Adjustable Triathlon Bicycle Design Proceedings

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***Abstract* -- A new type of triathlon racing bicycle is presented by Allied Bioengineering. The final product is a fully adjustable bicycle capable of pre-race adjustments to allow for increased comfort and efficiency as well as decreased frontal area. The main adjustable parts are the diamond frame, seat angle and handle bar configuration. The design consists of daughter tubes within mother tubes allowing for elongation or contraction as necessary, which also results in angle changes. These changes are to allow the rider to change the bicycle to fit their dimensions and meet the required dimensions of the race as well as to allow changes for the type of race, whether short track, long track, straight or winding. The design was simulated and tested in NX 4.0 showing points of high stress and strain as well elemental stress.**

***Index Terms* -- Adjustable Frame, Bicycle, Seat Tube Angle, Triathlon bicycle**

I. Introduction

Triathalon bicycles have been produced and modified, for years. Improvements are made to decrease frontal area, reduce weight, and increase efficiency with an outcome of increased speed and performance.

The main constraints involved with this project are that the design must not exceed a weight of 13 kg and must accommodate the average body type. The criteria of focus are minimizing cost, weight, transition time and wind resistance while maximizing comfort, aerodynamics and pedal stroke power.

Professional racers have bicycles that are custom fitted to their dimensions and comfort, which takes time, money and a visit to a professional fitter. The design of a fully adjustable, rideable bicycle is completely original and allows for adjustments pre-race, which can be a huge advantage with varying race conditions and venues. The best way to maximize a triathlete's performance is to properly fit a bicycle to him or her [2].

The bicycle was modeled in the CAE program, NX 4.0, which allows for further simulating loading and providing some insight of the structural integrity using the built in iterative solver NX Nastran[1]. The final milestone is to get a working assembly in NX 4.0 and a finite element model.

II. Conceptual Design and methodology

A. Overall design

Figure 1 illustrates the adjustable bicycle frame. Sections S1/S2, T1/T2, T3/T4, H1/H2 and R4/X1 are of variable length. These segments are pinned at four joints forming two distinct triangles, characteristic of a conventional diamond bicycle frame.

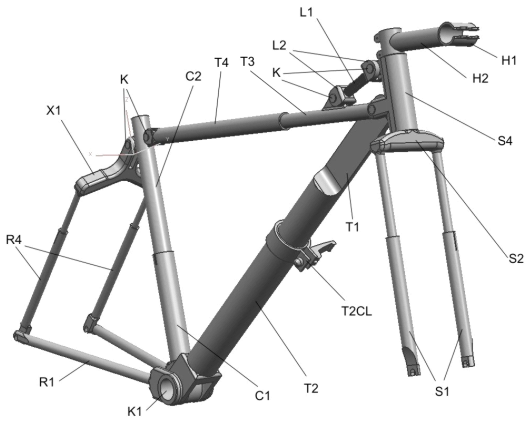


Figure 1: Adjustable Bicycle Concept

B. Major components

The major components involved in the design are the adjustable tube segments. The use of quick-release style clamping units was employed that fix the desired tube dimensions. Another major component used in our design is an additional device mounted to the horizontal cross tube that will be used secure the steer column. The material of choice is aluminum, which is durable and relatively inexpensive. Carbon fiber composites as well as titanium and various other metals were considered but were decided inappropriate due to cost, weight or mechanical properties.

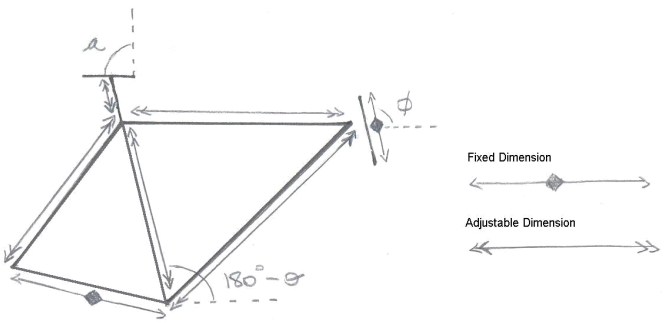
III. Detailed Design

A. Adjustable Tube Segments

Each section of tubing on the bicycle (with the exception of the chain stay tubes and the handlebar bracket) have a mother and daughter component which will allow the entire segment to contract and elongate as desired within an allowable range. Limiting this range of extension is important to ensure structural stability. It is required that at least 6cm of overlap between mother and daughter parts at all times. The design was based on current triathlon bicycle dimensions using the largest and smallest bicycles on the market. This allows for maximum adjustability within reason and regulation of triathlon sporting events. A model was developed to acquire the length of each tube segment that would be required for a particular cyclist with a given height and weight with respect to a given seat tube angle. This model was used acquire the maximum ranges of

1. NX 4.0 and NX Nastran are computer-aided engineering and digital simulation software titles respectively from UGS Corp.

variability and the forces experienced in each tube segment while cycling.



B. *Quick-Release Style Clamps*

Quick-release style clamps that are typically found on common bicycles to secure the height of the seat within the seat tube, as well as to secure wheels to front forks, are used in our design to secure desired tube dimensions. These will induce hoop stresses on the overlapping mother and daughter tube segments to ensure their configuration remains uncompromised.

C. *Moment Stabilizer Unit*

The moment stabilizer unit is a device that is mounted to the cross tube section and it connected to the handlebar bracket in order to maintain its angle with the horizon. Without it, the handlebar bracket would be free to rotate about the bicycle's forward-most tube joint and the bicycle would not be rideable.

IV. Discussion

The main advantage the adjustable bicycle possesses is its ability to accommodate everyone considering ergonomics and performance. The frame is very adaptable to every triathlete's sizing requirements.

Most riders regardless of cycling background will experience some initial discomfort with the adjustable bike fitted to their dimensions by a certified bicycle fit technician. This initial discomfort will dissipate within the first few hours of riding. Any discomfort (if experienced at all) is most prevalent in skilled riders who have grown accustomed to their particular bicycles (if they have not already been fit) [1]. Bicycle fit technicians use stationary devices, similar to our proposed adjustable design, to acquire the optimum dimensions for a rider which is then passed on to a manufacturer where a custom frame is built. Our design would also allow the technician to fit the bicycle to the athlete at which point the athlete can proceed immediately to competition.

The feasibility of the adjustable bicycle design was considered more closely and some revisions were required. After performing a more in-depth review of the available bicycle fitting literature, and with some personal communications with professionals in the bicycle fitting industry, it was decided that the chain stay tubes of the design need not be adjustable. By assigning a fixed dimension to these parts, the need for a rear braking system designed to accommodate for changes to its position relative to the wheel (needed with adjustable tubes) was removed. Another simplification that was made because of this decision was that a derailing unit was no longer necessary to accommodate for changes in the wheel hub distance from the crank.

Preliminary digital simulation of the typical loading schemes in bicycle frames revealed that the need to reinforce each tube joint in the frame would be more important than addressing buckling stresses in the tube lengths. However great concern has arisen with the separation tolerances involved in the adjustable tube segments which has also been addressed. The larger the tolerance in the fitting of the parts in tube segments, the more the bicycle frame will drift in every direction when ridden. The best possible balance of part machining accuracy to cost was chosen in order maintain good stability while minimizing manufacturing costs.

Acknowledgement

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