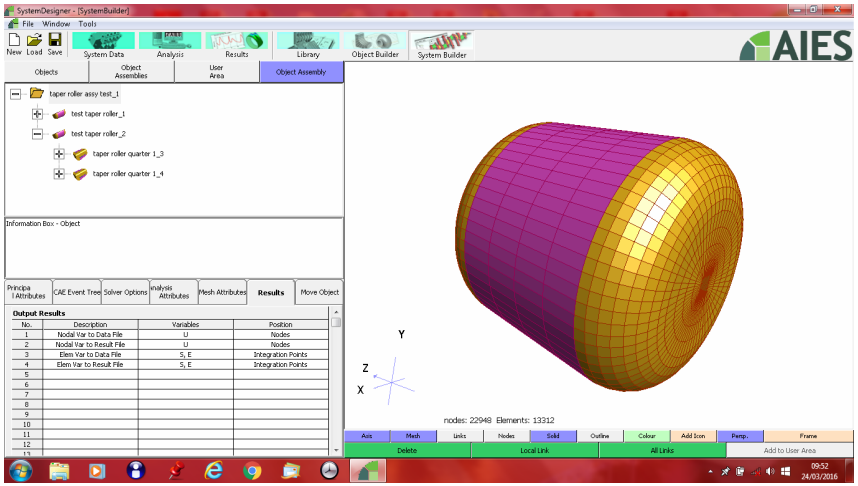
Taper roller quarter without closing rectangle



