



Creating Comfort: The Making of the Logitech Comfort Wave Design

The story behind Logitech's breakthrough keyboard design

Keyboards. Around the world, we find these thin, rectangular objects in nearly every home and office. For many of us, typing is so ingrained in our daily lives that we don't even think about doing it. Like driving, we do it automatically. But think of the role keyboards play in our lives. Consider for a moment just how many ways we use them. E-mails. Proposals. Spreadsheets. Instant messages. Web searches. Browsing the Internet. Video games. In fact, according to a recent study at Harvard, for Logitech, the average person types more than 2 million keystrokes every year. That's equal to five forty-hour weeks of sitting in a typing position.

While the rest of the world takes these input devices for granted, Logitech's Switzerland-based keyboard development team has dedicated endless hours – even years – to improving and reinventing keyboard design and features to provide the most comfortable typing and best computing experience possible.

A Tradition of Innovation

When Logitech entered the keyboard market in 1998, the company had already established itself as a leader in mouse innovation. And it quickly demonstrated that it could deliver innovative keyboards as well, beginning with its creation of a mouse-and-keyboard bundle, which Logitech sells under the Desktop® trademark. Today, many other companies sell keyboard-and-mouse combinations and they even have a dedicated section in the keyboard aisle.

Since entering the keyboard market, Logitech has steadily challenged the accepted function and design of keyboards. In 2003, Logitech introduced new comfort features: Zero Degree Tilt™ to address wrist extension, two-handed navigation to distribute work more evenly between the right and left hands, and a redesigned 5-pack (the Home, Delete, End, Page Up and Page Down keys) to minimize the distance traveled from keyboard to mouse.

In 2004, in response to the computer's increasing visibility in the home, the company announced the highly designed Logitech® diNovo™ Media Desktop™. The recipient of numerous design and technology awards, the keyboard incorporated sleek design with advanced technology, such as a redesigned key mechanism, Bluetooth connectivity and a separate MediaPad™ for controlling media on the computer. People who purchased the diNovo desktop no longer had to hide their computer in a home office – instead, they could proudly display it in common living areas.

Having worked since early 2005 on updating the diNovo design, in 2006, Logitech announced the diNovo Edge™ keyboard, a significant evolution of the diNovo Media Desktop. Another result of the Logitech Desktop team's successful collaboration, the

diNovo Edge keyboard set a new standard in keyboard style due to its ultra-thin, minimalist design, rechargeability and dynamic backlit keys.

Looking Ahead

Over the years, many different types of keyboard designs have been explored. One of the most common alternatives to the straight keyboard is the split, or ergonomic, keyboard. (Logitech and other manufacturers have manufactured ergonomic keyboards for more than 10 years.) However, ergonomic keyboards have never attracted more than a small portion of people; most people are discouraged by the strange shape; for many people, these designs require that they relearn how to type. However, scientific studies have confirmed that split keyboards reduce forearm pronation because they allow people's arms to take a more natural position when they type.

With the bulk of the diNovo Edge keyboard development efforts behind them, in the summer of 2005, Logitech's desktop development team turned their attention to an emerging, unmet need. The team realized that although people were spending more time on their computers than ever before, unlike many other frequently used products, the shape and comfort of mainstream keyboards hadn't really changed or evolved in response.

What could Logitech do for the millions of people laboring at their computers with tired hands or wrists for hours on end each day, for the people who wanted more comfort but didn't want to relearn how to type?

They set out to develop a keyboard that would deliver comfort and usability in an approachable design. With this goal in place, Logitech Ergonomic and Usability Expert Sylvain Sauvage began researching basic ergonomic principles to apply to the new keyboard design.

Addressing the Four Points of Discomfort

To begin, Sauvage reviewed the available ergonomic research and established that Logitech's new keyboard design must address the discomfort that can arise from the traditional, straight keyboard. The following four points of discomfort established the underlying criteria that would drive the development of the Comfort Wave Design:

1. **Pronation:** Straight keyboards require people to rotate their arms (pronation) to position their hands parallel to the desktop. A comfortable keyboard should reduce arm rotation.
2. **Finger Static Load:** Straight keyboards are designed as if human fingers are all the same length. A comfortable keyboard should allow fingers to rest in a natural position.
3. **Wrist Ulnar Deviation:** Straight keyboards cause the wrists to bend unnaturally (wrist ulnar deviation). A comfortable keyboard key frame should curve to reduce wrist ulnar deviation.
4. **Wrist Extension:** Straight keyboards often take an angled profile, forcing wrists to flex (wrist extension). The key frame on a more comfortable keyboard ought to remain parallel to the desktop, instead of at an incline, to eliminate the need to flex the hands at the wrist.

