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Flopping, Klapping and Gene Doping : Dichotomies Between 'Natural' and 'Artificial' in Elite Sport

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ABSTRACT The application of genetic technology seems to threaten what is considered *natural* in elite sport. This paper explores the role of genetic technology in elite sport and questions the significance of dichotomizing between the *natural* and *artificial* element. How do shifts in technology affect the attribution of the *human element* in athletic performance? To explore the attribution of *human agency* we compare the genetic enhancement of athletes with two other shifts of the 'natural performance' in sport: first, the introduction of a revolutionary high jump technique, the Fosbury flop, in 1968; and, second, the introduction of the klapskate in speed skating in 1997. The three cases show that artificiality as such can hardly be a criterion for evaluating processes of innovation. The context of elite sport is itself highly artificial. Boundaries between the natural body and the enhanced body are the *outcome* of institutional processes of boundary work. When discussing new technologies in sport it is better to ask if athletes are still playing the same game and whether or not there are equal opportunities and an equal distribution of means for playing the game. The introduction of gene technology may result in inequalities, with great impact on the outcome of the game. This outcome may be considered irrelevant for the inequalities that the game is supposed to produce and measure. Genetic enhancement may also threaten the public view of athletes as moral agents and possibly change the appreciation for human performance.

Keywords elite sport, Fosbury flop, gene doping, (gene) technology, klapskate, natural versus artificial, relevant inequalities, sport ethics

Flopping, Klapping and Gene Doping:

Dichotomies Between 'Natural' and 'Artificial' in Elite Sport

Ivo van Hilvoorde, Rein Vos and Guido de Wert

The question of what exactly constitutes an honest and fair competition is heavily debated within the philosophy of sport literature. The use of performance-enhancing substances is an especially intriguing case. The illegitimate use of performance-enhancing substances (such as blood doping or the use of anabolic steroids) touches on fundamental ethical questions regarding the *internal goods* of the sport practice (cf. MacIntyre, 1985; McNamee, 1995). It challenges the limits of individual freedom within a social community, and may seem to justify strong variants of paternalism or even the criminalization of individual athletes. Doping also provokes discomfort and challenges the boundaries of fair sport. Discomfort about the anti-doping

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code[1] stems from the inability of sport authorities and controlling institutes to make sure that all competitors are following this code. Public indignation is the result of uncertainties about whether or not the outcome of the game is decided by an *unequal access* to new performance-enhancing substances.

Speculations about the possible application of gene technology in elite sport make the issue even more complex. The World Anti-Doping Agency (WADA) defines gene doping (or cell doping) as 'the non-therapeutic use of genes, genetic elements and/or cells that have the capacity to enhance athletic performance' (World Anti-Doping Agency, 2004: 6). It is, however, still uncertain if gene doping will become a safe technique for enhancing athletic performance, and if so, if this kind of enhancement will be detectable. Other complexities involve questions of how to distinguish between therapeutic and non-therapeutic interventions in elite sport and how to define the natural body when genetic make-up can be modified. Despite these complexities, anti-doping authorities treat this technology as if it were the next illegitimate performance-enhancing method in a long series. The same arguments are being used that had been used for all the other illegal enhancements of athletic performance.

Most arguments for the anti-doping rule circle around the concepts of fair play and health.[2] Opponents of performance-enhancing substances often argue that doping is unfair, as well as unnatural and unhealthy. To resist certain innovations, sport authorities often resort to an image of the pure and unaffected game or make an appeal to the 'tradition' of a sport.[3] Opponents of the present doping policy criticize the criminalization of doping and emphasize the responsibility of the individual athlete. Several authors also stress the problems that arise with the use of concepts such as 'natural', 'artificial', 'pure', the 'spirit of the game', 'internal goods' or 'cleanness' (König, 1995; Gugutzer, 2001). The presupposed dichotomies are susceptible to misunderstanding and ideological misuse. In the name of the 'essence', the 'nature', the 'purity' or the 'spirit' of the sport, completely opposite claims are made. It is not clear, for example, what the International Olympic Committee (IOC) and WADA mean by using the concept 'spirit of the game'. Critics of the anti-doping policy use the same concepts to claim that elite sport by definition is about transgressing the 'natural limits' of the body (Franke, 1988; König, 1995; Burke, 1997; Bette & Schimank, 2001; Gugutzer, 2001).

Several authors have stressed the necessity to transgress boundaries within elite sport. Michael Burke even categorizes the Fosbury flop within the same class of innovation as drug-use in sport:

> Drug users test the latitude of the rules in a way that is not far removed from the change that Dick Fosbury produced with his new technique as we would like to think. New knowledge, technical innovation, training methods, new materials, and stronger, faster athletes all create redefinitions of games. Athletes try to gain an edge and convince others that they have done nothing wrong in gaining that edge. All testing of the latitude involves egocentric attempts by players to shape the practice. No one attempt is more morally condemnable than any other. All attempts, whether successful or not, involve the production of beneficiaries and victims. The drug user in

> modern times is a victim, just as the exponents of the scissors method of high jumping were also victims. Both are victims of the aesthetic sensibilities of the community. (Burke, 1997: 60)

Is it just a matter of 'aesthetic sensibilities', or is there more at stake when comparing Fosbury's technique with other transgressions of 'natural performance'? Which inequalities is sport supposed to measure? Sport can be described as a voluntary attempt to overcome *unnecessary obstacles* (Suits, 1988). Mountaineers take pleasure in 'beating' a mountain that happens to be there. Sport is about challenge and *artificial inefficiencies* (Gelberg, 2002). For some, running around on a track is not 'artificial' enough: they are even willing to jump over hurdles.

In addition to presenting obstacles, technology often aims to take away unnecessary obstacles and inefficiencies through a process of rationalization. Technology is supposed to make life easier and more comfortable, which is generally not the goal in sport. The term 'technology' is used here in a broad sense (Tiles & Oberdiek, 1995: 10). In this broad sense, techniques and skills of the body are technologies as well (cf. Mauss, 1973 [1934]; Miah & Eassom, 2002: xix). Having a 'good technique' in sport either requires a mastery of technological equipment or the body to achieve the particular goals of a specific contest.

One can even claim that sporting performance is wholly the result of technological intervention (Shogan, 2002: 94). Technology and sport are, from a historical and conceptual perspective, inseparable domains. As Eichberg (1978, 1982) shows with the emergence of the stopwatch in athletics and parallel bars in gymnastics, these innovations can only be understood when the complex reciprocal interaction between socio-cultural behaviour and technology is acknowledged. Not only is it misleading to suppose a one-way influence of technology on sport, 'rather, a new type of sports behaviour as part of the industrial change of society created a new technology' (Eichberg, 1982: 55).

The most prominent – and often controversial – role of technology in sport is generally to enhance efficiency. Technology may even take away 'unnecessary obstacles' that were once part of the specific goal of a sport. For example, modern equipment makes it possible for an increasing number of people to climb Mount Everest. The obstacle 'lack of oxygen' can be taken away by carrying oxygen up the mountain (creating, of course, a new obstacle). One of the main characteristics of competitive sport is to measure performances with the aim of comparing differences in talent, skill and dedication. Competitive sport can be characterized as a rule-governed social practice in which the organization of equal opportunities (by way of constitutive rules and levels of performance) makes it possible to express *relevant differences in abilities* (Breivik, 2000; Loland, 2002).

This means that the outcome of the game should be decided by a balanced and credible combination of human potential and technological assistance. It does not exclude initial inequalities between opponents (in body size for example), or even differences in material (such as in Formula One racing). These inequalities do, however, incorporate two crucial elements: differences in strength (a light-weight boxer cannot show his boxing skills against a heavy-weight boxer; in many sports women cannot show their full potential when competing against men) and the 'definition' of the sport itself (is the competition still measuring what it is supposed to measure?). The principle of equal opportunity means (relevant) equality of opportunity before the competition starts. Fair competition requires (relevant) a priori equal opportunities in spite of a posteriori inequality (König, 1995: 249), but what is considered relevant strongly depends on the social–historical context in which the sport has evolved (cf. Bottenburg, 2001). For example, boxers and wrestlers are classified into weight categories. However, unequal height in basketball and volleyball is accepted.

Sport needs a subtle balance between the rigidity of the obstacle and the urge for records and ever-growing efficiency (cf. Gelberg, 1998). Ongoing technological innovation forces each sport to always reconsider this balance between tradition and technology, between *equal opportunities* and *relevant inequalities*. What inequality is measured in sport, and what is the role of technology? Recent developments within biotechnology may take the concept of 'equal opportunity' to a very new stage. Is the modification of genes for athletic purposes unfair in every case or can it enlarge the possibility of an equal point of departure? If a sport contest measures differences in the 'dedication' of athletes, what is wrong with equalizing genetic make-up with regard to relevant features, such as maximum oxygen uptake ($V_{O_2 max}$) or muscle force?

The sporting body remains a site of both powerful idealization and constraint and a prominent contested zone between nature and culture. Athletes have to act on the 'impossibly thin edge of the acceptable and the unacceptable transgression of the body's natural limits' (Franklin, 1996: S100). That means that elite athletes will continue to experiment with boundaries, both of sport and their bodies. It might even be suggested that athletes are encouraged to experiment and to technologize their bodies, while at the same time risking punishment if they are caught doing so, 'which is to say caught transgressing the boundaries of a nostalgia for an innocent, human, pre-cybernetic body' (Pronger, 1998: 286).