Taper roller quarter withclosing rectangle



Taper roller with highlighted quarter without closing rectangle



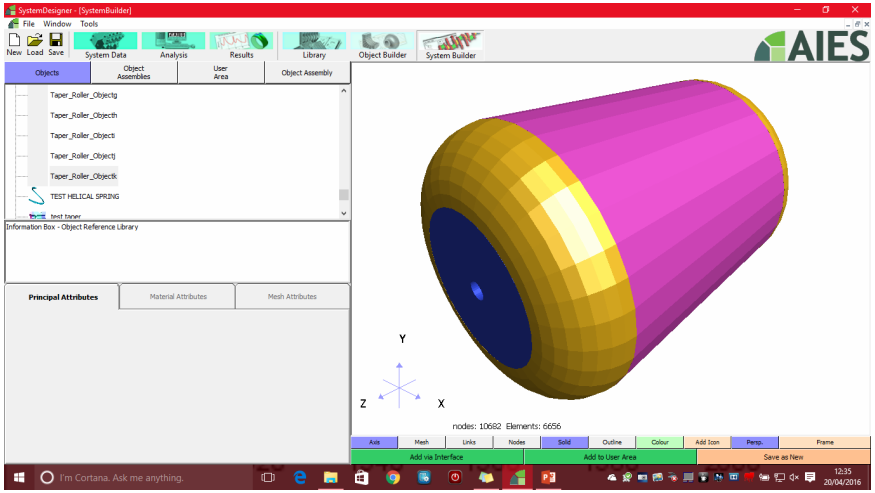
Completed taper roller bearing element

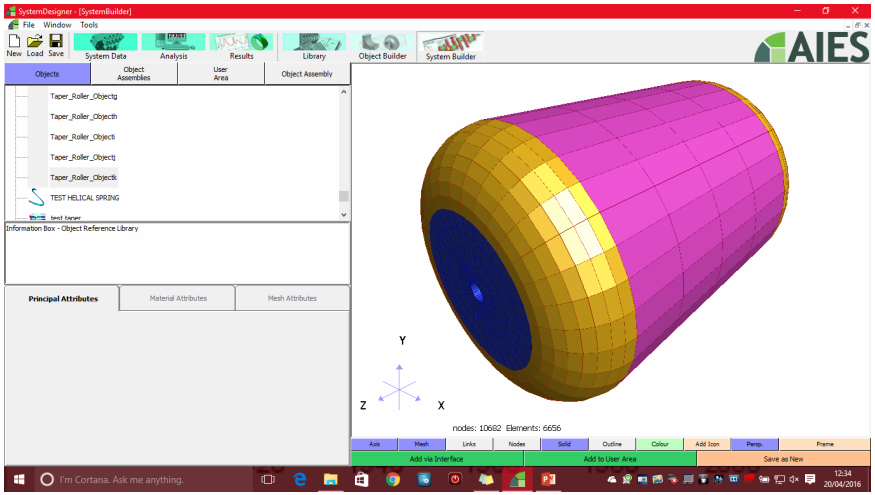
Building a taper roller bearing

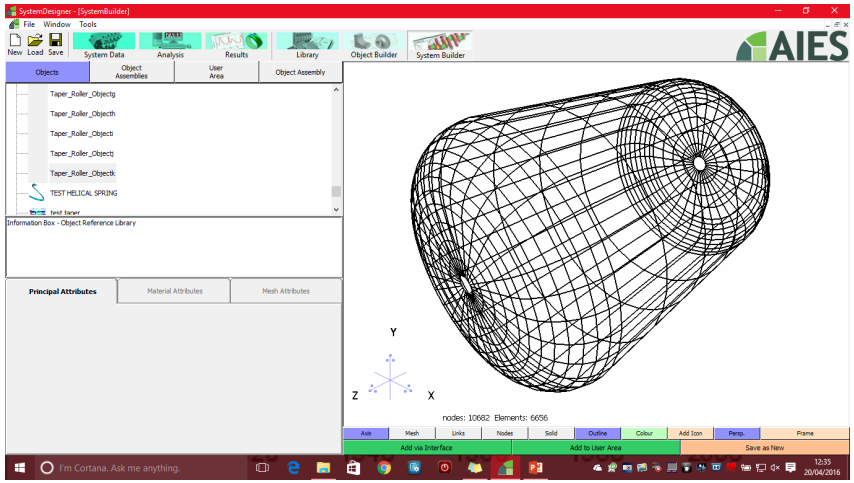
Building the taper roller – alternative way

This can be carried out the same way as the outer and inner raceways. But with have to fill the middle as building the roller from quarters.

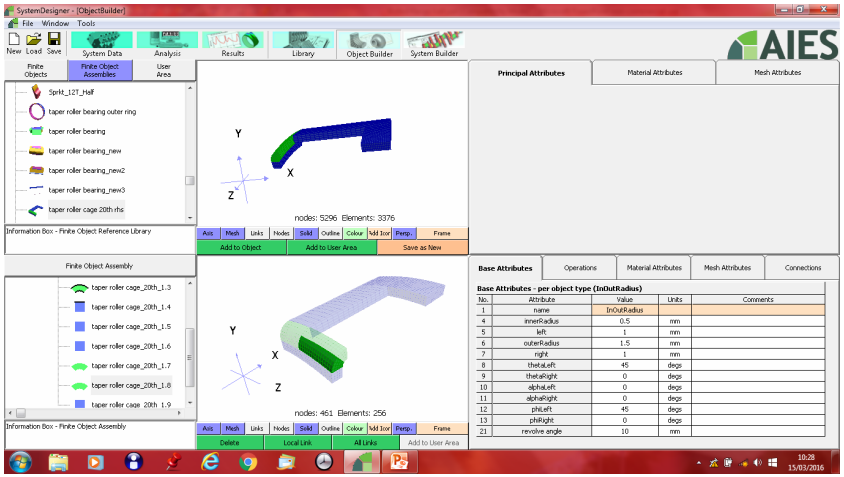
We start by building the tapered roller, the tapered face is straight, but we can make it, curved, or may have a profile. What we do here is revolve the finite objects through 360 degrees in order to have a well ordered mesh pattern in this instance to fill the centre of the ball with a cylindrical prism(not shown here).



