

TECHNOLOGY APPLIED TO SPORTS AND SPORTING EQUIPMENT

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Introduction

It is undeniable that we have become better, faster and stronger as humans. This fact is glaringly apparent when looked at through the lens of sports performance's today, compared to just 30 years ago. Many factors can be attributed to the increase in human performance that we have witnessed in our lifetime, but it is accurate to say that it has been a dynamic process influenced by the times and trends that we, and the generations before us, have lived through till now. Sports in our current culture has evolved and risen to an unprecedented height. Fueled initially by radio broadcasts of sporting events and followed by the invention of the television, the experience of watching a game or event was for the first time, brought directly into people's living rooms through real time communication. If television had any flaws or limitations it had to have been, its one-way information flow rather than interactivity. But, since technology is always advancing, eventually the earlier breakthroughs in innovation led to the development of computers, and the creation of the once unfathomable idea of "*the internet*". The internet miraculously made it possible to connect with people from all over the globe and enabled us to receive, create and interactively access vast amounts of information at the speed of light. With geographical access to sporting events no longer an obstacle, the popularity and fan base across all sports grew exponentially. Hand in hand with this continual growth has been the ever increasing presence, implementation and reliance on technology in sport, as well as the never-ending quest to constantly develop new advancements in technology. This paper will review and discuss a few of the most noteworthy and recent technological contributions to sport in areas of wearable sport technology, advancements in sports health technology and improvements made in movement analysis technology to improve sports performance. Also, how the use of sport technology is changing sport, and the positive and negative implications of these changes. The

most interesting of which, is the controversial thought that with the use of advances in sport technology, any "average Joe" could potentially become the next champion.

Technology

It is first important to try to define what we mean by “*technology*”. The word technology has many definitions. Technology: (1) is the specific methods, materials, and devices used to solve practical problems; (2) a technological process, invention, or method; (3) the application of knowledge for practical ends; the sum of ways in which social groups provide themselves with the materials objects of their civilization. Sport technology on the other hand is a bit more specific and is defined as: man-made means developed to reach human interests or goals in or relating to a particular sport. Technology in sports is a technical means by which athletes attempt to improve their training and competitive surroundings in order to enhance their overall athletic performance (University of Ulster, n.d).

Average Consumer to Elite Athlete - Wearable Sports Technology

There was a time when it was *unusual* to have a cell phone. Early versions were clunky and inconvenient, and seldom worked the way you wanted them to, or, more importantly, when you needed them to. Today most of us can't imagine going anywhere *without* a cell phone. We rely on them so much, we don't even remember half of the things we used to need to know, and instead, we store it all in our “contacts” and “notes” and move it from device to device. Apple of course revolutionized and still continues to contribute to technological advancements in so many ways, but with the introduction of the first generation iPod in 2001, boom boxes, counter top radios and clunky MP3 players went out the window. Wearable technology became the next great thing and the battle for space on the body began.

What we have experienced is that, when it comes to sport technology, anything "new", will soon be outdated and will most certainly be replaced by the latest and better version of itself. The iPod is a perfect example of this phenomena. The first generation iPod had 4 GB storage, and basically played music. Today we have the many versions of iPhone, the iPad, iPod video, the iPod Nano which use flash memory, and has an accelerometer, and the iPod Touch, with touchscreen comes complete with an accelerometer, Bluetooth and Wifi capability and, therefore, access to the App Store. From a fitness, sport and training standpoint, apps make it very easy to do a myriad of tasks, all very conveniently located on an armband that can be worn during workouts. App's such as: Interval timers, Tabata timers, Nike Fitness Pro, Runkeeper GPS and Map my Run, tell the user exactly what to do to physically train in general, or condition in a more sport specific way. Sports App's such as WatchESPN and Yahoo Sports keep users entertained and informed to all that is going on in the world of sports and sport apps have been developed that instantly reflect live time scores, stats, and schedules.

Activity wristbands, such as the FitBit HR, Garmin and BodyBugg, are equipped with motion sensors and are able to take instantaneous heart rate, store daily activity, some have caller ID and sleep monitors and the Bodybugg is even able to detect skin temperature, skin perspiration, and air temperature.

Other wearable technology has been inspired by the world we live in, and is embodied in a relatively new field of science called biomimetics. Biomimetics, is the study of the structure and function of biological systems as models for the design and engineering of materials and machines (American Heritage Dictionary, n.d). The field of biomimetics, is the application of methods and systems, found in nature, to engineering and technology, and has spawned a number of innovations far superior to what the human mind alone could have devised. The

reason is simple. Nature, through billions of years of trial and error, has produced effective solutions to innumerable complex real-world problems (Butler,2005).

