Tim Lane

Bicycle Design Engineer

Multi-award winning:

reddot design award winner 2010

Designpreis Deutschland 2010 NOMINEE

CADESIGN CALIFORNIADESIGN BIENNIAL

Conception of, industrial design and engineering of aerodynamic road chassis; significantly less drag in wind tunnel testing than competitor bikes ...UCI legal

Conception of, industrial design, engineering, development of new manufacturing processes and patent writing for flagship time trial chassis with innovative steering system, brake placement, cable management ...still UCI legal.

Pre DA: TT bike structures are with simple, straight tubular forms, some have partial wheel cut-outs

Mil-spec sealed internal guides makes routing cables almost joyous.

Internal cable routing & behind the stem cable entry reduce aerodynamic drag by >4%.

Replaceable aero seat post clamp and non-integrated seat tube for easy customer service and transport.

My patented Bayonet Steering System improves the aerodynamics >4% while improving steering stiffness 60%.

The Bayonet Steering System fits in a conventional headset allowing conventional unicrown forks to be used for budget models or customer service.

The Bayonet's adjustable stem allows a complete scope of fitting adjustment using the supplied components.

Full rear wheel cutout reduces aerodynamic drag on the bicycle by >5%.

The offset seat tube allows UCI conformity. Holistic monocoque design was adopted by many players in the industry.

My patented positioning of the brake in the 'dirty' air between the cranks reduced aerodynamic drag by ~4%. Moving the brake caliper to the chainstay also lowers the bikes center of gravity to improve handling.

Unconventional brake positioning was uncommon before the release of the DA, it is now commonplace.

Felt DA...still UCI legal, even with the Bayonet

Post DA: integrated brakes, novel steering systems, elongated airfoil monocoque forms are commonplace

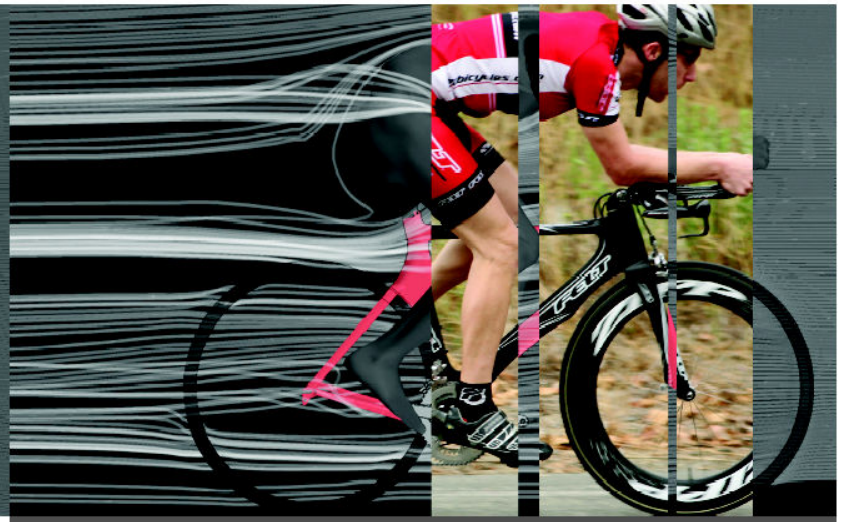
Conception of, industrial design and engineering of time trial handlebar; novel extension/arm-rest adjustment system requires a minimum of hardware ...still UCI legal.


DEVOX
DEVOX

CD-adapco help Felt Racing

to design "the most aerodynamic, UCI-legal bicycle frame ever created"

Stephen Ferguson, CD-adapco



▲ **Fig:01**
The Felt DA is the fastest UCI legal Tri / TT bike built today. Developed over two years with careful use of NACA aerofoil profiles, CFD flow modelling and wind tunnel experimentation, the DA frame system delivers unsurpassed aerodynamic advantage with incredible drive-train and steering stiffness.

▶ **Fig:02 (overleaf)**
Felt Racing Design Engineer Tim Lane aboard the revolutionary DA carbon-fibre bicycle.

Felt Racing recently unveiled their new DA Carbon Fibre racing bicycle that, according to company founder Jim Felt, is designed to be "the most aerodynamic, UCI-legal frame ever created." Although Felt's claim is a bold one, he has a sheaf of wind-tunnel data to prove it, and can point to a two-year design process for the bicycle that involved extensive CFD simulation right from the start.

Founded in 2000, Felt Racing is an American manufacturer of high-end racing bicycles, particularly aimed at the demanding Triathlon and Time-Trial markets. Under the leadership of Felt, an internationally renowned frame-building guru with a host of world-championship winning designs under his belt, Felt Racing have quickly established a reputation for technological innovation and aerodynamic design, with a stated mission *"to design, develop, and deliver the best bicycles in the world. Period."*

The DA is a significant step in that direction, featuring a remarkably narrow (25mm) frame, with aerodynamically optimised tubing shape and innovative wind-defying features such as a revolutionary brake-mounting that sits inside the seat tube, and a unique bayonet steering system.