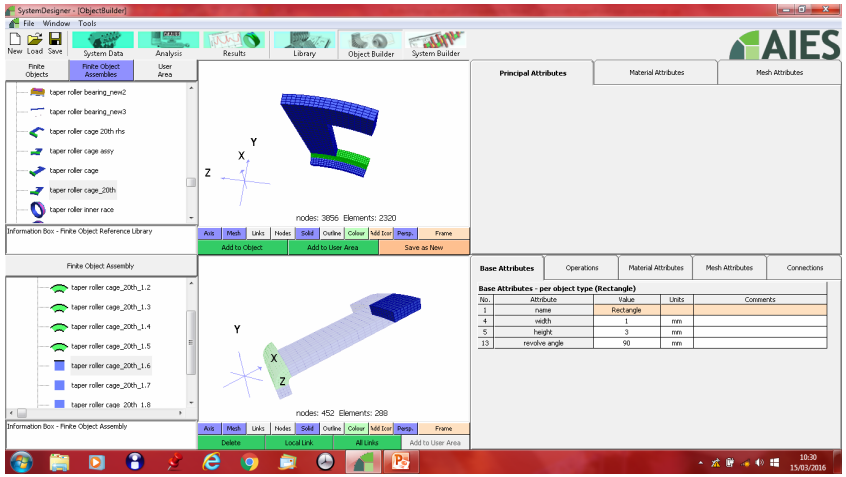




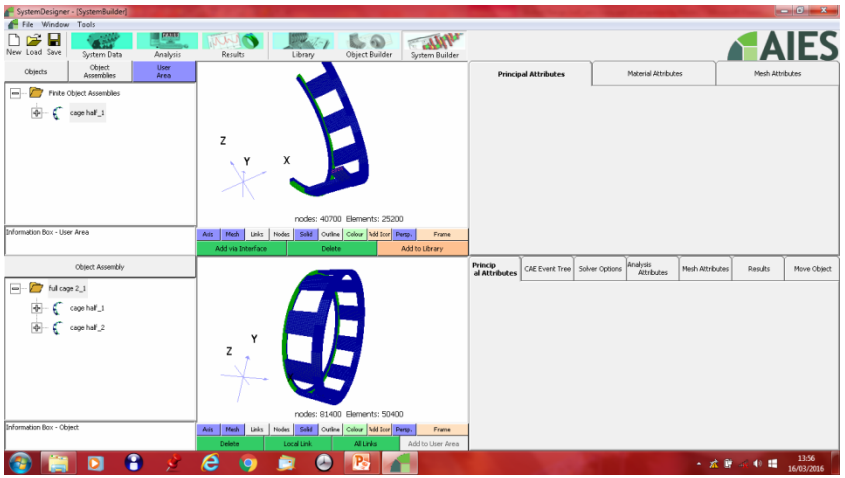
Building a taper roller cage



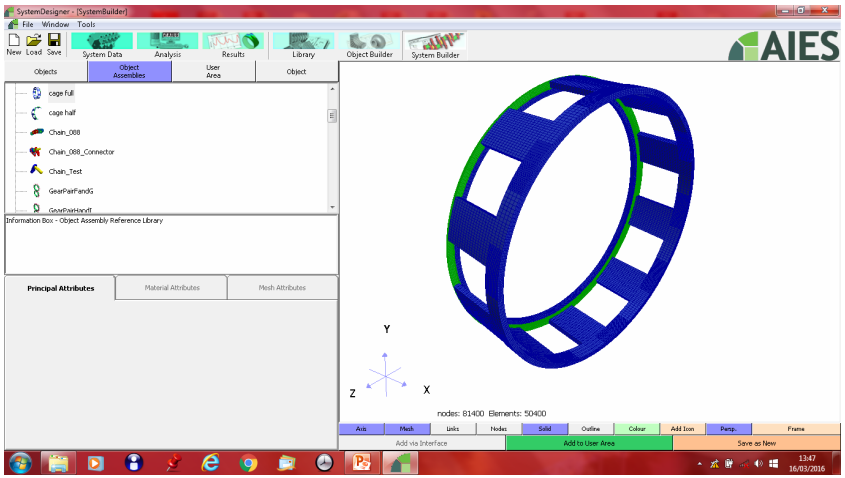
LHS cage finite object assembly



RHS cage finite object assembly



Half cage finite object assembly and cage object



Built cage object

Building a taper roller bearing assy

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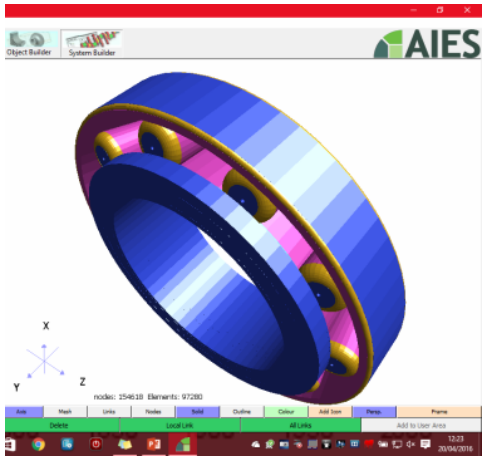
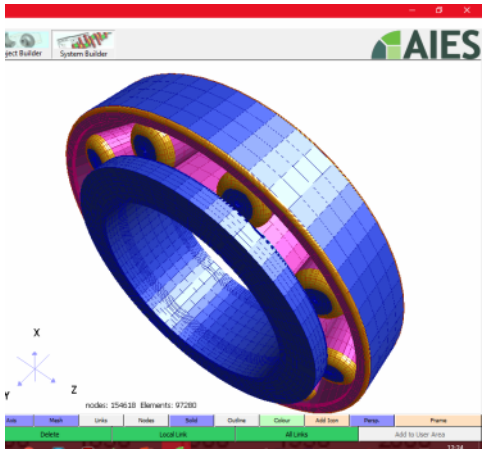
Building the taper roller bearing object assembly

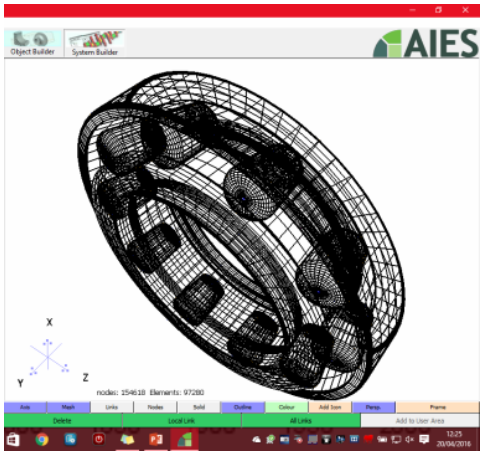
Building the taper roller bearing assembly involves assembling the objects together in position and connecting objects via interface objects. Which in this case would be through **EHL tribology objects** which model the films between the roller and outer and inner race contact tracks. These models (solid and mesh) are fully parameterised



