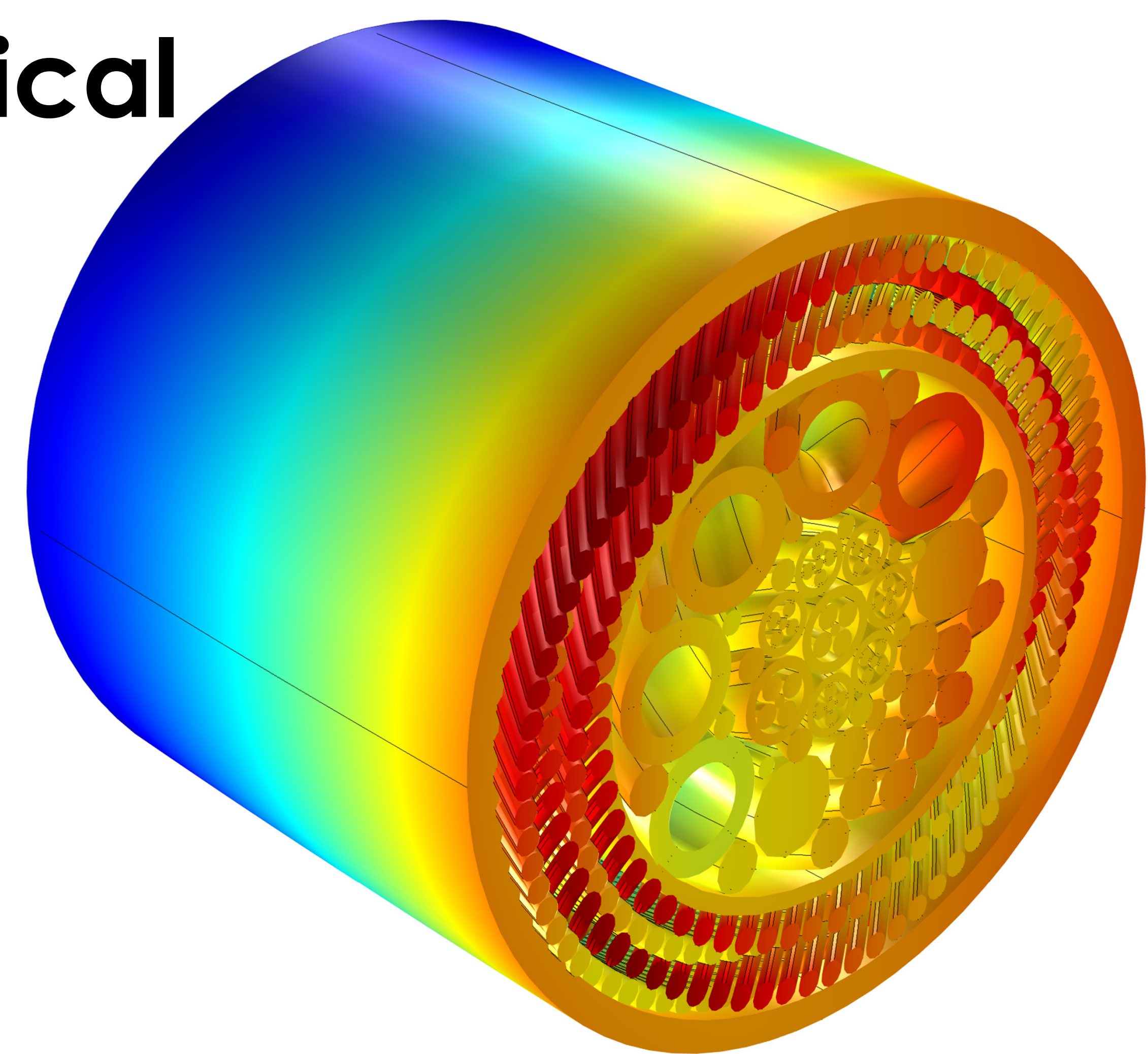


Stress & Fatigue Analysis of Subsea Umbilical & Cable Systems

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INTRODUCTION

With the ever changing energy requirements & demand for better communication links across the planet, subsea umbilical & cable requirements are becoming more stringent, where longer service life at a lower cost is now expected from manufacturers. In addition to this, with the need to exploit more sustainable energy sources from offshore wind & wave, where extreme weather conditions are encountered, harvesting and providing a continuous link from these sources to the worlds energy grid requires dynamic power cable structures which can survive under severe load conditions. With this, cable companies are now turning to multiphysics modelling to reduce the cost of materials and thus manufacture, while maintaining cable performance and long service life under these higher demands.