An example of biomimetic inspired equipment is the friction reducing sharkskin full body swimsuit. The development of this as a material evolved because of the observed ability of shark's skin to reduce drag by manipulating the boundary layer flow as the fish swims (Howes, n.d). The boundary layer is the area closest to the surface where viscous conditions cause drag—in this instance a shark's skin. Researchers are trying to explain why fast sharks that swim upwards of 60 mph have smaller denticles, or scales, than slower shark species. Evidence suggests that sharks with smaller denticles have the ability to stick out their scales when they swim, allowing them to swim faster and creating a unique surface pattern on the skin that results in various mechanisms of boundary layer control (University of Alabama, 2007). Swimsuits for Olympians and athletes are being developed to take advantage of these unique biological properties.

Speedo's Fastskin FSII swimsuits made their appearance at the Beijing Olympics and many have argued that it was this edge in apparel that helped US swimmer Michael Phelps to his record eight gold medals in that competition (Howes,n.d). On a larger scale, research projects in this regard are exploring natural solutions for the reduction of skin friction over solid surfaces, which could result in new innovations and applications concerning energy conservation as well as developing future methods of flow control and drag reduction that can be applied to underwater mobile vehicles (coatings for ship's hulls), as well as aircraft fuselage (University of Alabama, 2007).

Computers, Sensors and Analytics

The above mentioned technologies are wearable for the most part, designed for use by elite athletes as well as the average consumer, are effective in their intended purpose and are somewhat accessible and affordable. These technologies will surely continue to evolve and be improved on in the future. What all of the mentioned technologies have in common thus far, is that they all have been put through a great deal of trial, testing and research prior to their release. Basically, all technologies go through some sort of a process of evaluation. Similarly, most elite athletes as part of their training regime go through some form of human performance evaluation. Performance analysis, as related to sport, can be defined as the analysis of data or information to help in the acceleration of athlete performance. The identification of performance indicators, repeatable methods for collection of data and the manner in which the information is analyzed, are all key factors to a successful performance analysis (Stergiou & Katz, n.d). Analytical equipment such as force sensors, pressure sensors and muscular measurement devices provide an understanding of the forces produced and how they act on and affect the athlete, and can be used to collect immediate and accurate information about performance. Other technologies to be used in this regard are; accelerometers, which as mentioned earlier, are small devices that can be attached to a body part or piece of equipment to measure velocity or acceleration and similar information (velocity) can be obtained by using timing lights, radar guns or GPS technologies (Stergiou & Katz, n.d). The process usually entails the collection of data via the aforementioned technologies or through sensors that are worn by the athlete during training and/or performance. The collected information about movement patterns and performance is then sent to a computer. Developed software analytics, allows athletes and their coaches to take the recorded information and use it to study body movement down to the minutest detail. Thorough biomechanical

analysis can be conducted, comparisons can be made to past or better performances, and exercise stress testing and cardiovascular evaluations can be conducted as well as injury risk assessments.

Ariel Dynamics is a company that has developed sophisticated biomechanical analysis and equipment, for use in elite sports training and injury and rehabilitation assessment. The Ariel Performance Analysis System (APUS) and ACES (Ariel Computerized Exercise System). APUS measures, analyzes, and presents movement characteristics. The system provides a means to quantify motion utilizing input information from any or all of the following media: visual (video), electromyography (EMG), and force platforms (Ariel Dynamics, 2012).

ACES equipment reproduces real athletic movement at speeds comparable to those achieved in competitive sports. It is a computerized "closed loop" exercise system that monitors present physical status, ability, and daily progress while exercising. ACES provides a continuous measurement of "real time" human performance allowing for feedback, as a loop between the machine and the computer providing controls over the measured parameters (force, velocity, power, acceleration, and fatigue) (Ariel Dynamics, 2012).

Force plate measurements are frequently used in most biomechanical research that has to do with animal and human biomechanics of walking, running and jumping. The use of force plates in sport biomechanical analysis is more common in present-day than ever before. Essentially, the device resembles an electronic scale which measures the magnitude of the vertical and two horizontal forces, the torque about the vertical axis and the location of the resultant force acting on the platform (Elvin, Elvin & Arnoczky, 2007). Force plates are used in combination with other measurement software in order to ascertain, jump height, upward thrust, displacement, and landing as well as forced loading measurements of individual athletes in a variety of sports. Force plate analysis and ground force reaction analysis have been used by several companies,

biomechanists and organisations to analyse golf swings to improve golfers performance (Stuart,2009). Applied force plate technology can be used to record golfer's center of gravity, flexibility, range of motion, strength and ultimately power, during a golf swing. Showing that center of gravity movement patterns are directly linked to the resulting shot shape, and can have a noteworthy effect on distance (Stuart,2009).

Sports Health Technology

Of all the advancements in science, sport and technology, the most valuable are those developed in the field of sports health technology. The physicality of sports takes its toll on athletes of all ages, and the need for continued research and development in technologies that protect as well as identify life-threatening and potentially debilitating risks such that those that occur as result of heat illness and concussions, cannot be understated. While we are in the infant stages of the development of these technologies, the following technologies are both necessary and are amazing examples of how far we really have come in such a short time.