Sport authorities appeal to the innocent, human, pre-cybernetic body. The IOC and WADA have an interest in adhering to distinctions such as the one between natural and artificial. Based upon Latour's (1993) analysis of modern society, Gugutzer (2001: 220) argues that the modern doping crisis is intrinsically linked with a strong wish to hold on to the distinction between the 'natural, non-manipulated body' (nature) and the 'enhanced body' (society). This desire to demarcate between the 'natural' and the 'unnatural' also manifests in the IOC definition of doping. The IOC defines drug-use or doping as 'administration or use by a competitive athlete of any substance foreign to the body, or any physiological substance taken in abnormal quantity, or taken by an abnormal route of entry into the body, with the sole intention of increasing in an artificial and unfair manner his/her performance in competition' (<www.wada-ama.org>).

The question 'What is an abnormal quantity?' is, of course, a matter of debate, but can be more or less pragmatically solved by setting exact limits for specific substances. The inclusion of an 'abnormal route of entry' in the IOC definition, for example, suggests that blood doping with an injection is 'unnatural' compared with 'natural' high-altitude training (or sleeping in a hypoxic tent or barometric chamber). The dichotomy between natural and artificial seems to have an arbitrary place in this definition. It is also hard to agree upon the third element in the definition: 'What is foreign to the body?'. The use of ergogenic aids, such as anabolic steroids and human growth hormone, is illegal in sport, but it may seem unjustified to call these substances unnatural, in so far as they are produced in each person's body.

Several authors give practical objections to definitions of the 'natural' and emphasize the necessity to transgress boundaries of the sport-body. However, in spite of these objections and in spite of any tendency to meld together human and machine, the polarity between natural and artificial remains crucial. How do dichotomies such as these emerge, and what functions do they have for different actors? There is an increasing interest in empirical questions about the relevant contexts in which demarcations emerge and become relevant (Franklin, 1996; Wesely, 2001; Butryn, 2002, 2003).[4] What is the role of technology (including 'body technique') in (re)constructing the relevant (in)equalities, and how does this role relate to the attribution of agency to the performed inequality?

We intend to explore the role of genetic engineering in sport by comparing this new technology with two major innovations in sport in which the dichotomy between natural and artificial is at stake. Genetic technology in sport can be regarded as a technological modification 'inside' the body, whereas the Fosbury flop introduces a 'technological change of the whole body', and the klapskate in speed skating introduces a technological change 'external' to the body. We chose these cases because the changes in technology result(ed) in apparent inequalities. At the same time, there are clear differences in the moral evaluation that accompanied the introduction of these new technologies. The purpose of this paper is to explain some of these differences. How are the new techniques introduced – by whom, and under what conditions? Who, if anybody, resisted them? What are the parallels? Are dichotomies such as inside/outside, internal (physiology)/external (technology) to the body or natural/artificial useful and relevant for describing the dynamics and reciprocal relations between technology and sport?

The Wizard of Foz and 'The Way the Lord Meant Man to High-Jump'

Organized sport has contributed enormously to the differentiation of human jumping techniques. Team sports (such as soccer, American football, hockey) require a continuous alertness and well-developed jumping ability – for example, to score or elude opponents. In other sports, such as volleyball, basketball or hurdling, jumping is an even more essential part of the game. In gymnastics, the height of a jump plays an important role because it is evaluated with aesthetic criteria. In high jumping, it is just the height of the bar that counts. Not least because of this simplicity, it is one of the oldest games still present in modern sport and Olympics.

People are not born with a uniform, natural capacity for high jumping. Even though high jumping has remained relatively uniform as a game, high jumping techniques have undergone a remarkable evolution. The first modern competition was organized in early 18th-century England. This early competition shared important characteristics with the event today. Each competitor was allowed to jump three times and was not allowed to take off with two feet. One of the dominant techniques that developed at the time is called the 'scissors'. The high jumper runs up to the bar, swings up the inside leg, and when this leg drops over the other side of the bar, the jumper raises the other leg in a movement that mimics a scissor.

The first acknowledged world record was held by George Horine, who jumped 2 m high in 1912. Horine developed a technique known as the 'Western roll'. Slightly different variants were also called the straddle or barrel roll. With the Western roll, the jumper first raises one leg and one arm above the bar, and then follows with the torso and the rest of the body. This was a controversial way of jumping, and officials tried to outlaw it because people said this was diving rather than jumping over the bar. Until 1935, the bar had to be jumped over feet first. Other athletes were disqualified based on this diving–jumping distinction. The legendary athlete Babe Didricksen lost the gold medal in the 1932 Olympics because her arms passed over the bar before her legs did so, and this was understood as diving. Ideas of the 'natural jump' specified the inequalities that were considered relevant to the game.

After the rules changed, high jumping underwent several changes. One of the most spectacular and revolutionary changes in high jumping was the Fosbury flop, named after Dick Fosbury. Fosbury's gold-winning flop during the Olympics in Mexico City in 1968 (with 2.24 m) has become part of collective sport memory. Walt Murphy, a track and field authority, remembers that '[s]pectators were in awe the first time they saw it. When people first saw him doing his Flop, they said: "this guy's nuts". Then they saw what he was doing, and people began to take him seriously. The novelty became the reality.'[5] 'The style is backward, but it may be avant-garde', Roy Blount Jr wrote in 1969 (at the time he was the editor of *Sports Illustrated*). 'It defies tradition, but it could be the way the Lord meant man to high-jump.' Fosbury radically changed the technique of high jumping. Blount describes his body almost as a new instrument, unconventional but efficient.

> In detail, Fosbury charges up from slightly to the left of center with a gait that may call to mind a two-legged camel, hooks to the right at the last moment, plants his outside (or right) foot action of a 'screw', as he says, so that his back turns abruptly to the bar and, ideally, rises seven feet and change into the air. Then, cocking an eye over his shoulder at the bar, he extends himself like a slightly apprehensive man lying back on a chaise

> lounge that's too short for him and finally kicks his legs up – and falls flat on his back. (Blount, 1969)

Several authors use the Fosbury flop to illustrate the importance and beauty of innovation in sports (for example, Burke, 1997; Dixon, 2001). Fosbury invented a more efficient technique, with his whole body as a performance-enhancing instrument. Does it make sense to call this new technique 'artificial'? Was he, for example, still competing in the same event as his opponents?

Fosbury's technique may be considered artificial compared with the already known jumping techniques. It was the unknown, the similarity with the 'two-legged camel', that gave the jump an 'unnatural' appearance. However, despite the fact that the new jump created some sort of inequality, it was nevertheless considered the result of a skill that is relevant for the game. Fosbury just used his own body in accordance with the rules. Does it make the flop in fact the natural way to high jump? There are two elements of this question: first, did this new jump fulfil perfectly the biomechanical demands for all jumpers (universality as a criterion for what is considered natural); and, second, was there any role for technology which forced people to draw a boundary between natural and artificial?

Universal Laws for the Best Way to Jump

Historical accounts of the process of developing the flop document that there was no biomechanical 'flop-theory' prior to the flop itself. No superior theory of high jumping existed that just waited for application. Instead, Fosbury's struggle with height has been described as more or less an accidental process. As a child, Fosbury had learned to use the scissors technique. In high school his coach tried to teach him the more efficient straddle. Lack of success made Fosbury decide at age 16 to revert to the scissors again. While trying to jump higher, Fosbury started 'laying out' increasingly. Years later, Fosbury described this process as follows:

> And I am sitting there looking at the bar at 5-6, trying to figure out, 'Now how can I jump higher?' I know I have to lift my butt up, because that is usually where you knock the bar up. So as I try to lift my hips up, my shoulders go back a little bit, and I clear 5-6. It was kind of a lazy scissors. At 5-8, I lift my hips a little higher, and my shoulders go back a little further, and I make it. At 5-10, same thing. By this time, I am going over the bar flat on my back. I'm upside down from everyone else, into kind of a back layout. I go out at 6-feet, and nobody knows what the heck I'm doing. (Eggers, 1998)

It was a typical case of one step backwards and two steps forward. Fosbury even surprised himself. 'I was blessed to be the first. I am totally convinced somebody was going to discover the technique. It just felt natural to me. I didn't know others would find it natural' (Eggers, 1998).

Biomechanical explanations for the supposed superiority of the technique soon followed (although many were not convinced of the superiority).[6] Some said the flop was successful because it exposed a minimum area of the body to the bar and projected as little weight as possible above the bar at any one time. The body goes over in a straight line, which is simpler because human bodies are bilaterally symmetrical (Blount, 1969). The last curved portion of the approach, which facilitates the required rotations along the three body axes, is a unique characteristic of the flop.