AIM

To build a user interface which automatically generates full 3D cable models & analyses them under various load conditions, using COMSOL Multiphysics. The user interface should be able to take data from 2D cross-sectional drawing files & convert these into 3D structures ready to be solved, with materials, contact sets, solvers, output plots & data required for the various loads to be analysed. This will reduce turn-around times allowing for the assessment of material options, component layout, stress concentration areas, fatigue & service life of various cable designs in a few days.

METHOD

A MATLAB™ GUI was developed which automatically assess 2D cross-sectional drawing files for pre-set cable components (Figure 2). It then generates the full 3D subsea models for subsea cable analysis & implements all the model requirements, including contacts & boundary conditions, solvers, plots & various mesh options (Figure 3).

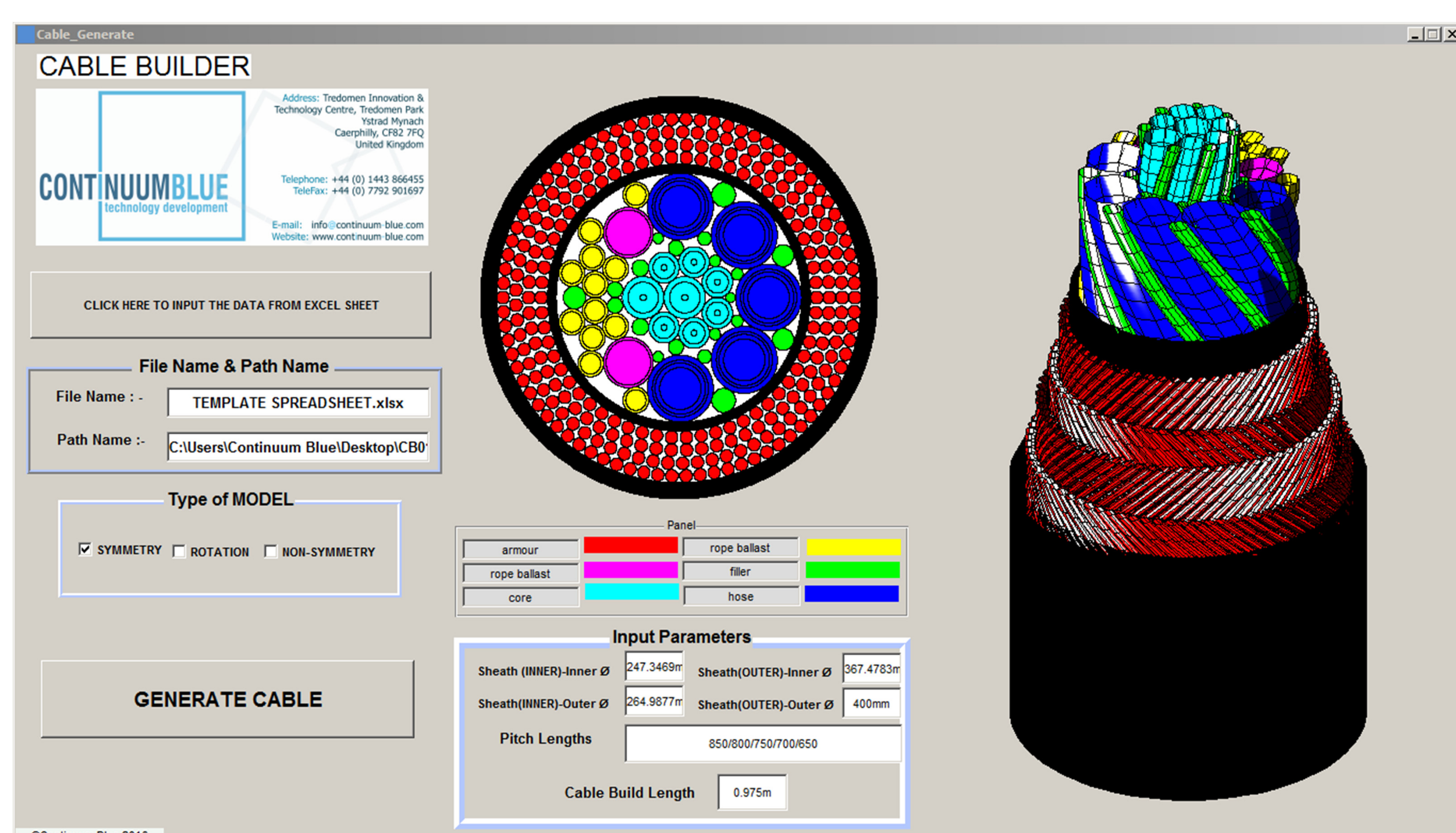


Figure 1. Screenshot of MATLAB® GUI developed to generate subsea cables in COMSOL using Livelink™ for MATLAB®.

RESULTS 1: GUI

The cable builder GUI is illustrated in Figure 1, & utilises a MATLAB™ script, which reads 2D cross-sectional cable drawings & interrogates them for already defined pre-built cable components (Figure 2). If found, it then mathematically interrogates the drawing file in conjunction with additional input parameters, such as pitch length & direction, that no components overlap or have interference when built. The GUI also makes use of symmetry & gives the user the ability to choose between a number of options on this front. Once the drawing file & input parameters have been interrogated, the GUI generates a 2D cross-sectional view & full 3D schematic of the subsea cable as a final visual check for the user, prior to proceeding with the final step of building the COMSOL model.

RESULTS 2: FEATURES

The GUI builds subsea cables with several features, including various material types (hyper-elastic rubber-like materials, plasticity & orthotropic materials for aramid reinforced structures), contact pairs (including friction coefficients), various mesh options (coarse, medium & fine), multiple load conditions (bend, axial, torsion & combinations), pre-set solvers, output plots & data.

RESULTS 3: BUILD & SIMULATION TIMES

Depending on the number of components & contact points (typically 275 components & 12,000 contact points) a complete 3D subsea cable model with all the features, meshes, solvers & load cases ready to be solved, takes 8-10 hours to generate on a PC with 2x Intel® Xeon® E5620 2.4GHz processors & 24GB RAM. Simulation times for a single transient load over a single load cycle typically take 10 hrs to run on the same PC.

