Athletic Performance Enhancing Inventions: The Conflicting Interests of Inventors, Spectators, Athletes, and Companies

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Athletes desire to win, spectators want to see an exciting and fair competition, sports equipment manufactures want to sell their products, and engineers and researchers want to do their part to push the envelope of human performance by designing new mechanisms for use by athletes. However, the goals of each of these parties do not always coincide with one another. Athletes desire to win may conflict with the spectator's desire for fair competition. Spectators' desire to view fair competition may conflict with an equipment manufacture's desire to sell performance enhancing equipment. An engineer's desire to license a performance enhancing mechanism or drugs may conflict with the desire for fair competition as well.

This paper will examine the conflicting interests of engineers, athletes, spectators, and sport equipment manufactures with regard to the fair use of new performance enhancing inventions. The sports of swimming, cycling, and golf will be addressed. The current rules for equipment use will be explained, followed by the past, current and future trends of equipment use in each respective sport. The controversies surrounding the use of new performance enhancing equipment will be addressed followed by the explanation of several possible resolutions proposed by the author.

Swimming is a prime example of how new inventions affect the fairness of competition. In the sport of swimming, 90% of a swimmer's propulsive energy is used to just to overcome the drag force created by the water [1]. Consequently, reducing a swimmer's drag has been by far the area where the a large amount of research has been focused and many patented inventions have been created from this research[1]. The swimming

governing body, Federation Internationale de Natation (FINA), rules on the acceptability of swimming equipment used in international competition. The rules are:

- no swimmer shall use any device that may aid his speed, buoyancy or endurance during a competition [3]
- The costumes of all competitors shall be in good moral taste, non-transparent, and suitable for the individual sports discipline and not to carry any symbol which may be considered offensive [3]
- Before any swimsuit of new design, construction or material is used in competition, the manufacturer of such swimsuit must submit the swimsuit to FINA and obtain approval of FINA [3]

The rules are rather open ended at best, and with regard to speed, simply say that speed may not be increased by the suit. The current opinion is that reducing drag is not the equivalent of increasing speed, so this has opened the door for swimmers to try and beat out their competitors by choosing a suit with less drag. This intern has also opened the door for equipment to become a factor in determining the winner of a swim race, not an athlete's swimming ability alone.

In the past, swimmers wore heavy wool swimsuits. There were no advanced materials swimmers could use. This was the golden age of swimming, where lack of technology meant purity of performance, similar to the athletes of ancient Greece who performed nude. Then something changed; the governing bodies of swimming began to allow the

use of lighter materials such as nylon and lycra. These materials did not soak up water like wool, so drag was dramatically reduced and world record times followed.

The future of swimming technology is towards full body suits. These suits use a new kind of material which for the first time has a lower drag coefficient than human skin [3]. It is therefore advantageous to the athlete to cover as much of his or her body with the material as possible. Other future trends are the placement of high drag materials on key portions of the body where a swimmer grabs the water, such as the forearms [3]. Full body suits also compress a swimmer's muscles and therefore reduce energy wasting muscle vibration [3]. Lastly, these suits incorporate small ridges along the swimmer's body to trip fluid boundary layers, a principle similar to dimples on a golf ball [3]. This boundary layer technology was banned from down hill skiing, but it has been allowed for swimming [3]. The arbitrary nature of some of these ruling further demonstrates the need for a different policy.

The implication of all these new developments is obvious. Among elite athletes, performance is now a function how much of your body you can cover with a low drag material. These suits are also very, very expensive. This restricts the market for the performance enhancing suits to rich individuals who can afford them.

There are several possibilities for keeping swimming competition fair, but not at the expense of the inventors of new sports products. One possibility is to create a handicapping system where, based on the drag coefficient of a swimmer's suit, a penalty

is added to the swimmer's final time. This would ensure that a swimmer's final time would reflect the same amount of resistance that they compete with. Using this approach, the market for performance enhancing equipment would be preserved and researches and inventors would still have a motivation to invent in this discipline. A side effect of this approach would also be the addition of a strategic element to suit selection, making the sport more dynamic and exciting for the spectator.

Another possibility is the introduction of a rule by FINA that defines a standardized suit material and design. This would directly define the suit drag and eliminate the unfair advantages created by performance enhancing suits. This however, would in effect bring upon the death of technological advancement in suit design. The researchers would have to change their focus from advancing suit materials and designs to developing low cost processes of manufacture, which would differentiate the suits based on price.

A third possibility is the creation of two separate leagues for swimming competition: an open league where athletes are free to use whatever suits they wish, and a restricted league where the suit code is standardized. The open league would provide a forum for sports equipment manufactures to sell their products, and preserve the impetus of product development by inventors. Spectators interested in seeing fast performance could view this league and accept suit advantages as part of the sport. Inventors would also have the opportunity to compete vicariously through the athletes that use their equipment. The restricted league would generally be slower than the open league, however, it's appeal would be for demonstrating pure athletic performance.

