Medicine of Cycling Bike Fit Task Force
First Consensus Statement on Definitions and Key Concepts
July 2013

The Medicine of Cycling Bike Fit Task Force is comprised of health and fitness professionals with teaching and certification backgrounds across various fitting philosophies, which include *BikePT, Serotta, Specialized, Trek, Bikefit.com, Fit Institute Slow Twitch (FIST), ReTul* and others. The goal of this consensus statement is to enhance understanding and communication within the medical and the at-large cycling communities about definitions and key concepts in bicycle fitting. The intended use of this consensus statement is as an educational guideline and does not replace a consultation with a trained bicycle fitting professional or a medical professional.

The Medicine of Cycling Bike Fit Task Force Consensus Statement serves to develop a common language and initiate collaboration on the process of fitting. It is not meant to be a comprehensive guidebook, but rather a starting place for dialogue. This consensus statement document will be a dynamic document that will be updated as research and consensus evolve.

In this document we introduce bike fit, discuss basic concepts, and define basic bike fit terms.

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Introduction

Bike fitting as a profession has been growing as has the body of knowledge over the last 20 years. Initially, fitting was simply based on a coach's or cyclist's gut feeling. Trials of basic positioning resulted in initial formulas for seat height based on leg length. As the discipline of cycling became more elaborate, coaches and athletes learned to expect a detailed evaluation process to match a bike to a rider. With the growing number of fit schools and philosophies contributing information to the fitters' tool box, there remains a wide discrepancy in what constitutes an excellent fit among practicing fitters.

Historically, there has been little collaboration on fit amongst the various professionals in the fitting industry, which includes bike shops, physical therapists, chiropractors, physicians, and coaches, about the interpretation of bike fitting philosophies. This relative lack of collaboration resulted in a lack of consensus and consistency in the best practices, language, fit theories and philosophies within the bike fit industry and key stakeholders. This multidisciplinary bike fit task force collaboration and consensus is the first of its kind in scope.

Bike Fit Consensus Discussion

A **bike fit** is the detailed process of evaluating the cyclist's physical and performance requirements and abilities and systematically adjusting the bike to meet the cyclist's goals and needs. Though all riders may benefit from a fit session, those who have specific training goals, spend significant amount of time on the bike, and would like to improve features such as speed, comfort, or handling of the bike may benefit most from a bike fit session. A typical fit session may include a history, evaluation of the athlete on the bike, coaching, therapeutic exercise and/or other interventions, depending on the skill set of the fitter. A typical fitting may cost between $100 and $450 depending on the amount of time, type of expertise, and tools used during the session.

1) A professional bike fit is usually a one- to three-hour session that has the following components:

- An interview with the cyclist, during which the fitter collects information, including goals of the fit session, detailed pertinent cycling and medical history, and current concerns .
- An on-bike and off-bike objective evaluation with variable components depending on the fitter's education, rider's needs, and available tools.
- Modifications to the bike based on the evaluation.
- Other services such as posture training, corrective exercise instruction, adjustment of pedaling mechanics, and flexibility/strength/stability training can also be included depending on the fitter's training.

- Tools and technologies may be used to assist in assessing the proper fit. However, the quality of the fit is largely dependent on the training and skill level of the fitter, and not a result of the technologies used. Bike fit sessions during which fitters practice beyond their level of training can result in poor and even unsafe outcomes for the bicyclist.

2) 2) Benefits and goals of a professional bike fit include:

- Helping riders accomplish individualized riding goals.
- Promoting bicycling posture that minimizes stress and strain on the involved musculoskeletal components to optimize rider comfort and help to avoid postural pain and overuse injuries.
- Increasing safe bicycle operation through education and proper positioning of both the rider and the equipment on the bike. These adjustments can include: preventing inappropriate front wheel weight distribution, ensuring appropriate reach to the brakelevers evaluating and adjusting for inappropriate front wheel to toe overlap, and selecting an appropriate saddle type for a rider.
- Increasing speed by optimizing the rider's position on the bicycle to maximize power, mechanical economy, efficiency and aerodynamics.