In spite of Fosbury's success, other jumpers and coaches were still convinced that the straddle was potentially a more successful technique.[7] Tom Ecker wrote in one of the leading sport journals *Track & Field News* in February 1978: 'After close technical analysis of the individual styles of the leading straddlers and floppers of the present and recent past, I believe the straddle – if executed ideally – to be the more efficient technique of the two and capable of attaining slightly higher marks.'[8] After biomechanical analysis, French national coach André Daniel wrote in *L'Equipe* (28 March 1978) that he was convinced that the straddle would be more efficient. 'I am sure that I can promise that in five years, the straddle will have shown its absolute superiority over the flop.'[9]

Furthermore, the biomechanical advantages of the flop cannot always be defined without considering characteristics of the specific high jumper. Body height is especially important because the centre of gravity of taller people is higher at take-off than that of shorter people. There are no performance-determining factors that apply universally to all jumpers. The tall (1.85 m) and long-legged Romanian Iolanda Balas, who dominated the high jump between 1957 and 1967, expressed this as follows: 'My style is quite obsolete but it suits my body structure.'[10]

All coaches agreed that the Fosbury flop was much easier to learn than the straddle. Beginners had better results with the flop and improved faster. Ecker thought the straddle should be the high jump technique of the future, but that it did not dominate because of the simplicity of the flop. In his opinion, the flop *de-skilled* the high jump. The straddle, much more complicated than the flop, had to be perfectly executed. If this had been the dominant opinion, the flop could have been regarded as an irrelevant 'advantage over the game' or even forbidden based on the distinction between high jumping and diving.[11]

Technology and Safety

The first flop was received with shock and awe. However, there was little or no indignation. Rival high jumpers did not react as if they were being denied secret knowledge of this innovative technique. Controversies on the best way to jump were primarily technical and internal to the game. The new jump did, however, arouse some controversy over its supposed safety risks. For example, US Olympic coach Payton Jordan voiced serious doubts about the safety of the new jump: 'Kids imitate champions. If they try to imitate Fosbury, he will wipe out an entire generation of high jumpers because they will all have broken necks' (quoted in Bigold, 1999). Several anti-flop articles were written about the supposed risks of vertebral damage.

There are different views on the role of technology in this process of innovation. Since technology made the high jump safer, some people supposed that the new technique was only possible because of the possibility of a safe landing. By reversing the interaction between technological knowledge and sport practice, the superior role of technology can be stressed. A typical example of reversing this relationship can be read on the website of the Sport Technology Research Laboratory of the University of Calgary, which addresses the question 'Does sport technology devalue personal achievement?'

> What most people do not realize is that technology enabled Fosbury to create his new technique. Up until the 1950s and early 1960s, the landing area in high jumping and pole vaulting was a pit of sand. Then experiments began with softer materials, first cork and rubber chips, and eventually the foam landing pit. Now jumpers didn't have to land on their feet after completing a jump. If Fosbury had tried his flop into a sand pit he would likely have seriously injured himself. This is not to diminish Dick Fosbury's innovation and its effect on his sport, it is just to point out that the technique innovation could not have happened without the technology innovation occurring.[12]

This is, however, a false representation of history, because Fosbury did not need the foam landing pit to discover the flop. He developed his style while landing into wood-shavings. And he did injure himself. Technology did not enable Fosbury, but followed him. This underlines Eichberg's (1982: 55) claim that the design and construction of objects are a result of changes in behaviour rather than the other way around. Neither the technological innovation leading to the foam landing pit nor a principle of biomechanical theory preceded or directed Fosbury to his new technique. The innovation that followed the new high jump technique was, however, crucial for propagating the flop. Thanks to the soft and safe landing pit, the flop attained the status of a 'natural high jump technique'. The soft landing was included as part of the game, and the technique of landing safe on one's feet became irrelevant for the game. Had Fosbury been the only athlete to profit from a soft landing pit, it would have been considered an irrelevant inequality.

People expect to see transgression of the 'natural' in elite sport, but only as long as they leave organized equalities intact. In high jump competitions, the most essential relevant inequality is the ability to jump higher than the others. After the dichotomy between diving and jumping became irrelevant to the game, the coordination of the jump became subordinate to height as the major obstacle. The skill to innovate a dominant technique is one of the sources of inequality people expect to see in this sport. After centuries of training and selection, the event 'chooses' the ideal body structure (usually tall, long legs) and technique.[13] The 'natural high jump' emerges within this alliance of obstacle and body characteristics. It emerges from the superior way of high jumping.[14]

The First Klap on Ice: A Huge Step for Speed Skating

There are people in north-west European countries for whom skating on ice is as natural as carrying an umbrella. Skates are necessary 'tools for dealing with a frozen world' (Whedon, 1988: 19). When watching people learning how to skate it is hard to imagine that people have been skating (on wooden strips or bones) since the beginning of the Christian era. The Swiss sports museum in Basel even holds skates that are 4000 years old (Koolhaas, 2000).

Much of the history of skating technique can be learned from looking at old pictures and paintings (cf. Glöckle, 1987; Whedon, 1988; Blauw, 2001). This underlines the claim that there is a synchrony of changes of sport at the end of the 18th and the beginning of the 19th century (Eichberg, 1978). During this period, the dominance of feudal exercises (including figure skating) shifted towards a dominance of sports of the 'citius, altius, fortius' type, the so-called c-g-s-sports (performance measured in centimetres, grams and seconds). When organized speed skating originated at the end of the 19th century, the speed skates were primarily designed for efficiency.

Highly influenced by globalization processes in sport, both the technique of speed skating and the design of skates have become increasingly uniform. In spite of many innovations during the past centuries, one of the most revolutionary changes of the speed skate took place only a few years ago: the introduction of the klapskate.[15] Contrary to the Fosbury flop, the idea of the klapskate had been recorded for more than a century before it was actually manufactured. Between 1884 and 1937, five patents were granted based on similar ideas of a shoe that moves relative to the blade.[16]

With klapskates, the skate disconnects from a skater's boot. A hinge beneath the ball of the foot between the shoe and the blade allows the foot to rotate while the blade remains gliding on the ice (Houdijk, 2001). This way, the skater stays in contact with the ice longer than with traditional skates. It allows plantar flexion of the foot at the end of the push-off (Ingen Schenau et al., 1996). The klapskate is a good example of a technological innovation that results in a forced *re-skilling* of the game, which meant that skaters had to 're-learn' how to skate. At first, elite skaters did not want to risk the investment and were not convinced by biomechanical theory. This explains the long interval between the conception and actual introduction of the klapskate.[17] However, after the introduction of klapskates in elite speed skating in 1997, the serious elite speed skater no longer had any choice. Speed skaters on traditional skates could not keep up with all the new records that were being made.

With conventional ('Norwegian') skates, one of the key aspects of good skating technique is the ability to suppress plantar flexion. Otherwise, the tip of the blade presses into the ice, which increases the ice friction (Houdijk et al., 2001). The klapskate combines advantages of skating with an ability to use plantar flexion, as in running.[18] Some elite skaters reported a much 'more natural' feeling on the ice, while others could not get used to the new clapping device. In the context of competitive speed skating, many skaters perceived it as a rather artificial step in the evolution of the speed skate. The skaters who spoke the most about artificiality were those who did not use the new skates at all. Reactions that followed the introduction of the klapskate in speed skating were not just related to the technology as such. Rather, a storm of indignation had to do with the timing (just before the Winter Olympics of Nagano in 1998) and the secretive way the skates were introduced.

'Slapskates Melt Records, Anger Purists', the *Washington Post* headlined on 30 November 1997. Under the headline 'Technology Race is on, and Dutch [K]lapskate has the Lead', Tom Weir wrote in *USA Today*: 'Virtually everyone outside the Netherlands' inner circle of speedskaters was surprised last season when the Dutch unveiled the [k]lapskate' (Weir, 1997). Even Gerard Kemkers, Dutch coach of the US speed skaters during the Nagano Olympics, was very surprised. 'All of a sudden, our skaters got beat by people who should not have beaten them.' 'Most of our skaters did not get them, which meant we left last season with a feeling of being behind.' 'Suddenly,' Weir adds, 'buying [k]lapskates was as important as organizing workouts.' Kemkers said: 'To spend my time with engineers is almost more important than spending time with my skaters' (Weir, 1997).

The inequality of opportunities experienced by rival skaters did not only concern the unknown technology. The non-Dutch competitors were also being frustrated in their attempt to purchase the klapskates. 'Because the Dutch have as much pride in their speedskaters as Americans do in their basketball Dream Teamers, getting the [k]lapskates wasn't a simple cash transaction.' Elite skater K.C. Boutiette complained: 'we ordered them, but they gave us a really crappy pair. They just didn't want to give us the good stuff' (Weir, 1997). One of the reactions to this inequality in opportunities was to blame the dominance of technology and to argue that this technology would unfairly augment performance. 'In one year, we have had to go from traditional skates to these machines on ice', top US female sprinter Chris Witty said (quoted in Shipley, 1997). Boutiette's first reaction to the skates was one of dismay and a desire to bring another innovation to the starting line. Boutiette said that he was bitter and wanted to get a mountain bike, put studs on the tyres and show up with that.

US Speedskating, the US international speed skating association, tried to ban the klapskates for the season 1997–98, including the Winter Olympic Games. President Bill Cushman declared in a letter: 'in our view, the slapskate is nothing more than a mechanical, performance-enhancing device. We want to keep the sport pure. To our thinking, this is no different than doping' (quoted in Shipley, 1997). The International Skating Union (ISU) shared a concern that the technological developments would go 'beyond reasonable limits'. The ISU tried to bridge the interests between a majority of indignant countries and the Netherlands, which had a dominant voice within the skating community and institutional and commercial interests in the matter as well (the klapskate generated much attention and many new records). The ISU did not do much more than to propose a clause stating that 'all energy expended during a race must originate from the metabolic work of the skater'.[19]

Rival skaters tried to construct an idea of the klapskate as a device that takes over some of the skater's work (similar to using a trampoline in high jumping). According to Boutiette, 'you don't have to be technically perfect on them. Someone could come out of nowhere who couldn't skate on regular skates and really light it up on slapskates' (quoted in Shipley, 1997). Boutiette was convinced that the outcome of the game was not decided by the superior skills that are central to the game (cf. Dixon, 2001). The founding father of the klapskate, Van Ingen Schenau, replied to this suggestion: 'you have to deliver all the extra work yourself. The idea is not only that more of the calf muscle is involved, but also the knee is much more involved. It replaces one type of coordination with another that requires its own type of perfection' (quoted in Shipley, 1997). That is why some of the elite skaters dropped back in their ranking: they were less successful in the process of *re-skilling*.

