# How Force Technology optimized the performance of a composite longboard using CES Selector

During a web seminar hosted by Granta, composite specialist Benjamin Hornblow, from technological consultancy FORCE Technology in Denmark, spoke about the challenge of developing products using composite materials: how to determine which materials to use and how to combine them in order to maximize the unique properties and benefits of each. He presented a case study detailing this process for a longboard, aiming to optimize performance, minimize weight and absorb vibration to create a more comfortable ride. He explained that by using the CES Selector™ software, the team at FORCE Technology was able to quickly identify candidate materials and evaluate the ways in which they could be combined to achieve optimal results. The final composite provided a longboard with similar bending stiffness, a smoother ride and 30% weight saving compared to the current state-of-the-art board.

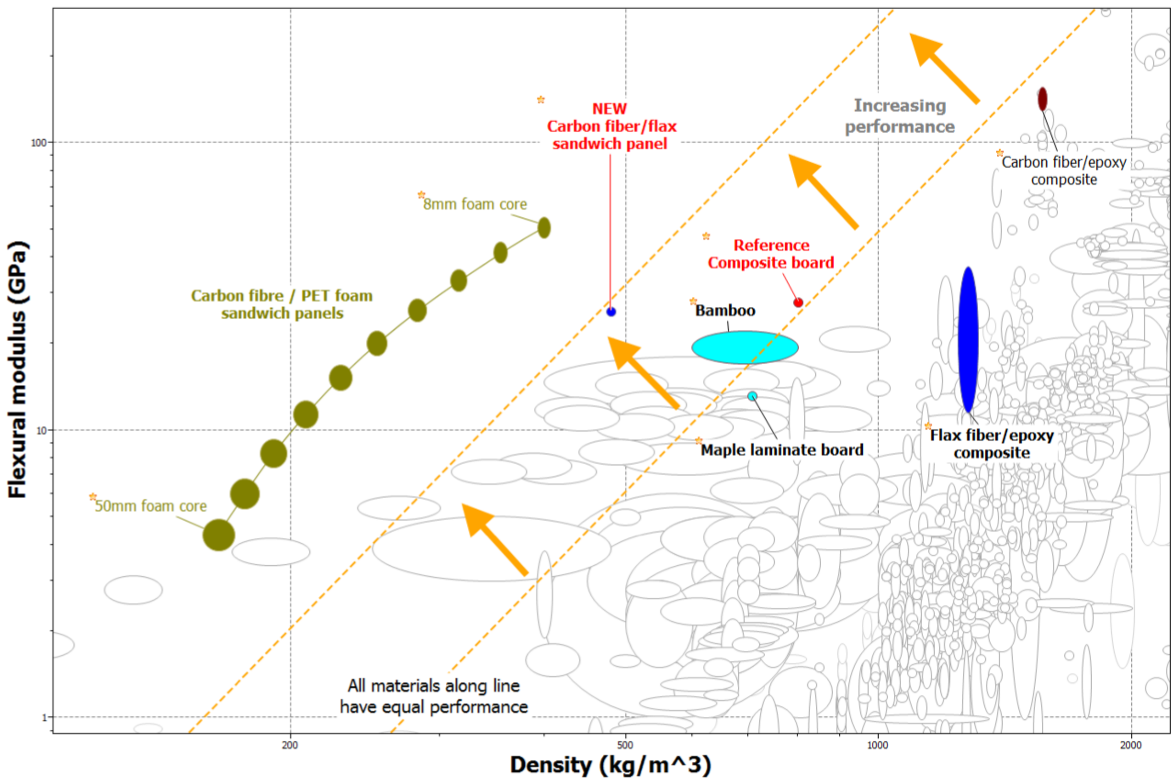
## Using CES Selector to identify candidate composites materials

When considering the use of composites and sandwich panels, the question is how best to determine which of the multitude of material configurations would best suit the application. The first step was to investigate the available materials currently being used for longboards, and compare their performance. FORCE Technology discovered that there were three main variants of board – maple, bamboo and composites. A state-of-the-art board comprised of a sandwich panel of carbon fiber on the bottom, maple in the core, and glass fiber on the top was used as a reference. The next step was to consider the performance of reinforcing fibers that would provide the main structural component of the board. Using Granta's MaterialUniverse, FORCE Technology compared the performance of five natural fibers – cotton, flax, hemp, jute and kenaf with glass fiber, carbon fiber, and aramid fiber (a man-made organic polymer). The first consideration was stiffness. Within CES Selector™, the company was able to plot Young's modulus to see that flax fibers lie within the same stiffness range as glass, though both fall far below carbon fiber. When comparing tensile strength, the natural fibers could not compete with the artificial ones, but performance was acceptable given that the longboard is a stiffness-driven design.

By comparing the mechanical loss coefficient of the fibers within the software, it was also clear that the damping characteristics of the flax fibers was three orders of magnitude higher than those of the glass or carbon fibers. This raised the question whether flax could be combined with carbon fibers to create a board that would benefit from the stiffness of the carbon and the damping properties of the flax fiber. As flax is lighter than carbon fiber, there are also potential weight reducing benefits too. The natural flax fibers seemed like an interesting candidate—but how would they perform as part of a composite?

## Generating composites within CES Selector

FORCE Technology's next step was to use CES Selector's Synthesizer Tool™ to model the performance of the reference board and new composite boards with up to seven layers. Graphs were created in CES Selector to compare flexural modulus (bending stiffness) with density and a performance index for a light, stiff panel in bending was applied, so that the team could easily identify which materials would perform better. This identified that a longboard made from a solid flax fiber/epoxy composite would have poorer performance than a maple board, whilst bamboo would be more suitable. They were also surprised to see that the state-of the art reference was no better than the cheaper bamboo board in terms of performance.




*Comparing the performance of the different longboard designs*

Next the team considered the use of a lightweight foam core, modeled the performance of a carbon fiber/PET foam cored sandwich panel, and identified that this could lead to a large improvement over both the bamboo and composite reference boards. Based on these results, and knowledge of composite materials, the company decided to combine the concept of using a hybrid carbon and flax fiber composite with a sandwich panel, and created another seven-layer composite model within CES Selector. This consisted of a three-layer face sheet with carbon fiber twill as the outermost layer, a layer of UD (unidirectional) carbon fiber and then a layer of biaxial flax fabric, and a PET foam core.

## Refining the design and results

Performance of the new seven-layer design was plotted, and it showed a significant improvement over the previous boards (including bamboo), and towards the idealised sandwich panel design. The design was then refined by modeling the longboard in Dassault Systèmes' CATIA 3D CAD program, before a prototype was manufactured and tested.

*Benjamin Hornblow tests the longboard to check that it offers an enjoyable ride*

The final longboard, which turned out to be slightly thicker than the reference and deflected a little bit more under three-point bending, was more than half a kilogram lighter (30%), providing greater acceleration and, critically, the board offered a smoother and more enjoyable ride. Mr Hornblow said: "It was great to use the multilayer Synthesizer Tool in CES Selector to 'test out' different materials, concepts and configurations early in the design process. "This saved valuable time by reducing the number of iterations required for the more labor-intensive CAD modeling and prototyping stages of the project, resulting in the development of a much better performing longboard."