The Actual Shape of the Human Hand

With the four points of discomfort in mind, Sauvage began examining the human hand and its natural resting position. He noticed that when we place our hands on a straight keyboard, our hands actually take the shape the keyboard guides them into. Sauvage began to think about the basic concepts behind designing a keyboard for the natural shape and resting position of the hands.



Office Playground, Inc.

Figure 1 Pin art

One of the defining moments came when Sauvage was playing with a pin-art toy, which uses metal pins to capture the three-dimensional shape of any object placed against it. Sauvage pressed his hand onto the pin-art toy and saw the outline of his hand. And he realized what had always been apparent but never explored and commercialized in keyboard design: each of our fingers is a different length. Logitech could create a more comfortable keyboard by shaping the key frame to fit the variable vertical length of the fingers, by offering a key frame that mirrored the actual shape of the human hand.

From that moment, Sauvage began to feel confident about an innovative design – a wave-shaped key frame that would mirror the actual varying length of the fingers. A keyboard design with the potential to bring comfort to the masses.

The Specifications of Comfort

To determine the specific variations in height of each key, from late September 2005 until March 2006, Sauvage worked with a team of industrial engineers at a U.S. university. Using design analysis and prototype testing, Sauvage was able to determine the ideal contour for what would become the signature element of the Logitech Comfort Wave Design.

He began by creating three-dimensional renderings that mapped a wave-shaped key frame onto an image of an existing keyboard – the Logitech® Cordless Desktop® MX™ 5000. They created drawings of each keyboard row and reviewed several options with various heights for each key. Finally, they created four prototypes and analyzed the perceived comfort of each design.

After testing and reviewing the results, Sauvage arrived at a critical decision, establishing that the ideal height differential between the lowest and highest key should be 4 mm. A smaller height – 2 mm or 3 mm – was too subtle. A higher one – 5 mm – was too drastic. Finding the right balance between what usability experts call the perceived and actual comfort would prove to be a critical decision. The peaks and troughs of the Wave key frame would rise and fall but never exceed a height differential of more than 4 mm.

But the new keyboard would need to offer more than just an innovative key frame. To achieve Logitech's goal of providing a comfort keyboard for everyone, Sauvage knew

that other specifications – key cap size, key travel – must also signal that this new keyboard was not a radical departure from the traditional, straight keyboard.

Sauvage recommended additional specifications: The distance between each key ought to be a consistent 19 mm. Key travel ought to meet the recommended distance – 3.6 mm. Key-cap size ought to each be the same size as a standard, straight keyboard – 14 mm – so that, compared to traditional ergonomic keyboards with larger middle keys, there would be no visual confusion.

With this knowledge in hand, Sauvage began sharing his findings with the rest of the development team, including Logitech's longtime industrial-design partner (who had also just finished working on the diNovo Edge keyboard), Design Partners, based outside of Dublin, Ireland.

Design Concepts, Inspiration

To develop a keyboard that delivered the maximum comfort, Sauvage and his team members saw a great opportunity. A wave-shaped key frame could reduce forearm pronation and finger static load. But what about wrist extension and ulnar deviation?

To answer these questions, Logitech and Design Partners came together at the initial design identification (ID) exploration meeting to identify several options that could address all of the four pain points outlined by Sauvage: a curve, with an angle that would displace the key frame from the horizontal plane; a wave, which would displace the key frame from the vertical plane; and a palm rest, which would support the hands.



Figure 2 Straight keyboard layout. Model developed for Wave project.



Figure 3 Curved keyboard layout. Model developed for Wave project. (Note: The large middle keys.)



Figure 4 Wave-shaped key frame for C row.

After the meeting, development moved along two fronts. While Sauvage continued to define the specifications for individual keys, Design Partners began defining a design ID that would support a wave-shaped contour, and possibly a curved layout and a palm rest.

Early on in the industrial-design development process, Senior Designer Cathal Loughnane of Design Partners accompanied one of his fellow designers to get his Land Rover serviced at a dealership.

Sitting inside one of the car models, Loughnane had an epiphany. He saw that an organic, curved shape could convey a powerful sense of performance and also provide exceptional comfort. He realized that, in contrast to the hard lines and angles of the diNovo Edge, whatever the final look the Wave keyboard would take, it should use a different design language – one with natural forms: rounded edges and smooth transitions.

With the design ID established, Design Partners began developing models. Linear designs. Curved designs. Keyboards with a wave-shaped key frame and a curved layout. A keyboard with only a wave key frame. A keyboard with only a curved layout. Keyboards with and without a palm rest. Different shapes – every one trying to speak the specific design language of comfort and performance.

In May 2006, Design Partners presented several models to Logitech's Desktop development team, including product marketing and engineering. When everyone gathered around the conference table in Logitech's offices in Switzerland, the response from the Logitech team was immediate and overwhelming.