Unlike the Fosbury case, there was clearly an imbalance between the organization of equality and the measuring of relevant inequalities. During the initial phase of transition, only a few skaters were in a position to use the new skates.[20] The advantage of the klapskate enabled some of the skaters to close the gap between being sub-top and top. Dutchwoman Tony de Jong was one of the first elite skaters on klapskates, and with these skates she was able to beat the German Gunda Niemann for the first time in a big event. She became European champion in 1997.[21]

From a biomechanical perspective, klapskating involves a more efficient type of coordination. Yet, sport, as a rule-governed social practice, is not *just* about maximizing efficiency. Athletic performances are governed by laws of physics, but ultimately limited by arbitrary rules of sport. There are sports in which restricted coordination is an essential part of the obstacle itself. In competitive walking, for example, participants are not allowed to run. One can argue that also in speed skating a specific type of coordination is being measured. External innovation changed some of the skills and introduced another type of coordination. But more important, the institutional decision to allow the klapskate to be used by just a few of the competitors resulted in a new source of inequality: access to the newest technology. This led to a conflict over how to account for the speed skating performance. The klapskater attributed the performance to successful *re-skilling* and the courage to experiment with the new skate. Others attributed the performance to the superior skate, which was called a performance-enhancing device.

One important difference in Fosbury's case is that, theoretically, every high jumper could have initiated innovative high jumping techniques. The ability to try out alternative styles in high jumping can be considered a skill that is part of the game. However, without the scientific means and without the people willing to experiment with the klapskate, there would be no possibility for an individual skater to change her style. Contrary to the flop there was already explicit and scientific evidence of the superior technology of the new skate.[22] However, both the Fosbury Flop and the klapskate required practice, and, ultimately, successful performance to demonstrate the advantages of the new technique.

The technological change in speed skating was highly determined by the needs of influential user-groups (cf. Bijker et al., 1987; Bijker, 1995). In this case, the relevant user groups included a small country with a large and successful tradition in speed skating, a scientific specialty that could attach its research to the successes of the skaters, and an industry that foresaw a new market. The ability to re-skill is relevant to the game when most competitors agree that it does not distort the game itself. The ability to purchase new material or to fund research is usually not accepted as a relevant inequality in sport. The distinction between a natural, human performance on the one hand and technology on the other was created as a result of moral discomfort. This discomfort originated in the unequal distribution of technological equipment and thus a lack of equal opportunities before the game actually started.

What was considered a 'natural performance' did not refer to some kind of essence of how a human performance should be or how it should be restricted. The idea of a 'natural' skating performance was challenged by unfamiliar technique and technology. The unfamiliar became familiar and accepted, first of all because of its superiority over traditional athletic methods and technology. Although initially problematic, the transgression of athletic limits eventually became non-controversial, after accessibility was guaranteed for all competitors. The question now remains what 'natural' refers to in the case of modifying human genes.

Modification of Human Genes

There is a long history of the use of performance-enhancing substances in elite sport (cf. Hoberman, 1992; Waddington, 2000). Every era can be characterized by the use and detection of newly discovered substances to enhance athletic performance. One of the latest worries for international sport organizations concerns the possibility of modifying human genes. Large research programmes are searching for the location of crucial genes that are related to athletic performance (Bouchard et al., 1997; Wolfarth, 2002; Pérusse et al., 2003). Several candidate genes are under scrutiny that might have a critical influence on specific sport talents. Features such as muscle size, muscle fibre composition (division of fast- and slow-twitch fibres), heart size, lung size and volume, resting heart rate, muscular strength, flexibility of joints and aerobic endurance all have a strong genetic component (Skinner, 2001). There is evidence, for example, that a polymorphism in the gene that encodes for angiotensin converting enzyme (ACE), which is active in muscle tissue and regulates blood flow, is associated with performance in endurance events (Montgomery et al., 1998).

Biogenetic experiments with mice and apes may be part of a preparatory stage for developing the first genetically modified athlete. After injecting a synthetic gene into the muscles (to produce more insulin-like growth factor-1 [IGF-1]) the muscle force of 'Schwarzenegger-mice' increased by 60% after 1 month. Speculation has grown that in the near future the first genetically modified athlete will enter the sports arena. Bouchard et al. (1997) suggest that in the very near future (within the next 10–15 years) the genetic engineering of super-elite athletes will not only be possible, but also will be routinely practised in certain corners of the globe (Singer & Janelle, 1999: 146). 'The technology to make it come true could well arrive even before 2008' (Aschwanden, 2000).[23] At this point, we shall concentrate on somatic genetic modification, because it is both controversial and at the same time realistic enough to be taken seriously. Other possible genetic applications, such as germ-line genetic modification or genetic selection of individuals, are beyond the scope of this paper.[24]

The explicit anticipation by sports authorities of yet-to-be-realized genetic modifications is rather unique in the history of performance-enhancing substances. WADA has tried to keep up with all developments within gene technology and repeats its militant statement: 'For once, we want to be ahead, not behind.' This latest appearance of a symbiotic relationship between the medical system and the sports system involves cooperation between WADA and leading geneticists. Ljungqvist, an anti-doping official and head of WADA's medical research committee, acknowledged the organization's cooperation with Theodore Friedmann, an authority on gene therapy.[25] To maintain its credibility as a controlling institute, WADA actually needs to incorporate expertise on gene technology. With their urge to limit what WADA helps to create (namely the extraordinary social and financial rewards for elite sports and records), anti-doping authorities need to think like the most ambitious athletes who are 'dying to win' (Houlihan, 2002). International sports institutes such as IOC and WADA play an important (global) role in maintaining the distinction between the 'natural, non-manipulated body' and the 'enhanced, infected body'.

The protection of health is an important motive for constructing a polarity between the natural and artificial. Even if genetic modification is accepted as a safe technique, further controversy is likely to arise in connection with the construction and perception of the natural and artificial. This will raise two important questions. The first is the conceptual question of whether the particular games will still measure the relevant inequalities. Will dedication disappear, for example, as a necessary condition for elite performance? The second question concerns the influence of public appraisal. Will admiration for athletes change when they start modifying their genes, and how could such modification change the evaluation of ('human'?) performance?

Equalizing Genetic Inequalities?

If and when it becomes possible to modify human genes with the aim of enhancing athletic performance, will the sports contest still measure the relevant inequalities? Is there reason to fear the *control* and *manipulation* of talent? The genetic lottery results in large inequalities on many different levels. Will genetic enhancement influence these inequalities or differences between people? Some authors believe biotechnology will endanger the diversity of our species or even lead to a *tyranny of the normal* (for example, Soderberg, 1998). Tamburrini (2002: 261) expects an unproblematic, equalizing effect among individuals. He writes: 'Genetic technology makes it possible to reduce current gaps in skills and inherited traits between individuals.' Biotechnology may reduce gaps within elite sport, but it seems plausible to imagine that genetic modification will just as easily accentuate some of the inequalities. For example, the more talented and better coordinated soccer player may benefit more from a genetically enhanced maximum oxygen intake because he can better use his talent that way.

Gene technology will also increase public knowledge of genetic inequalities. This raises the question of how such technology may influence the concept of 'equal opportunity' in sport. Sport always combines elements of control (mastered by means of certain skills) and elements of chance (not to be confused with uncertain outcomes). If chance becomes too dominant, sport loses its attraction and turns into a lottery. If sport is only a matter of control, it threatens to become a scientific experiment or a test between bioengineers. In the discussion on the balance between control and chance, it is important to distinguish between pre-game and in-game factors (Breivik, 2000: 149–51). Sport generally excludes as many 'in-game' chance factors as possible. In a speed skating competition, it is possible that the first skater profits from good weather conditions while the last skater has to skate in snow and wind. Speed skating is by now highly standardized when it comes to equalizing atmospheric conditions in indoor halls and cleaning the ice (which makes the unequal distribution of klapskates even more significant).

Breivik pleads for the flourishing of chance during the pre-game period, including genetic make-up as a variant of 'anthropological chance'. All elements of in-game chance that are relevant for winning a game should in his view be eliminated as much as possible. The primary distributive norm in sport should be meritocratic (Loland, 2002). A competition is supposed to proceed according to the postulate of formal equality and openness of the results (Bette & Schimank, 2001: 55). A just meritocracy means that people should not be treated differently in significant matters based on inequalities they cannot influence in any significant way. 'Equals ought to be treated equally, unequals can be treated unequally, and unequal treatment ought to be in reasonable accordance with the inequality in question' (Aristotle, quoted in Loland, 2000: 158). These general norms are, to a certain extent, followed in sport. They mean that inequalities in performance lead to inequalities in the distribution of game advantages. Athletic performance should be a combination of talent and cultivation of talent, in which the athlete's efforts play the dominant role.