Taper roller bearing assembly with rollers, inner race, outer race - solid



Taper roller bearing assembly with taper roller, inner race, outer race - meshed

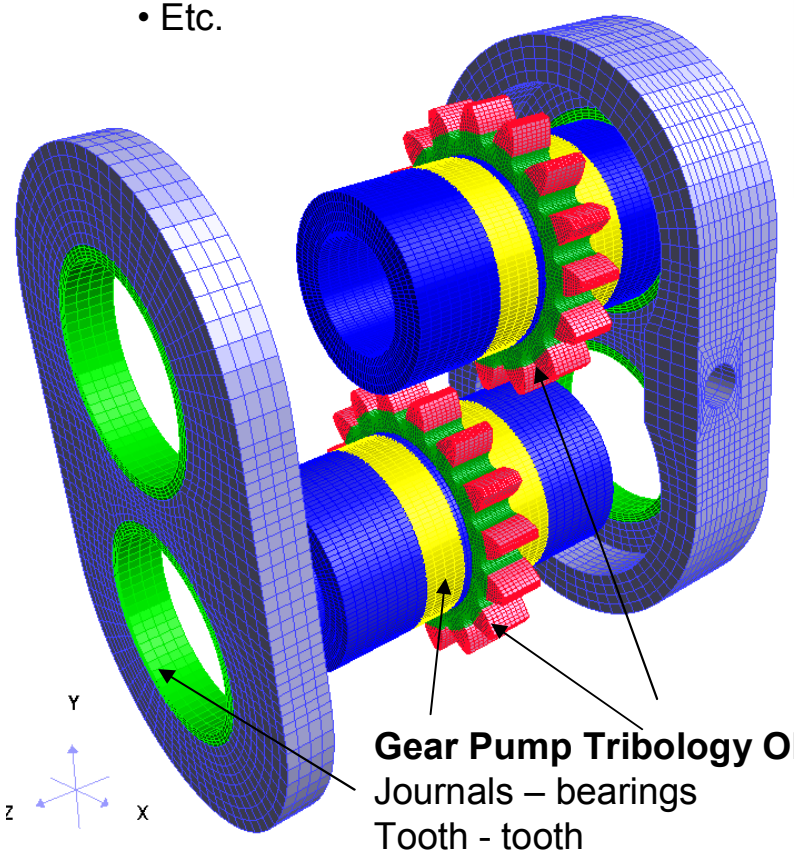


Taper roller bearing assembly with rollers, inner race , outer race – outline with auto contact surfaces

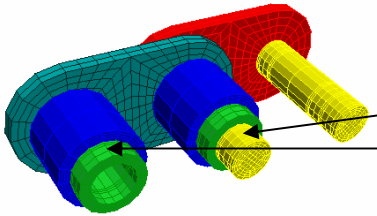
Other Object Assembly's @ AIES

Tribological Interface objects

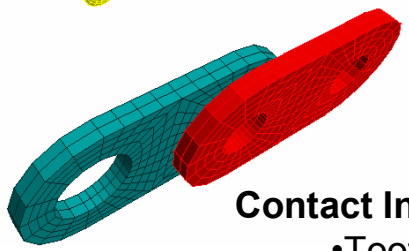
- Journals – bearings
- Pins – bushes
- Bushes – rollers
- Tooth – tooth
- Etc.



Gear Pump Tribology Objects
Journals – bearings
Tooth - tooth

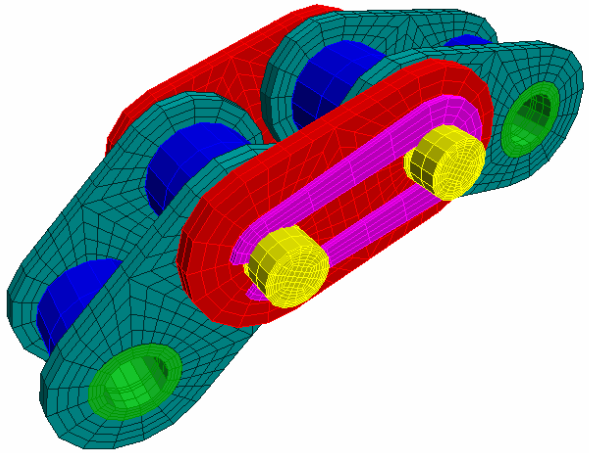


Chain Tribology Objects
Pins – bushes
Bushes - rollers



Contact Interface Objects

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



Conclusions

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

Thank you for your kind attention

Dr Ian McLuckie

April 2016

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