A fourth possibility is lowering the price of performance enhancing suits so that everyone who wanted to compete with the best suits could use them if they wished. A league fund, collected through small dues to swimmers or through donations, could help to subsidize the purchase of expensive equipment for economically disadvantaged athletes. However, the practicality of this proposal is questionable due to the shear numbers of athletes, the price of suits and frequent replacement, and the difficulty of finding a donor.

The effects of performance enhancing inventions on swimming competition are similar to the issues seen in cycling. However, the speeds and distances of cycling competitions make issues of drag and weight very significant in determining who gets to the finish line first. The governing body of cycling, Union Cycliste Internationale (UCI), has a rather extensive rule book on the limits of bike specifications. Their approach to regulating defines characteristics of a bike and gives maximum and minimum dimensions for components such as wheels, gears, handlebars, etc [6]. Probably the most important regulation that the UCI has imposed on bike design is that the bike may not weigh less than 6.8 kilograms. Essentially this leaves engineers with 15 pounds to play with and make trade offs between component weights. That again leaves researchers to solve drag force related issues.

The bike materials have evolved from steal to aluminum to titanium and carbon fiber materials. Due to the weight restriction imposed by UCI, for all intents and purposes, the work of material scientists has become concerned with material strength. The aerodynamics of bikes has also evolved, the greatest impact coming from the reduction in

the number of spokes on the wheels [2]. Stronger metal alloys have allowed for fewer spokes to be place on wheels [2]. The impact of this change is enormous, considering that the wheels are traveling twice as fast as the bike it's self and the drag force is a square factor of velocity. If the number of spokes is reduced from 32 to 24, this translates to a 30 second difference in a 3 hours race, just from spokes [2]!

Again, these new technologies are extremely expensive, even more so than swimsuits. This restricts elite competitors to well sponsored teams, leaving little room for the un-sponsored athlete to have a chance to win with inferior equipment. It would seem the solutions to the issues of cycling fairness are somewhat limit. The group race nature of cycling would make handicapping cyclists' finishing time or creating different leagues unfair. In contrast to swimming, an individual sport, cycling is a dynamic team work sport with drafting strategy and sprint finishes; if different leagues were created, who was in the league would influence the performance. A possibility which may work is to provide standardized bikes to athletes. This would hurt inventors and sports equipment companies by eliminating a market, but at least the race would be fair and spectators would be happy.

A final example of a sport where advances in technology influence how the sport is played is golf. People spend small fortunes to buy the next great driver which the manufacture claims will help their game. New clubs have changed the way golf is played and have changed the skills necessary to win. The primary regulation the PGA implements to try and level the playing field is a limit on the elasticity of collision created

by clubs, called coefficient of restitution (COR) [4]. However, the aerodynamics and weight distribution of the club head are not regulated and differ between clubs, allowing for a higher club speed with equal effort.

Golf equipment has evolved from wood, to steel, to aluminum, and finally to titanium and graphite. Inventors seem to be very skilled in squeezing the last few yards out of a ball, and as can be seen in the following two figures [5], continue to improve on what might to some appear like a simple metal rod.

Number of Golf Patents Issued Each Year

Golf Patents as a Percentage of Total Patents Issued Each Year

However, as drives get longer, the challenge of golf courses has decreased; what was once a par 5 can now be reached as if it were a par 4. New driver inventions have turned the game into a putting match. Everyone can reach the green in two shots; this is not the same game that people were playing a hundred years ago.

To solve these issues, golf courses may have to increase the length of holes, just to try and keep some level of challenge and semblance to the original game. An obvious solution could be for the PGA to distribute it's own clubs for use in it's tournaments. But perhaps a more practical change the PGA may include is more regulations regarding the shape and size of the golf club, not just it's COR. Perhaps restrictions on the coefficient of drag of the club head or its moment of inertia could be restricted.

Fairness of equipment is a fundamental issue in sports. Inventors, spectators, athletes, and corporations each do their best to promote their interest, either restricting the use of technology in sports or promoting it for competitive or financial gain. It seems clear that the current rules and regulations of sports favor the inventors and equipment suppliers which make a killing outfitting athletes who will do anything to win. Expensive hi-tech equipment restricts access to performance enhancing tools, biasing the playing field against the economically disadvantaged. The issues may possibly be resolved by having sports regulators make new technologies available to all competitors somehow, create different leagues to separate athletes who decide to use performance enhancing equipment from traditional athletes, create a handicap system for athletes who use performance enhancing equipment to level the playing field, or standardize athletic equipment so no competitor can have an advantage.

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