However, as the cases in this paper illustrate, there are potential controversies about the meaning of 'in reasonable accordance with the inequality in question'. An important characteristic of sport is that people are treated differently based on differences that are not (yet) subject to human influence. In addition, the outcome of the genetic lottery can be unfortunate. Jacobs was only 1.73 m tall, but still one of the best high jumpers ever, because he jumped 59 cm over his own height. Nevertheless, it is part of the definition of the game that absolute height instead of relative height is measured.

If it is possible to genetically modify certain features, and thus to exclude elements of pre-game chance, it only has an equalizing effect when genetic technology makes it possible to reduce gaps in talents. But again, apart from the question of whether gene technology leaves the necessary skills untouched, there is no reason to believe that gaps will be reduced instead of widened. Besides, given the high costs, it seems more realistic that – at least initially – only a small number of elite athletes may profit from biotechnological applications.

The elimination of elements of 'anthropological pre-game chance' certainly changes the competition. It introduces new kinds of pre-competition inequalities (comparable with secretly manufacturing new skates) and possibly changes the appreciation for human performance. When a pianist is engineered to have large hands to be able to play Rachmaninov, the audience may equally enjoy the music (assuming the pianist is not competing in a contest). This will not be the same in a sports contest. The principle of equal opportunities remains powerful in competitive sports.

Breivik's plea for a flourishing of anthropological chance during the pre-game period must therefore also be related to the (im)possibilities to control the elements of chance. Similar to the introduction of the klapskate, if some people do start to modify elements of genetic chance, it forces other competitors to make a choice. And that means that athletes who choose the 'flourishing' of anthropological chance in fact 'choose' not to be elite anymore. There is one major difference from the klapskate: there is no klapping sound (or other clear evidence) as a sign that someone is genetically enhanced.

The Abjected Athlete

Suppose there are no health risks and there is enough bioengineering expertise to genetically modify the size of the hands and feet of a swimmer. In swimming this means a large increase of efficiency, comparable with the klapskate.[26] Are enlarged hands and feet more artificial than klapskates? One can agree with Butryn that such genetic manipulation has the potential to challenge our 'well accepted notions of human performance' (Butryn, 2002: 113). This means that genetically modifying such elements of 'pre-game chance' challenges the understanding of the agent to which we should attribute the performed inequality.

Butryn (2002) distinguishes between what he calls 'self-technologies' and technologies that remain 'external to the athlete'. Self technologies such as blood doping, genetic manipulation and even psychological interventions have the potential to challenge our 'well accepted notions of human performance … while technologies like aerodynamic bicycles, lightweight shoes, and the Fosbury flop technique in the high jump simply allow the athlete, as is, to compete in different ways' (Butryn, 2002: 112–13). However, did the klapskate not at first challenge some of the accepted notions of human performance? It did at first. The distinction between natural and artificial is not stable. It is rather the outcome of an evaluative process in which both the internal values of sport (like the 'just' and 'equal' game which is largely based upon the tradition of a specific sport) and external values (health, safety) play an important role.

What is the difference between a swimmer who is 'naturally born' with shoe size 17 and someone who is genetically modified to become an elite swimmer? Questions about the accepted notions of 'natural human performance' in a fair and equal game cannot be answered sufficiently in analytical terms. In the public admiration for athletic performance, two factors play a crucial role: the supposed autonomy of the athlete[27] and respect for taboos and boundaries. The admiration of a 'natural' athletic performance includes the distinctions between the 'inner' and 'outer' body. For a better understanding of the difference in valuation of the work of the bio-*mechanical* or the bio-*chemical* engineer, one has to understand the *logic of abjection* concerning the boundaries of the body. The biomechanical engineer, disciplining the human body in order to reduce the performance to mechanical laws, does not 'intrude' upon the social boundaries of the body. Unlike the biogenetic engineer (s)he works on the 'outer, visible body', instead of the 'inner, non-visible body'.

The question of why athletic performances may lose their attraction is not just a matter of more or less artificiality. It also has to do with the role of athletes as models, exemplars. The 'abjected athlete' is an athlete who transgresses socially constructed boundaries, including gender boundaries (cf. Burke & Roberts, 1997). The masculinization of woman in elite sport evokes 'fears of the monstrous feminine' (Magdalinski & Brooks, 2002). Genetic modification may also threaten the public view of athletes as moral agents. 'If we look too closely at the athlete's singular efforts to gain a perceived competitive edge, we are likely to find an ignoble flaw that will bring us to what Julia Kristeva calls abjection' (Fairchild, 1989: 77).

Is it plausible to imagine that people will value a genetically modified athlete in the same way as they cheered for Fosbury? Some argue that it is a pessimistic fear of new technology to think that this is not possible. According to Butryn (2003), we should see athletes as *cyborgs* who are inextricably tied to a range of sports technologies. His view would help to alleviate the tension between the 'natural' and 'artificial', 'because it carries with it the recognition that elite athletes do not simply enter into competitions as technological tabulae rasae' (Butryn, 2003: 18). Of course, *the* natural athlete has never existed, but neither has *the* natural performance. Athletes have always interacted with and been shaped by various technologies since birth (Butryn, 2002: 18). Not even the first jump made by a child is devoid of enculturation. Does this omnipresence of technology in elite sport mean that the modification of genes falls within the same category as the introduction of the klapskate? Not quite, because of the already mentioned moral and aesthetic implications. There are differences in the acceptance of both technologies, because genetic enhancement transgresses limits of the socially accepted notions of a human performance. This notion of a human performance also includes physical appearance. Although there are no clear limitations to a particular body concept in sport (think of the extreme size of Japanese sumo wrestlers), abjection does play a role in each sport in constructing the natural and artificial. Swimmers with webbed feet are not considered 'natural'.

One can argue that the audience gets used to disproportionate physical features, just like the adaptation to changes in body technique. The shift from 'lucky genes' to 'designer genes' is, however, unlike the shift from straddle to flop. The history of elite sports teaches that processes of normalization in elite performance do not include doping in the way they include changes in equipment and technique. Most performance-enhancing substances that were used in the early days of professional sports are still surrounded by an air of artificiality and even criminality. Anabolic steroids have been used for many decades, but are not accepted outside body-building circles (Shapin, 2005).

Sports institutions have been successful in constructing and upholding distinctions between the natural, unaffected body and the enhanced body. Nevertheless, some commentators fear that genetic modification will break down the distinction between the natural and artificial in sport (for example, Hoberman, 1992). However, the boundary between the natural body and the enhanced body is the *outcome* of the institutional processes of boundary work. There is no difference between genetic modification and other performance-enhancing substances in that they all depend on sport authorities and available technological means to prove the illegal enhancement of the 'natural body'. In the absence of detection of some kind of genetic modification, the athletic body remains 'natural'. The construction of a credible dichotomy highly depends on the use of gene experts and gene technology to make the audience believe that the genetically enhanced athlete is not given an unfair chance to succeed.

Conclusion

The Fosbury flop, klapskates and gene doping all challenge the notions of 'natural performance' in elite sport in different ways. The objective of this paper was to understand some of the differences and nuances of the dichotomy between natural and artificial. Other dichotomies between inside/outside and internal/external regions of the body also represent the cultural paradox of being both preoccupied with purity, while at the same time stimulating the cult of sport records. Dichotomies such as these are used in a variety of contexts in sport, by a variety of actors with different, often opposing, interests.

The case of genetic enhancement illustrates an increasing discrepancy between discourses on the athlete-as-*cyborg* and the institutional representation of a 'pure and honest sport' for the wider public. These processes of hybridization and purification seem to be two sides of the same coin. The search for natural bodies cannot do without the unnatural, the enhanced and criminalized body (see Cole & Orlie, 1995: 238–39). There is, however, little use in defining the good sporting contest on the basis of a rigid distinction between natural and artificial. The principle that 'sport should be fair and enable equal opportunities for all' is hard to unite with the principle that 'sport should be about transgressing boundaries'. These opposing, deontological arguments are based upon incompatible presumptions regarding the definition or the 'nature' of sport. At the same time, they may be more alike in terms of consequences: 'anything goes' in elite sport as long as it remains within rational limits of taking health risks.

The three cases show that artificiality as such can hardly be a criterion by which one can evaluate processes of innovation. The context of elite sport is highly artificial in itself. When discussing new technologies in sport it is better to ask if athletes are still playing the same game and whether or not there is an equal distribution of means. What are the influences of specific technological innovations on the relevant inequalities that emerge in a specific game? Athletes accept inefficiencies 'not because ethics require them or the law mandates them, but because such inefficient means create the test they want to take' (Gelberg, 1998: 95).

The three cases also illustrate different attitudes towards the transgression of publicly accepted, athletic performances. Initially, new techniques and technology are often accompanied by concerns for health. Important for the acceptance of the Fosbury flop was the assurance that every jumper could be guaranteed a safe landing. Besides, the athletic edge gained by Fosbury could be attributed to his own athletic skills. The difference in technique is regarded as a relevant inequality that is part of the game. The initial differences in skating performance as a result of the klapskate could not just be attributed to the klapskater's merit. Unequal distribution of technological means surrounding the introduction of the klapskate was in fact not relevant for the skating contest itself. Only after the new technology became accessible to all skaters did the re-skilling of skating technique become an accepted element of the skating contest.

