Development and testing of a flexible seat-post

## based on pultruded profiles for use in road/racing bicycles

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http://ziv-zweirad.de/uploads/media/

European\_Bicycle\_Market\_Profile\_2015\_by\_CONEBI\_01.pdf

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The sport of cycling is as technological as ever as professionals and amateurs look to gain the slightest advantages over their competitors

Quote: 21.Nov.2015: http://www.cyclingnews.com/news/inside-the-cyclefit-store-gallery/









'**Comfort**' on a race bike?

# ....that is **NOT** our first objective.! we want:





reduce

#### reduce

loss of kinetic energy













### '**Comfort**' on a race bike?

# ....that is **NOT** our first objective.! we want:

#### reduce

# reduce

<u>rider fatigue</u>

loss of kinetic energy







Both can be achieved with (mini)-suspension, i.e. flexible seatposts. .... and if that comes along with some improved 'comfort' we'll be happy to take that 'comfort' as a secondary benefit as well.!







#### examples of existing designs: Parallelogram

quoted from Voves, Wheeley Cycling Science, 1996

...upon impacting the bump, the rider, ..., is accelerated **upward and forward** along an arc referred to here as the 'impact arc'.

...a portion of the forward kinetic energy is converted into (vertical) potential energy.

..metabolic energy is expended as leg and arm muscles brace and damp motions of the body









#### example of new design: *pseudo-Parallelogramm*

redesigned and large series production using prepregs / bladdermolding process

2013: market introduction by Canyon VCLS Post 2.0 CF and licensed to Ergon

**CF3 Pro Carbon** 





#### example of new design: pseudo-Parallelogramm

After successful market introduction of VCLS 2.0

re-consider & redesign ,**pultruded**' prototypes

in order to complement product range

→ ,mid-range' pricing





#### example of new design: *pseudo-Parallelogram*







→ built and tested within diploma thesis R.Müller (www.FAST.KIT.edu, 2013)





#### **Testing Compliance of pultruded profiles**









#### Testing compliance of ,system' including seatpost



# Testing compliance of ,system' including seatpost

(thesis S.Navidi, 2011)





#### Testing compliance of ,system' including seatpost

Displacement of 'Point 'C' under Load (1200 N @ 282°)



(thesis S.Navidi, 2011)

#### Test-Rig:

saddle-rails-substitute-rack, displacement-sensors, angle measurement,

force up to 1200 N @ 70 mm offset direction of force: 282°



#### Comparison of frames and seatposts (thesis S.Navidi, 2011)





#### Comparison of frames and seatposts (thesis S.Navidi, 2011)

















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re-design: 'pultruded'-seatpost (thesis Robert Müller, 2013)

Conclusions:

prototype seatpost based on two CFRP-profiles (8 / 8 mm)

almost matches the deflection characteristics of the ,reference' VCLS Post 2.0

weight of 255 gram – will make it difficult to develop a marketable product based on ,solid' cross section profiles.





goals for improvement:

- match the deflection characteristics of the ,reference' VCLS Post 2.0
- match the weight of the reference (< 220 g)</p>
- …besides the obvious:... cost, mechanical performance, appealing design

→ prototype seatpost based on two **hollow** profiles (10 / 10 mm) → replace aluminum parts with injection molded ones (PA6-CF20)





,Pullflex 3.0':

,connectors' (injection molding PA6-CF20) and

CFRP hollow profiles (pull-braiding)





- → pull-winding or pull-braiding necessary to better resist compression / crushing at clamp area
- → hollow pull-braided profiles (10 mm / 2 mm) match bending moment of inertia of 8 mm solid profiles













Pull-braided CFRP-profiles

88 g (for 660 mm = 2 x 330 mm)







goals achieved !

match the deflection characteristics

of the ,reference' VCLS Post 2.0

match the weight of the reference (< 220 g)</p>



> ...besides the obvious:... cost, mechanical performance, appealing design



- > Comment:
- > Pultrusion is the most cost effective production method for fiber-reinforced composites
- Total cost to produce a marketable product <u>cannot</u> be validated by University / R&D Institute. Such evaluation must be done by OEM – also taking into account production ,volume' per year and i.e. assembly cost, decals, packaging, etc....



#### additional goal:

does any ,mini-suspension' (i.e. as provided by a flexible seatpost) result in measureable reduction of required energy to ,travel' over rough surfaces.?

Bike: Ultimate CF SL 9.0 Di2 (2015) --> Canyon Power Meter: Info Crank --> Verve Cycling Data acquisition: navi2coach --> O-synce





#### **Road Testing**

Ride #1

Baden-Baden, Neuweier, Mauerbergstraße ca. 400 m / ca.14 Hm slope ~3,5%





#### **Road Testing**

Baden-Baden, Neuweier, Mauerbergstraße ca. 400 m / ca.14 Hm slope ~3,5%





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ride #2



































The new bike DOGMA K8-S.. has a bespoke mechanical rear suspension system ....that features a miniature rear shock and... flexible carbon chainstays.

The rear suspension has been co-engineered by Pinarello and Jaguar. A small elastomer-based shock is inserted in between the seatstays and seat tube. "... to make sure that rear wheel had the capacity for 10 mm of vertical travel.."

...the riders have told us that <u>on flat sections of road they can't feel the</u> <u>suspension</u>. It's like it doesn't exist on smooth roads. That's a good indication.

we've found that there's an <u>eight per cent increase in speed</u> over cobbles when the power remains constant between the current bike and the K8-S."



published 02.April 2015. full text here:

http://www.cyclingnews.com/news/team-sky-unveil-pinarello-dogma-k8-s-for-the-tour-of-flanders-and-paris-roubaix/













# complete presentation and data available upon request

# See us at Hall 5a – E70

# and at the 'Planet-Sports' area