Remember, Logitech was concerned that the majority of people would be scared away by a design that deviated too far from the norm. They wanted to try any element – a wave, a curve, a palm rest – that would add comfort. But they didn't want to intimidate people, either. Maybe all three together would be too much.

To everyone's delight, when they brought all the models in one room, and put their fingers on the keys, it was the most comprehensive approach – the keyboard with the wave-shaped key frame, the curved layout and the palm rest – that was the clear favorite. Everyone agreed: the keyboard with all three elements would provide the most comfort.

But would people embrace it? The product marketing team discussed taking a cautious approach. Perhaps, they reasoned, it might be wise to shelve the idea of incorporating more than just a wave; they felt that they could introduce the curve and the palm rest later.

The team had now been working on the project for nearly a year. It was time to get an unbiased opinion. The next step was to take their models to the people and see what they thought.

The Most Innovative Design Is the Right Choice

In June 2006, Logitech presented a series of models to focus groups in California, France and Germany. Participants were presented with straight keyboards, curved keyboards, wave keyboards, straight-with-a-wave keyboards, and curve + wave + palm rest keyboards.

Traditionally, the combined results of a focus group favor designs that fall in the middle of a range. In this case, the middle of the range was the wave and curved keyboards.

But to the surprise of everybody, however, the most comprehensive design approach – the curve + wave + palm rest combination – turned out to be the favorite.

The Logitech Comfort Wave Design was chosen and named. Logitech would be the first to combine a wave-shaped key frame, a U-shaped curve and a padded palm rest.

All the research and development – taking the keyboard design from concept to a viable model – was completed. It was time for the development team to start working with their colleagues in Asia to determine how to manufacture the Wave keyboards on a large scale.

Reinventing Assembly Tools

Traditionally, straight keyboards are assembled in several stages, which include creating the keys, the membranes and the housing. Because of the wave-shaped key frame, Logitech completely redesigned nearly every element of the assembly process, including key molding, rubber dome production, printing and testing.

Typically, keyboards have approximately a dozen different types of keys. There is one tool that creates all of the key caps. The plastic is injected and each key cap is molded by the tool in one shot. These are then automatically inserted into the keyboard's topcase.

For the Wave keyboards, Logitech's industrial design team, located in Taiwan, created an entirely different approach that involves seven tools with several key cap sizes for each tool. Then, Logitech's Suzhou, China-based manufacturing team went to work. Once molded, these key caps are collected into seven different bags and manually inserted on the product lines by operators, one by one.

But the key stamping process wasn't the only element that caused Logitech to alter the manufacturing process.

Like most keyboards, the Wave keyboard uses a rubber dome underneath the keys to send signals from the keyboard to the computer. Unlike the flat shape of traditional rubber dome membranes, the Wave rubber dome had to be fitted to conform to the shape of the Wave. That meant, the rubber dome had to be redesigned on three dimensions instead of just two.

Finally, the manufacturing-testing process had to be redesigned to accommodate the wave key frame.

New Packaging

Manufacturing wasn't the only group within Logitech that had to make substantial changes to accommodate the Wave keyboard.

After assessing existing Logitech keyboard-packaging designs, the California-based packaging team realized that the Wave keyboard demanded a new package altogether. One that would allow shoppers to get a feel for the Wave, rather than make a purchase decision based on a picture on the box.

To accomplish their goals, the packaging team created a specially designed, contoured-Thermoform plastic shaped to conform to the Wave key frame so people can experience

just how natural and comfortable this innovative new design really feels, even before they get it out of the box.

Wave Keyboards Confirmed Comfortable

With the engineering, manufacturing and packaging details in place, the development team began the second phase of product validation. In April 2007, two U.S. universities performed scientific studies testing the Wave Comfort Design. Their results showed that the Wave keyboards provide a significant reduction in the four points of discomfort – without causing a noticeable change in typing speed or accuracy.

A Comfortable Future

A significantly new design. A signature platform. These innovations wouldn't have occurred without the collaboration of industrial designers, usability experts, marketing specialists, mechanical and packaging engineers working around the world.

For the research and development, and the design, manufacturing and packaging of the Wave keyboard, Logitech brought together the unique talents of people working in the U.S., Ireland, Switzerland, Taiwan and China. Their worldwide effort speaks to the ambitions for this project: To make a comfortable keyboard available to the masses of people around the world.

It started with an epiphany. The idea that a keyboard should map to the shape of the fingers. And the realization that something that we use as often as a keyboard shouldn't ask us to conform to it – while we sit in pain.

A keyboard ought to conform to the shape of our hands. A keyboard ought to be designed for the actual shape of our fingers.

Now, one is.