Ingestible computers- heat related illnesses are the second leading cause of death for athletes due in part to the fact that the signs of onset are often missed in the monitoring of core body temperature is extremely difficult in the midst of sporting events. A thermometer pill has been developed that can now be ingested and then transmit data about heart rate and body temperature (Johnson, 2014).

Mamori gumshield – Mamori is a Japanese word meaning to protect or shield. It is a mouthguard with built-in sensors that can tell someone on the sidelines when a player has received a serious – yet invisible – injury, such as a concussion or head trauma. The combination of an accelerometer, gyroscope (sensory devices used to determine the position and orientation of an object), and magnetometer (an instrument for measuring the strength and sometimes the

direction of a magnetic field) are used to measure acceleration, force and 3D orientation. The built-in sensors measure force and head movement and the information is transferred wirelessly, in real-time to a computer. The force from each impact is measured and displayed on screen. Once the force threshold is exceeded the user will be notified, and the information is then stored in an event log (The Irish Independent,2013). Second-impact syndrome can occur when a player is concussed yet continues to play. Concussion can go undetected and, if a second impact occurs, the effects are cumulative, and can be fatal or have serious repercussions on a player's mental health. It is said to have a mortality rate of 50pc among young athletes (Johnson, 2014).

Conclusion

While some would argue that there is no replacement for raw athletic talent, many maintain that the technological advances in sporting equipment have added significantly to athletic performance. For example, there is disagreement about whether current-day athletic achievements should be viewed with the same regard as records established in the past—when athletes were performing without the benefit of graphite tennis rackets, fiberglass poles, ultra-light running shoes, and titanium golf clubs (Andrews,n.d). The criticism and debate regarding the fairness of the use of technology to improve sports performance will rage on, however, regardless of where each of us stands on the issue, the reality is that the continued development and implementation of new technology into all aspects of sport is, inevitable. With new materials and computer engineering, improvements are being made on sporting equipment faster than marketers can publicize them (Andrews, n.d). Pretty much anything that has to do with sports these days is big business! But, technology is not the big enemy that many make it out to be. Sports create opportunities for investment, employment and enjoyment for fans and many of these new technologies have the health and safety of all participants in mind when designing

their equipment to be used from the youth sport level on up to the pros. Consumer driven technologies such as the iPod and FitBit, heart rate monitors, pedometers, body fat monitors and calculators are a means for individuals to monitor and improve their own health and are motivating many to increase their daily activity. Development of certain sporting equipment has made many sports and activities safer for all participants, such as body protection and helmets, by preventing many injuries from occurring and saving lives. Through the fields and study of biomechanics and exercise physiology, a greater knowledge of the human body has been realized and we see athletes training smarter and avoiding injury, therefore, enabling many athletes to compete in sports much later in life than previous generations. And, sporting gear such as clothing and footwear has improved significantly in even just the last few years. Sports clothing is now made of fabric and materials that is lightweight and will whisk sweat away (lessening the likelihood of heat related illnesses), and footwear is made of flexible material that supports, is durable and is sport specific in order to give an athlete the best support for the activity they will be performing.

The ethical dilemma seems to lie in the fact that the sport technology that is recently being developed may be taking a sharp turn toward the goal of giving athletes a competitive edge rather than the earlier implemented technologies that were designed to solve the problem of making competition more fair and accurate. Technology was developed, implemented and accepted in the latter regard because it had introduced advancements such as instant replay, which could be looked at to assess if a call was fair, timing devices that could pick up a fraction of an instant, so we were *sure* who won, sensors on the line so you knew if a foot was “in” or “out” and the development of computer programs, websites and databases that made tickets readily available, and informed sports goers of any information they would need to attend the

events. With sports being the booming business it is, and the fans being stakeholders, anyone who pays to see a competition has an expectation that they will continue to see record-setting performances and experience the excitement of close games and high scores. Striking a competitive balance, therefore, is difficult. Especially in regards to international sport, due to the fact that technology is expensive and access to new technologies is unevenly applied. Wealthier nations, such as those found in Western Europe or the United States, can better afford the training facilities, expensive composite equipment and personal gear required for elite level competition. Thus, the benefits of technological advances applied to sports accrue most greatly to those who can afford the price (Rosalind, 2008). The future of sports may just be that even the “average Joe” can become the next elite athlete based on his access and the ability to afford the latest sport technologies, and the part regulators, administrations, and governing bodies’ play in sports is going to become larger. More rules will be put into place as to what is allowed and not allowed in competition, leading to more debate and battle depending on whose interest is being hampered by the decision and *who* gets to decide, *who* makes the rules.

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