EPIC FLASH

USING ARTIFICIAL INTELLIGENCE TO DESIGN THE NEW FLASH FACE

The Epic Flash driver incorporates a radically different clubface design with the express purpose of promoting faster ball speed for more distance. It was designed with a large assist from Artificial Intelligence (A.I.), a tool that lends itself exceptionally well to this type of challenge.

A.I. is the science of training machines to perform human tasks. It works by combining large amounts of data with fast, iterative processing and intelligent algorithms, allowing it to learn automatically from patterns or features in the data. A.I. is capable of analyzing more data to a greater degree than humans, and can look at things differently than humans do, seeing patterns and relationships that escape us. A.I. also functions much faster than humans. All of these qualities allow A.I. go deeper in exploring options and possibilities, allowing it to meet challenges and solve problems in ways humans might not.

It started when members of the Callaway R&D team, led by senior vice president of R&D Dr. Alan Hocknell, made a case to CEO Chip Brewer for investing in a Super Computer with A.I. capability to help in the design of advanced, better-performing equipment. Intrigued, Brewer approved, and a Super Computer was installed on the premises at Callaway headquarters in Carlsbad, Calif.

Callaway engineers wrote the software necessary to get A.I. started on the clubface-design project, and the computer manufacturer helped us configure the computer to work with the software. Part of getting started was helping A.I. build its own understanding of the physics involved between a clubface and ball at impact, and the in-depth details of the USGA's conformance test for clubface CT, or Characteristic Time. One more thing: To keep the face design focused, the super computer was instructed that its design had to work in accordance with the strict specifications of other design features of the clubhead, so that the face would work in harmony with all components -- sole, crown, Jailbreak technology, adjustable perimeter weighting – to promote maximum performance.

Marching orders in place, the Super Computer commenced. It created one design after another, learning from each, working non-stop, day and night.

> *"Our normal process for developing something like this is to try several iterations, with the design team analyzing and discussing the validity of each one," said Hocknell, "but we're limited to a human's assessment ability, and how many ideas a human can come up with. A.I. used Machine Learning to navigate that design and analysis loop thousands and thousands of times, while doing a better job than a human can of assessing each iteration."*

The Super Computer worked continuously for three weeks before arriving at a design it couldn't improve on in terms of ball speed generation. Altogether it created more than 15,000 iterations, or "virtual prototypes." (For an idea of the kind of computing power that took, it would take a conventional desktop computer 34 years to run this same analysis.)

At first sight, Callaway engineers were stunned. The design is asymmetrical, with what appears to be a random pattern of waves and ripples of different sizes and depths spanning the surface. It bears no resemblance to any face Callaway has conceived before. By looking at it it's hard to make sense of how it works.

The Super Computer also predicted what the face would deliver in terms of performance, including ball speed gains. We immediately machined a physical prototype at Callaway headquarters and tested it, finding the computer's prediction was accurate within .1%.

> *"We thought A.I. could figure out aspects of how the face works in the dynamic situation of impact to arrive at a deeper understanding of how the face works and how to improve its performance," said Hocknell. "That's what happened. We learned there are things going on in one part of the face that influence what's happening in other parts of the face at impact and this is a whole higher order level of analysis and design," said Hocknell.*

The unique design forced changes in the entire face production process. Our CAD designers had to work differently. Our manufacturing method had to change. Forging this face design is significantly harder than previous face designs. Even measuring the unusual contours of this new face posed new challenges.

Callaway