3) 3) Bike fit categories:

For the purpose of simplifying the bike fitting goals down to the most basic essentials, the task force chose to divide the fitting categories into "neutral" and "accommodated" fit. We chose to use the common definition of accommodation to mean *a reconciliation of differences, the sacrificing or prioritizing of one variable over another that is more or less important at that time.*

- **Neutral / Optimal Range Fit**: The fitter and cyclist are able to find *the ideal individualized position* that best accomplishes all goals of the cyclist *at the time of the fit*. The bike is 'wedded' optimally to the cyclist and cycling event* with no accommodations to the bike.
- **Accommodated Fit**: The fitter compromises on one or more of the goals of an optimal fit to *compensate for a physical limitation of the rider or the bike*. Ideally, an accommodated fit is a transitional position while the fitter works with the cyclist to identify the deficiencies that require compensation, offer possible solutions, and possibly refer the cyclist to the appropriate professional for medical evaluation. Frequently other professionals, including coaches, physical therapists, and medical specialists need to be involved in this process.
- Accommodations are frequently made when it is necessary to work with the limitations of a rider or a specific bike.. In dealing with these limitations, the fitter should always start by moving a cyclist toward a neutral position to correct inefficient biomechanics. Many times, neutral fit eliminates enough stress on aggravated areas to make significant

accommodations unnecessary. Accommodations are not optimal as some aspect of cycling is being compromised in order to address another issue. All accommodations can have short-term or long-term consequences on the cyclist's efficiency of biomechanics and handling of the bike. The goal of the fitter is to remove accommodations over time as the cyclist has improvement in function, form, and flexibility. Interventions can include education, treatment, or any other modality that is within the scope of knowledge and practice of the fitter.

*Each cycling discipline has different demands and thus, different ideal rider positions.

4) 4) Factors that can affect bicycle fit and positional outcomes:

- Experience, training and knowledge of the fitter.
- Goals and demands of the cyclist within cycling discipline (road, time trial, recreational, track, mountain, cyclocross, downhill, etc.).
- Experience and skill of the cyclist.
- Cyclist's level of conditioning and general health.
    - core strength, stability, and control.
    - Coordination.
    - prior and current injuries.
    - surgeries.
    - anatomical constraints including muscular flexibility, joint immobility(not sure if too much mobility would be a "constraint"?), and body asymmetry.
- The cyclist's bicycle and components.
- Current and past sport history, including involvement in sports other than bicycling.

5) 5) Cyclist and Bike Contact Points:

Each contact point between the cyclist and the bike, and each joint in the body, is a connected kinetic chain. Each link in this chain is key for the cyclist's bike handling and vulnerability to injury. An issue at one contact point or joint should signal a full evaluation of the closed kinetic chain, including other joints and all contact points. The three areas of contact that should be evaluated for biomechanical dysfunction, and which are discussed below, are the feet, the pelvis, and the hands.

- Foot - Pedal Interface:
    - A well-fitting cycling shoe is critical for comfort and efficiency of the whole bicycle fit.
    - Generally, riders do best with a small cycling-specific supportive insole.

  - This task force encourages minimizing accommodations such as wedging, supporting, canting or shimming the foot, as these have potential for unintended long term negative consequences to other areas of the body.
  - Members of this task force have a consensus about the general overuse of foot manipulation, and encourage a cyclist to seek medical expertise if the fitter is adjusting the foot positioning by more than 2-3 millimeters varus or 1 millimeter valgus.
- Pelvis - Saddle Interface:
  - A saddle should be 'about level,' defined as within 2.5 degrees of level front to back, and should be in line with the top tube of the bike. The rider should be positioned on the saddle so the majority of the body is supported on the bony pelvis, or pubic rami, rather than the soft perineum which includes the pelvic floor muscles, blood vessels, and nerves.
  - The fitter should consider the following when addressing a cyclist's saddle: torso angle on the bike, athlete size, build, overall health, ischial tuberosity distance, other contact points, and saddle type selected.
- Hands - Handlebar and Brake Hoods Interface:
  - In the appropriate fit position, a cyclist should feel 'light' on the hands since the majority of the support is in the feet, the saddle and core, while the hands land lightly on the bars.
  - A rider should be able to comfortably ride in all positions of the bars, and specifically should have easy access to the brakes and shifters, while being able to maintain an efficient upper body position.

6) 6) Common over-use injuries and pain syndromes on the bike (or that are exacerbated by cycling) that can result from a poor bike fit:

- Knee pain.
- Low - Mid back pain.
- Neck and/or shoulder pain or dysfunction (especially on triathlon and time trial bikes).
- Hand pain and/or numbness (hot spots).
- Foot pain and/or numbness.
- Ankle pain or stiffness (e.g. Achilles or peroneal tendon involvement).
- Perineum pain and/or numbness.
- Others not listed here.

7) 7) Conditions that may warrant referral to a medical provider:

- More than minimal accommodations are necessary outside of an optimal range fit.