According to Felt Racing Frame Designer Tim Lane, who was responsible for most of the CFD simulation, aerodynamics play a crucial role in Time Trial racing: *"With no team-mates to pull you through and no wheel to draft, Triathlon and Time Trial require not only a strong engine, but also a vehicle that is ergonomically and aerodynamically advantaged. Racers must convert every last ounce of energy into raw speed, and slice through the wind like a razor."*

In order to make sure that wind-tunnel resources are exploited to their full potential Felt adopt a complimentary approach, using CFD simulation to determine which designs are the most aerodynamically efficient, and only testing the best in the wind-tunnel. *"As a company we've invest heavily in wind-tunnel testing"*, says Lane, *"but we recognize that wind-tunnel testing is both expensive and time consuming. By using CFD simulation right from the start of the design process, we can ensure that by the time we get to the tunnel, we are fine-tuning an already aerodynamically efficient design."*

Tim Lane and his colleagues at Felt Racing have established an impressive process for CFD modeling so that *"right from the start of the design process"*, literally means from the moment that first CAD models are generated, usually many months before prototypes are built. Through a process called CAD-embedding, Lane and his team can access CD-adapco's CFD software directly from their Pro/ENGINEER CAD package. This enables designers to perform CFD simulations of their current design by expending just a few minutes of effort, with all the CFD functionality available from a small number of additional menus in the CAD tool.

Results of the CFD simulation (which typically take less than an hour to compute using a standard desktop computer) are automatically presented to the designer in terms of drag-coefficients, for the whole bicycle.

The results are not always what the designer originally expected: *"Bicycle aerodynamics is about the interaction between all the different components that make up the complete bicycle"*, says Lane. *"Just because a component or concept looks good on the CAD-screen or seems viable in theory doesn't mean that it will work out on the road. Unless you are very careful, an aerodynamically optimized component can sit in the dirty air generated by someone else's beautifully designed, yet aerodynamically inconsiderate component, thus still generating a whole heap of drag."*

Lane and his team investigate any unusually good, or unusually bad results by examining a predefined set of flow-visualization plots that are automatically generated and stored for each design simulated. *"The beauty of CFD is that if we want to, we can investigate every single component, and look in detail at the flow-features that it generates"*, says Lane.

This thorough investigation of the design envelope is warranted because competitive cycling, like Formula 1 motor racing, is bound by a very strict set of regulations, which are defined by the sport's governing body (the Union Cycliste Internationale or UCI). The regulations are specifically designed to maintain the traditional shape of a bicycle and to limit the scope for manufacturers such as Felt Racing to gain significant competitive advantage for their riders. As the DA proves, this doesn't mean that there's nothing that can be done: *"In designing the frameset we took advantage of every possible lenience permitted within the UCI rules"*, says Lane, *"it's not just a frame – but a completely thought out frameset comprised of a frame, fork and stem, blended together as a single unit"*.

Because the wind-tunnel mock-ups were unable to support a riders weight; when the basic bicycle design had been decided upon, Lane used additional CFD modeling to see check that the bicycle performed with a rider in a number of aerodynamic riding positions. Rider and bicycle were combined in CD-adapco's STAR-CCM+ and joined together using advanced surface meshing, that creates a single contiguous surface suitable for CFD modeling, while respecting the complex geometry of the bicycle – right down to every gear-tooth on the groupset.

Importantly, using CFD Felt Racing were able to speed up their design process: *"Of all the CFD technology we tried, only CD-adapco's combination of CAD-embedding and surface wrapping provided a robust and efficient process by which we could optimise our designs without delay to our demanding production schedule"*, says Lane. *"Ultimately, using CFD, we were able to build a more aerodynamically optimised bicycle at less expense, because of the cost and time saved in reducing the number of wind-tunnel prototypes."*

Although it is difficult to say whether Felt Racing have achieved their aim *"to design, develop, and deliver the best bicycles in the world"*, every triathlete and time-triallist that manages to race faster, using less-energy, because of Felt Racing's investment in CFD technology, will probably agree that the DA is a significant step towards it. ■

MORE INFORMATION ON FELT RACING AND THE DA **http://www.feltracing.com/**

Collaborate with CFD provider to develop and market aerodynamic bicycles

Working in the wind tunnel

Design and engineering of carbon suspension frames.

Design and engineering of alloy TT frames: aero carbon fiber seat stays, aero carbon fiber seat post

Conception of, industrial design and engineering of early aero road bikes for ITU/Century category


K2
SUPERLITE


FELT
carbon
FIBER
SUPERALLOY


FELT
FC TEAM
modular alloy carbon construction
SUPERLITE


FELT
FELT
FELT

Concept to production design of all current Felt cruiser frames.

Novel adjustable handlebar-fork interface. Concept to production design of chopper frame.


FELTBIKES
BMX2008
SECTOR

Concept to production design of aggressive juvenile frames allowing growth with a child.

This is just a selection of my work,
I have experience designing most bicycle components.