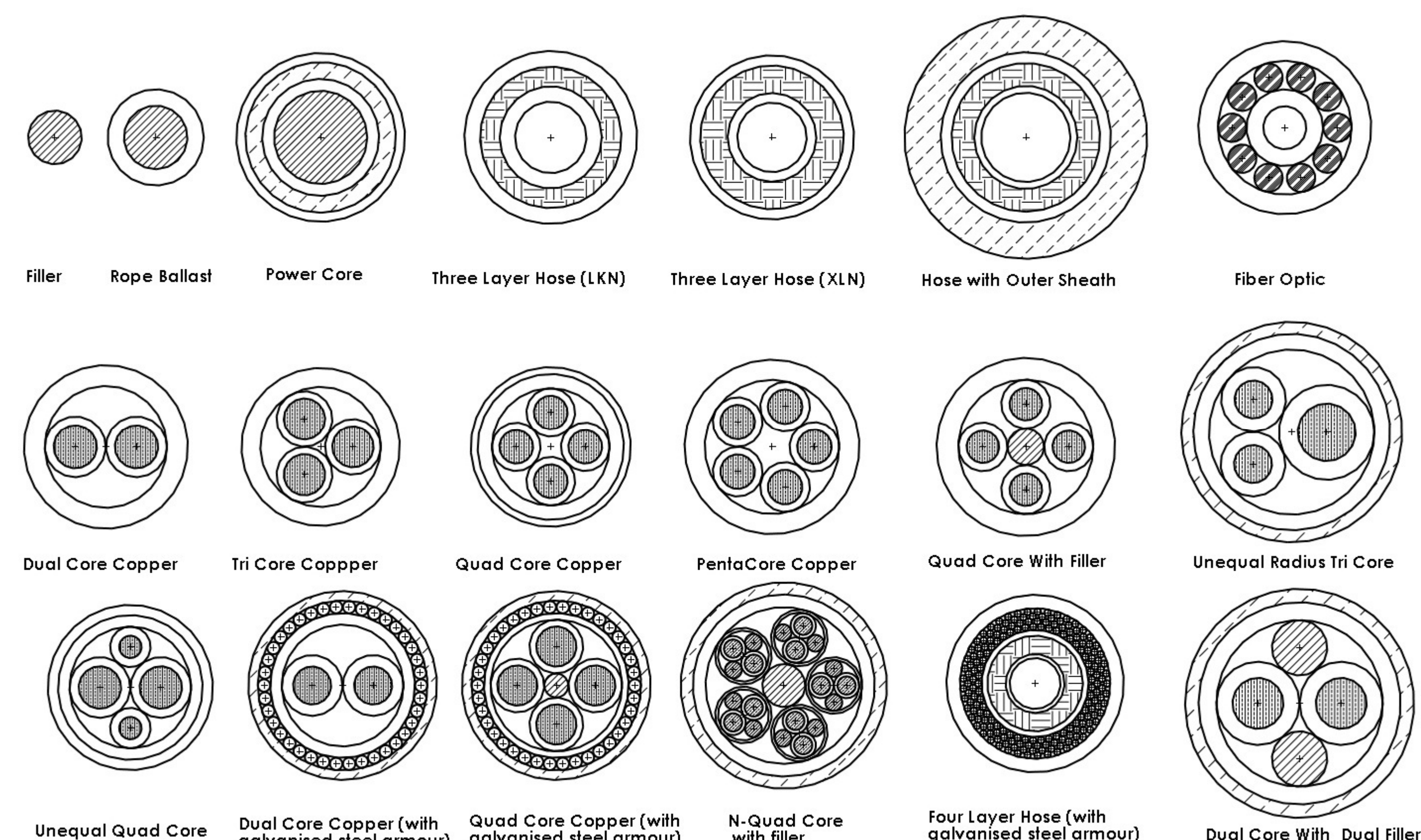


Figure 2. Sample of some of the pre-build cable components implemented available from drop-down menus

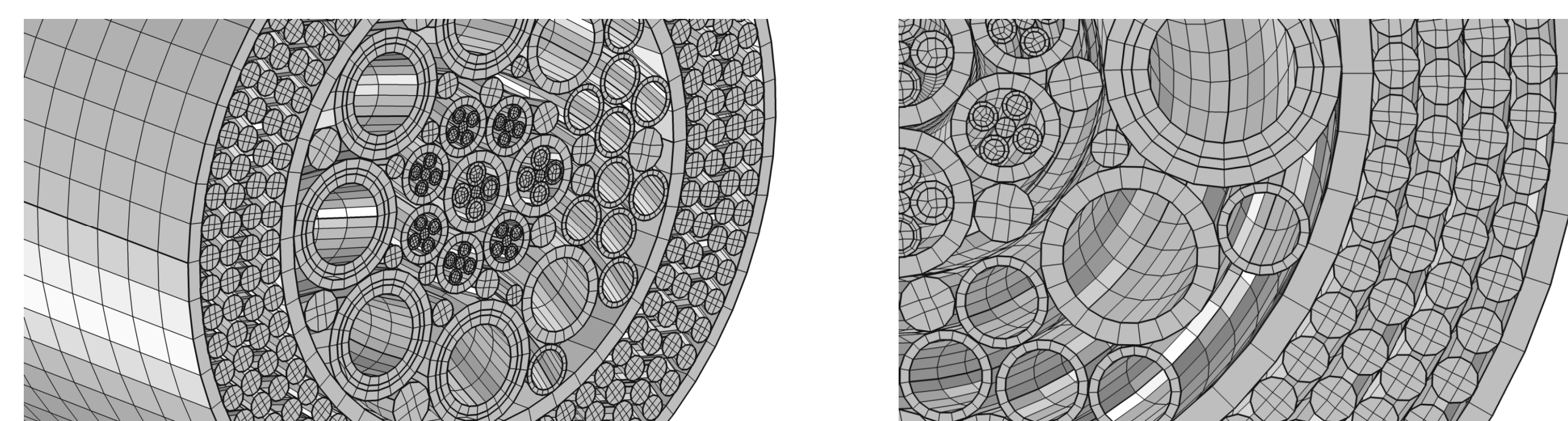


Figure 3. Various pre-set mesh options are available for analysis

DISCUSSION & CONCLUSION

The Subsea Cable Builder GUI, although it already has a number of pre-set cable components utilised & full model plasticity, does not entail all possible components that may be required by clients. Continuum Blue's Cable Builder GUI can be used to help reduce the cost of subsea cable analysis, help assess multiple cable design scenarios & select materials to reduce cost, while maintaining or increasing cable service life.