- Pain or problems persist after several bike fit attempts.
- Pain that persists off the bike, including nocturnal pain.
- Report of neurological or radicular symptoms.
- Pelvic, bowel, bladder or sexual dysfunction.
- Mechanical joint symptoms such as a joint swelling, warmth, locking, catching, or popping.
- ANY leg length discrepancy, functional or structural.
- Sudden or noticeable decline in exercise capacity in setting of ongoing exercise routines.Other complaints that are outside of the fitter's licensed area of expertise.

If the fitter encounters any of these issues, the fitter should discuss the concerns with the cyclist and refer the cyclist to a medical provider for further evaluation. New or worsening symptoms from the above list may warrant discontinuation of the fit session and a more urgent referral.

8) 8) Qualities to look for when selecting a fitter:

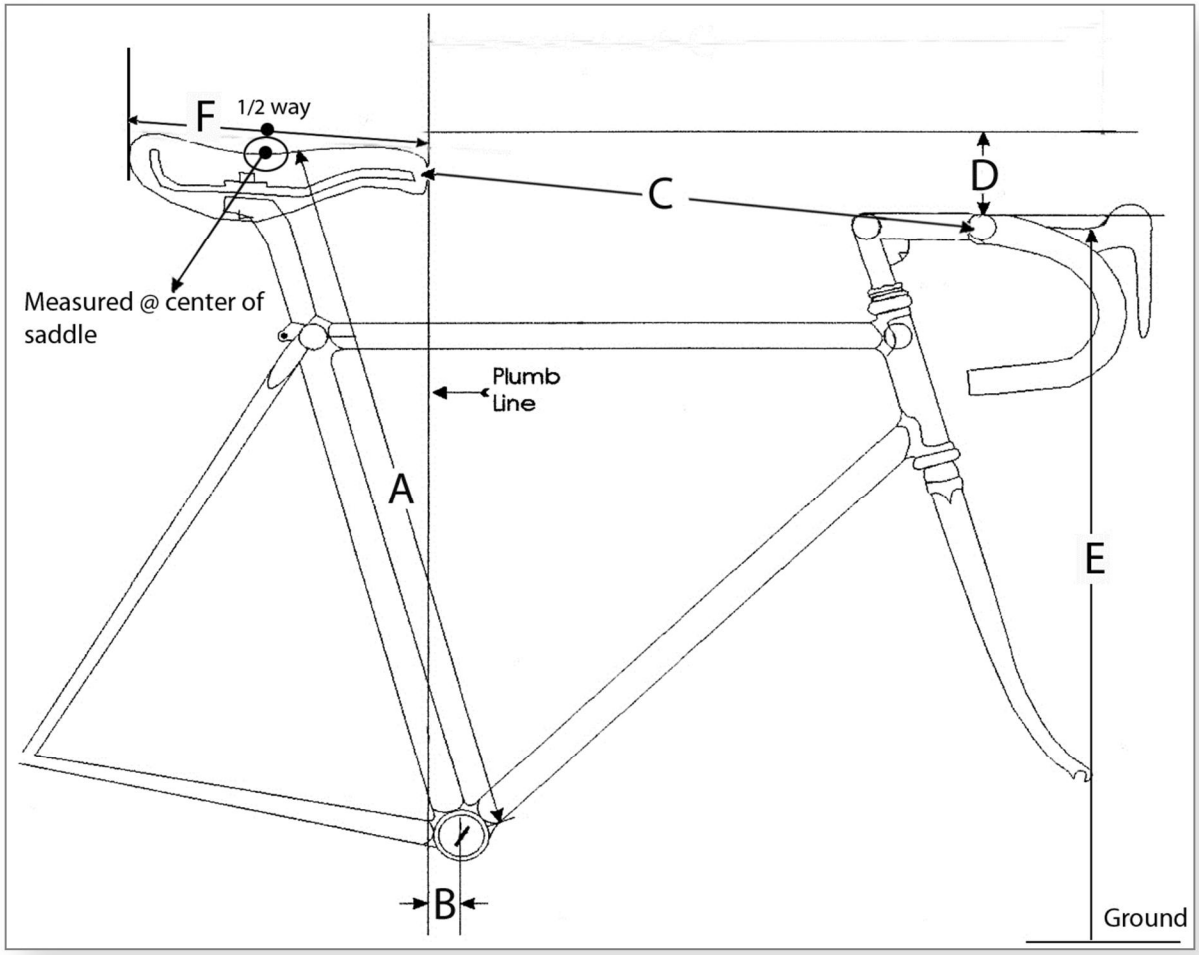
- Reputation within the cycling, fitting and medical communities.
- Fitting experience and education, including number and types of certifications and hours of classes towards professional development.
- Expertise within the bicycle discipline or type (i.e. cyclocross versus road versus triathlon etc.).
- Personality. As with any other working relationship, the cyclist will benefit most from a fitter that he or she establishes a good rapport with.
- The cyclist with pain or dysfunction should consider seeking a fitter with medical training and extensive fitting experience.