The use of performance-enhancing substances is generally excluded in elite sport because of health concerns and the protection of an honest and fair competition. As yet, health risks are the most powerful objection against the use of gene technology to enhance elite sport performances. It is intriguing to consider speculations about the radical changes that might be expected in elite sport when gene doping does become a safe technique and when it appears to be a non-detectable way of enhancing the athlete's body. Some argue that it is, or will inevitably become, part of the athletic skill to know what substances can and should be used – in other words, that drug-use may become a form of athleticism in itself. However, most people will agree that it is not a relevant aspect of the game to know what to inject, or where and when to inject it (cf. Shapin, 2005).

In the preparatory stages of gene technology, before it ever proves to be a safe technique, athletes have to be willing to experiment and accept the unknown effects of this new technology. Even when medical ethical principles such as 'informed consent' or 'negotiated consent' are met, and even when gene doping appears to be a safe technique, it is hard to imagine that it will ever lead to the kind of appraisal that has been given to the early execution of the Fosbury flop and the mastery of the klapskate.

Burke calls the Fosbury flop a 'masterful redefinition, which was tolerated within the practice of sport because it was both instrumentally effective and aesthetically appreciated' (1997: 61). Burke is right to stress the importance of the aesthetic sensibilities of the sport community. On the other hand, the comparison between the Fosbury flop and (bio)technological innovation falls short in terms of health risks (cf. Holowchak, 2000: 46–47). The paradigm shift within high jumping was soon followed by the construction of a safer landing pit.

One can argue that the first athlete with the courage to experiment with new technology should be credited with gaining an edge over opponents. Does this also apply for the first athlete who dares to enhance his or her genes? The fact that biotechnological experiments do not have their own foam landing pit means that it would take another kind of courage. There is a major difference between the sport-technical risks taken to re-skill the game (the 'athletic step back' by Fosbury and the first klapskaters) and the 'courage' to accept extreme health risks for athletic purposes. Instead of a mutual concern for excellence, athletic prowess, skill and dexterity, the contest would then become a game dominated by 'athletic dare-devils'. Some of the individual sports in which strength is of major importance may adapt features that are common within extreme bodybuilding: 'the one who dies with the most muscles wins'. The Fosbury flop was a technological innovation without the widespread (medical and social) implications that gene technology may have.

The analogy between Fosbury and gene doping also falls short of acknowledging the relevance of the organized equalities and the valuation of the relevant inequalities. The introduction of gene technology in sport may in fact result in enormous inequalities, with major impact on the outcome of a game. This outcome may be considered irrelevant for the inequalities that the game is supposed to measure.

The relatively individualistic and autonomous process of searching for an alternative technique explains part of the symbolism of Fosbury's flop. The 'ownership' of athletic performance has become less and less a matter of the individual athlete. Inventing a new high jump technique is considered an individual skill that is central to the game. Technological skills, such as inventing a klapskate or modifying genes, are not sport-specific skills, but they do influence major characteristics of sport. The klapskate is the result of more than a century of scientific research.

Fears surrounding the introduction of the klapskate were not expressed in terms of health risks, but rather in terms of fears of the dominance of technology and a radical change of the game. Like the case of the klapskate, gene doping involves the 'intrusion' of scientific innovation within the context of elite sport. Unlike Fosbury's search for the ideal way to jump, no one credits an athlete with the invention of a skate or the identification and enhancement of genes. Differences in competitive outcome that are based upon these 'external' inventions may be considered irrelevant inequalities. Inequalities become even less relevant to the sport itself when the distribution of technological means is unequal or the introduction is surrounded by secrecy.

If the new technology remains largely invisible and non-detectable it might break down the trust within the elite sport community. On the other hand, when genetic enhancement becomes so fine-tuned to the human body, as though the athlete was 'natural born' with the newly acquired capacities, and it does not dramatically affect the dedication that is still needed to excel, the attribution of the performed inequalities may still be directed to the athlete. Gene experts who would like to claim part of the merit for athletic success are bounded by legal restrictions and the current system of secrecy.

The most important difference that sets the discussion of gene technology apart from the two other cases is the potential impact of this technology, which is not restricted to the context of elite sport itself. Apart from some local nostalgia, the klapskate and the flop have little or no impact on society. The impact of biotechnology is much more embedded within a broader discussion of enhancing human features (cf. Gezondheidsraad, 2003; President's Council of Bioethics, 2003). It is not just about being a good or better skater or high jumper, it is about the question whether or not we should allow people to become 'better than well' in general, not just as athletes but as human beings. It is also about limiting the 'open futures' of children who do not themselves choose to be athletes. This also means that this discussion cannot be dealt with just within the context of sport institutions such as WADA, which exists in order to detect and punish. Allowing gene technology is not the same as allowing a high jumper to jump 'head first'. It could not only change the face of sport, but also change the identity of human beings in general.

The impact of biotechnology may be enormous in the near future. While recognizing that the impact of gene technology in sport may be great, one also has to be cautious to avoid 'genetic exceptionalism'. The discussion of human enhancement is a broad moral and social issue that is not restricted to the application of gene technology. There is little doubt that the credibility of major institutions such as the IOC and elite sport in general is at stake. Such institutions must deal with various, possibly incompatible ideas about the honest and good sports performance. Given the increasing interests, interdependencies and innovation processes in elite sport, and given the necessity of highly enhanced and 'artificial' environments of modern athletes, it will remain of great importance to protect certain boundaries of good and humanlike practices of elite sport.

Notes

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1. The fundamental rationale for the anti-doping code is formulated as follows:

   > Anti-doping programs seek to preserve what is intrinsically valuable about sport. The intrinsic value is often referred to as 'the spirit of sport'; it is the essence of Olympism; it is how we play true. The spirit of sport is the celebration of the human spirit, body and mind, and is characterized by the following values: ethics, fair play and honesty, health, excellence in performance, character and education, fun and joy, teamwork, dedication and commitment, respect for rules and laws, respect for self and other participants, courage, community and solidarity. Doping is fundamentally contrary to the spirit of sport. (World Anti-Doping Agency, 2003: 7–8)

   WADA president Dick Pound recently cited marijuana as an example of a substance (although not enhancing sport performance) that is contrary to 'the spirit of sport'.
2. See for example: Brown, 1990; McNamee, 1995; Schneider & Butcher, 2000; Holowchak, 2000; Dixon, 2001; Gugutzer, 2001.
3. This has been the case with the changing definition of a bicycle a decade ago. In 1993 Graeme Obree introduced a (homemade) revolutionary design to break the world hour record (with the arms completely under the breast and the nose almost on the front wheel). A year later Obree introduced the 'Superman position', with the arms stretched out on the handlebars like a downhill skier. Several records followed after which the Union Cycliste Internationale (UCI) created new rules that restricted the definition of a racing bike. In 2000 the UCI even decided to create two records, namely the 'UCI Hour Record' and the 'Best Hour Performance'. 'This distinction allowed for respect of a long tradition of classic cycling, without endangering the vital modern aspect of our sport' (Union Cycliste Internationale, Press release, 9 September 2000).
4. A good example of a context-specific dichotomy is the way steroid-using body builders make their own contrast between the 'use' and 'abuse' of drugs. For body builders it is relevant to distance themselves from 'unwelcome associations with other drug-users' (Bloor et al., 1998: 29; Monaghan, 2002).
5. Coffey, W. (24 March 2002) *Flipping Over Flop. Fosbury says Jump, Prep Kids Go High* (<www.fordhamprep.org/track/0102/fosbury.htm>).
6. In biomechanical terms, the high jump is a controlled acceleration using centripetal force to put the body in position to convert horizontal speed into vertical velocity, propelling the centre of mass over the crossbar. Two aspects are important when crossing the bar. First, the highest point of the centre of gravity path should be above the bar and not behind or below it. The second aspect is that the centre of gravity path should pass as close as possible to the bar.
7. Some elite high jumpers persevered with the straddle. American high jumpers Pat Matzdorf and Dwight Stones remained elite jumpers with the straddle technique in the seventies (Stones combined it with the flop). Women have jumped more than 2 m and men more than 2.35 m with the straddle technique (even 10 years later), which would still be top performances today.
8. <www.highjumpworld.com/HJstore/nelson/bkintro.htm>; accessed 28 May 2003.
9. <www.highjumpworld.com/HJstore/nelson/bkintro.htm>; accessed 28 May 2003.
10. <hipcat.hungary.org/users/hipcat/olympic_1960.htm>.

