Metamorphosis by design: innovations at Butterfly Seating

This is a special feature from *PAX Tech*'s 2023 April/May Seating & IFEC issue on page 8.

Alex Preston, Senior Editor at PAX Tech (foreground) and Lars Rinne (background) CEO and Co-Founder of Butterfly Seating

The newest office of the award-winning start-up seat manufacturer Butterfly Flexible Seating Solutions is tucked away on the Catalyst science park at the historic Titanic Quarter in Belfast, Northern Ireland. Butterfly Engineering opened in April 2021, focusing on the engineering and airworthiness certification of the Butterfly seat concept. *PAX Tech* visited in March 2023 to hear all the latest from CEO and Co- Founder Lars Rinne.

The system

Butterfly provides a flexible seating solution that allows for the instant transformation between Premium Economy and Business Class flatbed suites. Butterfly is composed of two recliner seats with the aisle seat offset backward. When both seats are used, an airline can sell it as premium economy seating. To upgrade the solution into a regional Business Class product, the change is simple: flipping over the inboard seat forms a flat surface and immediately turns the seats into a private suite for one passenger, with a seat and a side couch.

The award-winning Butterfly aviation seat by design for single-aisle aircraft offers airlines a new monetarization channel

When a passenger wishes to sleep, they can flip the aisle seat over as well. Combined with the side couch, Butterfly/Rinne says this arrangement forms one of the largest and flattest cabin bed surfaces in the industry. The configuration allows passengers to lay flat diagonally across the bed, which at 78 inches in length can easily accommodate the tallest of passengers.

What makes the Butterfly solution stand out is that the suite is primarily designed to be operated without motors. In fact, passengers can make the change from seat to bed in just ten seconds and with the use of only one hand. Hence, Butterfly claims this solution to be the only manual flatbed solution currently in the market — significantly reducing weight, maintenance and price compared to motorized solutions.

Rinne oversees the young, small but steadily growing company. Butterfly is currently occupied with stress testing and certification of its seat after successfully completing its first crash test last year.