9) 9) Tools and Definitions used in bike fitting:

- Common Tools and Equipment:
    - Goniometer, plumb line, tape measure, laser, stationary trainer, level / angle locator, basic bike tools, adjustable stem, bike components (bars, stems, pedals, etc.).
- More Advanced Setup:
    - Size cycle / fit bike (?), motion capture systems 2d/3d, Spin scan or similar, EMG / muscle evaluation tools, Brannock foot measuring device, scales for front / rear wheel weight distribution, XY tool for measuring frame characteristics, power measuring devices.

Introduction to Basic Definitions:

- **Frame Geometry:** Top Tube, Seat Tube, Head Tube - all measured from center of the intersecting tube for uniformity.
- **Torso angle:** measure from the horizontal to a line that is drawn between the hip and shoulder.
- **Knee angle:** greater trochanter - knee joint axis - lateral malleolus.
- **Bike measurements:**



  - **Core four:**
    - Seat to bar hood reach (C2),
    - Seat to bar drop (reach?)(D),
    - Seat height (A) - BB to CENTER of the saddle,
    - Seat setback (B).

- **Bar width:** measured at hoods Center to Center.
- **Cleat shim:** device placed between the shoe and the cleat, usually plastic.
- **Inside the shoe wedge**: wedge placed inside the shoe for canting the foot (usually forefoot).
- **Retrofit:** changing the bike the client brought in.
- **Fit bike:** Adjustable bike that can be used for determining appropriate fit parameters on a new bike or to transfer back to the client's bike.

Resources

Research Articles:

- Christiaans HH, Bremner A. Comfort on bicycles and the validity of a commercial bicycle fitting system. *Appl Ergon* 1998, 29(3) 201-11
- Gonzalez H, and Hull ML. Multivariable optimization of cycling biomechanics. *J Biomech.* 1989; 22(11-12), 1151-61.
- Gregor RJ and Wheeler JF. Biomechanical factors associated with shoe/pedal interfaces. *Sports Med.* 1994 17(2) 117-31
- Ruby P, Hull ML, Kirby K, Jenkins D. The effect of lower-limb anatomy on knee loads during seated cycling. J Biomech. 1992 25(10): 1195-1207.
- Ruby P, Hull ML. Response of intersegmental knee loads to foot/pedal platform degrees of freedom in cycling. *J Biomech.* 1993 Nov;26(11):1327-40.
- Usabiaga J et al. Adaptations of the lumbar spine to different positions in bicycle racing. *Spine* 1997 1 22(17) 1965-9.
- Fonda, Saraborn. Biomechanics of Cycling Literature Review (do we need page #?)
- Detori NJ, Norvell DC. Non-traumatic bicycle injuries : a review of the literature. *Sports Med.* 2006;36(1):7-18.

Online links:

- Builders and respected fitters in the industry: http://www.framebuilderscollective.org/
- UCI regulations on fitting / frame geometry
  - http://www.uci.ch/Modules/BUILTIN/getObject.asp?MenuId=&ObjTypeCode=FILE&type=FILE&id=NjUxMTY&LangId=1
  - http://www.uci.ch/Modules/BUILTIN/getObject.asp?MenuId=&ObjTypeCode=FILE&type=FILE&id=NTI0MDY&LangId=1

Books:

- Carmichael, Chris. The Ultimate Ride. *Putnam Books*
- Burke ER. Proper fit of the bicycle. *Clin Sports Med.* 1994 Jan 13(1) 1-14 (is this an article that should be moved up to Articles section?)
- Pruitt, Andy. Andy Pruitt's Complete Medical Guide for Cyclists. *Velopress*

Bicycle Fitting Programs (alphabetical order):

BikeFit - www.BikeFit.com
BikePT - www.BikePT.com
Cyclologic - www.cyclologic.com
Fit Kit - www.bikefitkit.com
Retul - www.Retul.com
Serotta - www.serottacyclinginstitute.com
Slow Twitch - www.slowtwitch.com
Specialized - www.specialized.com
Trek - www.trekbikes.com
Wobble-Naught - http://www.wobblenaught.com

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