11. The disappearance of the straddle does seem to indicate the universal superiority of the flop. This is also supported by the fact that Fosbury was not the first and only one to discover the 'backward' technique. At the same time that Fosbury introduced the Flop, Canadian Debbie Brill went through a similar process and developed the so-called Brill Bend. If her records had spread a few years earlier, perhaps people would be talking of 'bending' instead of flopping.
12. <www.strc.ucalgary.ca/faq_long2.htm>.
13. The current male record holder Cuban Javier Sotomayor is 1.93 m tall (he jumped 2.45 m), which means that he jumped 52 cm more than his own height. One could argue that body height is so dominant that it should be factored into the outcome. Swedish high jumper Stefan Holm, Olympic gold medallist in Athens 2004 (with 2.36 m) and the American Franklin Jacobs would then be the record holders with a jump 59 cm higher than their own height (Holm, 1.81 m tall, jumped 2.40 m; Jacobs, 1.73 m tall, jumped 2.32 m).
14. Of course, this does not preclude a more efficient way of high jumping. Fosbury could only become identified with the flop because of a simple change of rules. Similarly, another superior technique may eventually be established, which is for the moment limited by the rules. For example, some people believe that new records will be broken if the rule of jumping from one foot is changed, and competitors are allowed to jump with two feet at the same time. Hans Kuiper, a civil engineer, has even tried to attach his own name to a 'two-feet-jump' launched from a tumbling approach (for an animation of the 'Kuiper flop', see <web.inter.nl.net/hcc/Hans. Kuiper/highjump.htm>).
15. The term *klapskate* seems by now internationally accepted, although the spelling may be adapted to different languages (in German: Klappschlittschuh) and some still prefer to call it the *clapskate or slapskate*. The term is not based on the klapping or slapping sound of the returning blade (the Dutch word for 'to slap' is 'klappen'). Rather, it refers to the extra slap (klap) on the ice that enables the skater to slap an extra amount of work per stroke (De Koning et al., 2000). The ISU President, Ottavio Cinquanta, tried to call for a renaming because 'clap' is slang for a sexually transmitted disease.
16. The first patents of the idea were granted to the Englishman Charles Corneby in 1884, in 1891 to the American John Diedrich Freese, and in 1894 to the German Karl Hannes (Blauw, 2001: 93).
17. This was not unfamiliar to Fosbury: 'The elite athletes were not interested in dropping 12 years of dedication and practice to switch over to something that was unproven' (<groups.yahoo.com/group/highjump/message/1060-25k>).
18. From a biomechanical perspective skating is a much more *efficient* method of locomotion. Elite skaters reach speeds of more than 60 km per hour. An elite sprinter is able to stay close to the skater for a maximum of about 100 m. This has to do with the low friction of ice and because the push-off is executed against a gliding skate. That means that the speed of locomotion becomes independent of leg extension velocity (Houdijk, 2001: 15–16).
19. CBS Sports Line wire reports, *ISU considering clap skate controls* (8 January 1998, from: <http://home1.gte.net/pjbemail/ClapSk8_ISU.html>).
20. Although biomechanical evidence was already provided by Van Ingen Schenau in the early 1980s, it was not until the winter of 1994–95 that the klapskates were actually tried for the first time by junior skaters on a regional team (De Koning et al., 2000).
21. The German newspaper, *Rhein Zeitung*, headlined: 'De Jong "klapperte" auf Goldkurs' and called it 'den Siegeszug des Klappschlittschuhs' (13 January 1997). Niemann said that she would start training with 'Klappi' immediately. De Jong also won the European Championship for speed skating in 1999.
22. Interesting in the relation between biomechanical theory and speed skating practice is the fact that by now the practice runs ahead of the scientific data. The klapskates are much faster than was hypothesized from biomechanical and exercise physiological data (De Koning et al., 2000: 1229).

23. Although some of the high expectations have been tempered (cf. Steinacker & Wolfarth, 2002), the discussion on gene doping has past the stage of mere speculation. Before the start of the Olympic Winter Games (Torino 2006), emails of the German athletic coach Springstein were found in which he asked for the gene therapeutic medicine *Repoxygen* ('EPO-gene').
24. Cf. Munthe (2000). The use of genetic information for selection raises complex (legal) issues, for example, on the privacy of the athlete (see Australian Law Reform Commission/Australian Health Ethics Committee, 2003) and on (the limits of) 'athletic predestination' (Tamburrini, 2002; Hilvoorde, 2005).
25. *The International Conference on Gene Technology in Elite Sports* (University of Sport, Stockholm, 22 and 23 May 2003).
26. The example is not as speculative as it seems, after the accusations against the top Australian swimmer Ian Thorpe. Thorpe – with the extreme shoe size 17 – was accused by other elite swimmers of taking human growth hormone. Whatever the origin of his foot size, the fact is that Thorpe has considerable advantage when using his feet as a pair of 'flippers'. Australian coach Brian Sutton said: 'If you were going to do a Frankenstein, if you were going to put a swimmer together from scratch, you'd build Ian Thorpe' (<www.timesonline.co.uk/article/0,,4807-502474,00.html>).
27. The issue of early selection and talent is beyond the scope of this paper. Some of the objections against 'athletic predestination' of children are: an instrumental relation with the offspring, the idea of exploiting talent and endangering the right to an *open future*. This widely discussed concept of an *open future* raises other complex issues and does not offer unambiguous criteria (see Davis, 2001; Savulescu, 2001; Tamburrini, 2002; Hilvoorde, 2005).

References

Aschwanden, Christie (2000) 'Gene Cheats', *New Scientist* 15(1): 24–29.

Australian Law Reform Commission/Australian Health Ethics Committee (2003) *Essentially Yours: The Protection of Human Genetic Information* (Canberra: Australian Law Reform Commission and Australian Health Ethics Committee [ALRC Report 96]).

Bette, Karl-Heinrich & Uwe Schimank (2001) 'Coping with Doping: Sport Associations under Organizational Stress', in Proceedings from the Workshop *Research on Doping in Sport* (22 May 2001): 51–69.

Bigold, Pat (1999) 'The Flop that Flabbergasted. Dick Fosbury's Unusual Method Won Him Olympic Gold and Revolutionized the High Jump', *Honolulu Star Bulletin* (13 February, <http://starbulletin.com>).

Bijker, Wiebe (1995) *Of Bicycles, Bakelite and Bulbs. Toward a Theory of Sociotechnical Change* (Cambridge, MA: MIT Press).

Bijker, Wiebe, Thomas Hughes & Trevor Pinch (eds) (1987) *The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology* (Cambridge, MA: MIT Press).

Blauw, Wiebe (2001) *Van Glis tot Klapschaats. Schaatsen en Schaatsenmakers in Nederland, 1200 tot Heden* (Franeker: Uitgeverij Van Wijnen).

Bloor, Michael, Lee Monaghan, Russel Dobash & Rebecca Dobash (1998) 'The Body as a Chemistry Experiment: Steroid Use Among South Wales Bodybuilders', in Sarah Nettleton & Jonathan Watson (eds), *The Body in Everyday Life* (London & New York: Routledge): 27–44.

Blount, Roy, Jr (1969) 'Being Backwards Gets Results', *Sports Illustrated* (10 February, <http://sportsillustrated.cnn.com/features/cover/news/2000/07/21/fosbury_flash/>).

Bottenburg, Maarten van (2001) *Global Games* (Chicago, IL: University of Illinois Press).

Bouchard, Claude, Robert Malina & Louis Pérusse (1997) *Genetics of Fitness and Physical Performance* (Champaign, IL: Human Kinetics).

Breivik, Gunnar (2000) 'Against Chance. A Causal Theory of Winning in Sport', in Torbjörn Tännsjö & Claudio Tamburrini (eds), *Values in Sport: Elitism, Nationalism,* *Gender Equality and the Scientific Manufacture of Winners* (London: E & FN Spon): 141–56.

Brown, W.M. (1990) 'Practices and Prudence', *Journal of the Philosophy of Sport* XVII: 71–84.

Burke, Michael D. (1997) 'Drugs in Sport: Have They Practiced Too Hard? A Response to Schneider and Butcher', *Journal of the Philosophy of Sport* XXIV: 47–66.

Burke, Michael D. & Terence J. Roberts (1997) 'Drugs in Sport: An Issue of Morality or Sentimentality?', *Journal of the Philosophy of Sport* XXIV: 99–113.

Butryn, Ted (2002) 'Cyborg Horizons: Sport and the Ethics of Self-technologization', in Andy Miah & Simon Eassom (eds), *Sport Technology: History, Philosophy and Policy* (Amsterdam: Elsevier Science Ltd): 111–33.

Butryn, Ted (2003) 'Posthuman Podiums; Cyborg Narratives of Elite Track and Field Athletes', *Sociology of Sport Journal* 20: 17–39.

Cole, Cheryl L. & Melissa A. Orlie (1995) 'Book Review Essays: Hybrid Athletes, Monstrous Addicts, and Cyborg Natures', *Journal of Sport History* 22(3): 228–39.

Davis, Dena S. (2001) *Genetic Dilemmas: Reproductive Technology, Parental Choices, and Children's Futures* (New York/London: Routledge).

De Koning, Jos, Han Houdijk, Gert de Groot & Maarten Bobbert (2000) 'From Biomechanical Theory to Application in Top Sports: The Klapskate Story', *Journal of Biomechanics* 33: 1225–29.

Dixon, Nicholas (2001) 'Rorty, Performance-Enhancing Drugs, and Change in Sport', *Journal of the Philosophy of Sport* XXVIII: 78–88.

Eggers, Kerry (1998) *Fosbury will Compete with No Fear of Flop* (<www.geocities.com/Colosseum/Midfield/7241/fosbury.htm>).

Eichberg, Henning (1978) *Leistung, Spannung, Geschwindigkeit. Sport und Tanz im gesellschaftlichen Wandel des 18./19. Jahrhunderts* (Stuttgart: Klett-Cotta).

Eichberg, Henning (1982) 'Stopwatch, Horizontal Bar, Gymnasium: The Technologizing of Sports in the 18th and Early 19th Centuries', *Journal of the Philosophy of Sport* IX: 43–59.

Fairchild, David L. (1989) 'Sport Abjection: Steroids and the Uglification of the Athlete', *Journal of the Philosophy of Sport* XVI: 74–88.

Franke, Elk (1988) *Ethische Aspekte des Leistungssports* (Zellerfeld: Clausthal).