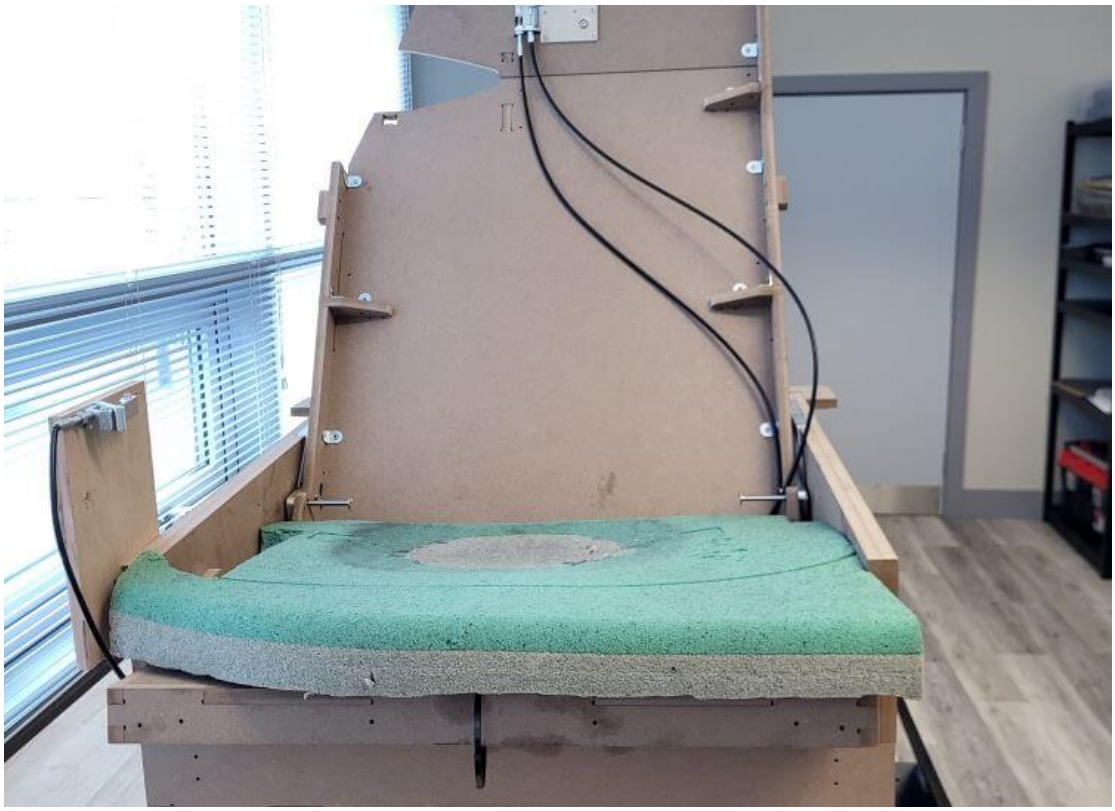
Crash test innovations

As explained during *PAX Tech*'s on-site visit, prior to the development test, the Belfast team had the entire seat simulated into a Finite Element (FE) model to give them a good understanding of how the seat would perform during the test.

But developing and simulating a crash test in a mathematical model requires high skills in modelling — something the Belfast team happens to do well.

Through the use of computer-aided design (CAD) and dynamic finited element method (FEM) software, the team/ crew built a virtual model to identify issues and solutions that can be repeatedly validated via such experimental tests, including Head Injury Criterion (HIC) tests using virtual Anthropometric Test Devices (ATDs). There are as many as 16 different testing scenarios to satisfy.

The Belfast team's dynamic method avoids the trial-and-error approach that some companies take. The efficient Butterfly technique reduces time and cost— an essential aspect for a start-up the size of Butterfly Engineering and certainly on the wish list for any OEM.



The team in Belfast uses cardboard models to investigate changes in design and component placement before moving on to more stringent testing

The ability to test assumptions and introduce changes, however minor or critical, into the simulations requires a lot of computational power and runtimes — it can be hours or even days depending upon the complexity of the test. While time-consuming, such attention to detail is at the heart of the mission of Butterfly, especially in light of the possible configuration for the seat: sitting (either as two individual premium economy seats or as a single private seat) and sleeping.

"It's worth spending the time at the start to get it accurate," Rinne says.

The accuracy of the FE model is best shown in the results of the actual tests. For instance, the FE stress test analysis prior to the actual physical dynamic testing showed potential points of failure in some components. Having identified these and redesigned them, the structure of the dynamic seat remained intact during the pitch and roll elements of the test.

"Analysis on the seat was worth it, as it showed the seat structure was valid," Rinne tells *PAX Tech*. The seat survived with all four attachments remaining in place.

The Belfast office is also home to the seat demonstrators, which over the years have transformed from simple cardboard/ MDF (medium density fibrewood) variants into today's impressive shell scheme. The improvements are in part due to the increasing talents of the Butterfly team both in Belfast and Hong Kong but also the long-standing support of sponsors, which are namechecked on the demonstrator's accompanying data sheet.

Looking ahead

The Butterfly concept has other applications — it can be adapted to work on other types of public transportation where passengers travel long distances, such as coach and rail. The Belfast office is at the heart of this pursuit too.

Butterfly Motorcoach, a convertible seat designed for coach buses, recently entered service between Washington DC and Nashville with US-based launch customer Napaway Coach. Each coach carries 18 Butterfly motorcoach suites — all of which contain more than 13 square feet of usable space and a 78-inch-long flatbed that can be transformed into a personal lounge or two separate seats. Bedding and other amenities are provided.

The still intact seat underwent a successful dynamic test, including pitch and roll

As Rinne says of the Butterfly product, “Now we know what is working, the mission is refining the product further.” With such a skill base and passion on display in Belfast, such improvements are sure to deliver a unique, comfortable and monetizable seat, all built on a tried and tested approach.