Franklin, Sarah (1996) 'Postmodern Body Techniques: Some Anthropological Considerations on Natural and Postnatural Bodies', *Journal of Sport and Exercise Psychology* 18: S95–S106.

Gelberg, J. Nadine (1998) 'Tradition, Talent, and Technology: The Ambiguous Relationship between Sports and Innovation', in Akiko Busch (ed.), *Design for Sports: The Cult of Performance* (New York: Princeton Architectural Press): 88–110.

Gelberg, J. Nadine (2002) 'Developing Sport Technology Policy: A Statement', in Andy Miah & Simon Eassom (eds), *Sport Technology: History, Philosophy and Policy* (Amsterdam: Elsevier Science Ltd): 1–3.

Gezondheidsraad (2003) *Signalering Ethiek en Gezondheid 2003*. Den Haag: Gezondheidsraad (publicatie nr 2003/08).

Glöckle, Hanns (1987) *Geschichte des Sports. Nach Bildreportagen von 1840–1900. Holzstiche aus dem Historischen Sportarchiv Adidas* (München: Südwest Verlag).

Gugutzer, Robert (2001) 'Die Fiktion des Natürlichen. Sportdoping in der Reflexiven Moderne', *Soziale Welt* 52: 219–38.

Hilvoorde, Ivo van (2005) 'Sport and Genetics: Moral and Educational Considerations Regarding "Athletic Predestination"', in C. Tamburrini & T. Tännsjö (eds), *Genetic Technology and Sport. Ethical Questions* (London & New York: Routledge): 91–103.

Hoberman, John (1992) *Mortal Engines: The Science of Performance and the Dehumanization of Sport* (New York: The Free Press).

Holowchak, M. Andrew (2000) '"Aretism" and Pharmacological Ergogenic Aids in Sport: Taking a Shot at the Use of Steroids', *Journal of the Philosophy of Sport* XXVII: 35–50.

Houdijk, Han (2001) *The Klapskate: Shifting Gears in Speed Skating*, PhD Thesis, The Free University Amsterdam.

Houdijk, Han, Arjen Wijker, Jos De Koning, Maarten Babbert & Gert De Groot (2001) 'Ice Friction in Speed Skating: Can Klapskates Reduce Ice Frictional Loss?', *Medicine and Science in Sports and Exercise*: 499–504.

Houlihan, Barrie (2002) *Dying to Win: Doping in Sport and the Development of Anti-doping Policy* (Strasbourg: Council of Europe Publishing).

Ingen Schenau, Ian Gerrit van, Gert de Groot, A.W. Schreurs, H. Meester & Jos de Koning (1996) 'A New Skate Allowing Powerful Plantar Flexions Improves Performance', *Medicine and Science in Sports and Exercise* 28: 531–35.

König, Eugen (1995) 'Criticism of Doping: The Nihilistic Side of Technological Sport and the Antiquated View of Sport Ethics', *International Review for the Sociology of Sport* 30: 247–59.

Koolhaas, Marnix (2000) 'Schaatsen: Onze Nationale Volkscultuur', in Wilfred van Buuren & Peter-Jan Mol (eds), *In het Spoor van de Geschiedenis. Hoofdlijnen uit de Nederlandse Sportgeschiedenis* (Haarlem: Uitgeverij Arcadia): 131–58.

Latour, Bruno (1993) *We Never Were Modern* (Cambridge, MA: Harvard University Press).

Loland, Sigmund (2000) 'Justice and Game Advantage in Sporting Games', in Torbjörn Tännsjö & Claudio Tamburrini (eds), *Values in Sport: Elitism, Nationalism, Gender Equality and the Scientific Manufacture of Winners* (London: E & FN Spon): 157–71.

Loland, Sigmund (2002) *Fair Play in Sport: A Moral Norm System* (London & New York: Routledge).

MacIntyre, Alasdair (1985) *After Virtue* (London: Duckworth).

McNamee, Mike (1995) 'Sporting Practices, Institutions, and Virtues: A Critique and a Restatement', *Journal of the Philosophy of Sport* XXII: 61–82.

Magdalinski, Tara & Karen Brooks (2002) 'Bride of Frankenstein: Technology and the Consumption of the Female Athlete', in Andy Miah & Simon Eassom (eds), *Sport Technology: History, Philosophy and Policy* (Amsterdam: Elsevier Science Ltd): 195–212.

Mauss, Marcel (1973 [1934]) 'Techniques of the Body', *Economy and Society* 2(1): 70–88.

Miah, Andy & Simon Eassom (eds) (2002) *Sport Technology: History, Philosophy and Policy* (Amsterdam: Elsevier Science Ltd).

Monaghan, Lee (2002) 'Vocabularies of Motive for Illicit Steroid Use Among Bodybuilders', *Social Science and Medicine* 55(5): 695–708.

Montgomery, H.E., R. Marshall, H. Herringway, S. Myerson, P. Clarkson, C. Dollery et al. (1998) 'Human Gene for Physical Performance', *Nature* 393: 221–22.

Munthe, Christian (2000) 'Selected Champions: Making Winners in the Age of Genetic Technology', in Torbjörn Tännsjö & Claudio Tamburrini (eds), *Values in Sport: Elitism, Nationalism, Gender Equality and the Scientific Manufacture of Winners* (London: E & FN Spon): 217–31.

Pérusse, Louis, Tuomo Rankinen, Rainer Rauramaa, Miguel A. Rivera, Bernd Wolfarth & Claude Bouchard (2003) 'The Human Gene Map for Performance and Health-Related Fitness Phenotypes: The 2002 Update', *Medicine and Science in Sports and Exercise* 35(8): 1248–64.

President's Council of Bioethics (2003) *Beyond Therapy: Biotechnology and the Pursuit of Happiness* (New York: Harper Collins Publishers).

Pronger, Brian (1998) 'Post-Sport: Transgressing Boundaries in Physical Culture', in Geneviéve Rail (ed.), *Sport and Postmodern Times* (Albany, NY: State University of New York Press): 277–98.

Savulescu, Julian (2001) 'Procreative Beneficence: Why We Should Select the Best Children', *Bioethics* 15(5/6): 413–26.

Schneider, Angela J. & Robert B. Butcher (2000) 'A Philosophical Overview of the Arguments on Banning Doping in Sport', in Torbjörn Tännsjö & Claudio Tamburrini (eds), *Values in Sport: Elitism, Nationalism, Gender Equality and the Scientific Manufacture of Winners* (London: E & FN Spon): 185–99.

Shapin, Steven (2005) 'Cleanup Hitters. The Steroid Wars and the Nature of What's Natural', *The New Yorker* (18 April 2005).

Shipley, Amy (1997) 'Slapskates Melt Records, Anger Purists', *Washington Post* (30 November): D9.

Shogan, Debra (2002) 'Disciplinary Technologies of Sport Performance', in Andy Miah & Simon Eassom (eds), *Sport Technology: History, Philosophy and Policy* (Amsterdam: Elsevier Science Ltd): 93–109.

Singer, Robert N. & Christopher M. Janelle (1999) 'Determining Sport Expertise: From Genes to Supremes', *International Journal of Sport Psychology* 30: 117–50.

Skinner, James (2001) 'Do Genes Determine Champions?', *Sports Science Exchange* 14(4): 1–4.

Soderberg, William (1998) *Genetic Enhancement of a Child's Memory: A Search for a Private and Public Morality* (<www.bu.edu/wcp/Papers/Bioe/BioeSode.htm>).

Steinacker, Jurgen M. & Bernd Wolfarth (2002) 'Molekularbiologie und Molekulargenetik: Eine Zukünftige Herausforderung in der Sportmedizin', *Deutsche Zeitschrift für Sportmedizin* 53(12): 337.

Suits, Bernard (1988) 'The Elements of Sport', in William J. Morgan & Klaus V. Meier (eds), *Philosophic Inquiry in Sport* (Champaign, IL: Human Kinetics): 39–48.

Tamburrini, Claudio (2002) 'After Doping, What? The Morality of the Genetic Engineering of Athletes', in Andy Miah & Simon Eassom (eds), *Sport Technology: History, Philosophy and Policy* (Amsterdam: Elsevier Science Ltd): 253–68.

Tiles, Mary & Hans Oberdiek (1995) *Living in a Technological Culture* (London/New York: Routledge).

Waddington, Ivan (2000) *Sport, Health and Drugs: A Critical Sociological Perspective* (London: E & FN Spon).

Weir, Tom (1997) 'Speedskaters Get a Hand. Technology Race is On, and Dutch Clapskate has the Lead', *USA Today* (7 August): 05.E.

Wesely, Jennifer (2001) 'Negotiating Gender: Bodybuilding and the Natural/Unnatural Continuum', *Sociology of Sport Journal* 18: 162–80.

Whedon, Julia (1988) *The Fine Art of Ice Skating: An Illustrated History and Portfolio of Stars* (New York: Harry N. Abrams Inc.).

Wolfarth, Bernd (2002) 'Genetische Polymorphismen bei Hochtrainierten Ausdauerathleten – die Genathlete-Studie', *Deutsche Zeitschrift für Sportmedizin* 53(12): 338–44.

World Anti-Doping Agency (2003) *The World Anti-Doping Code* (Lausanne: WADA).

World Anti-Doping Agency (2004) *The 2004 Prohibited List International Standard* (Lausanne: WADA).

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