



# The Current State of Tennis Technology & Analytics

A White Paper Summary from the 2018 Tennis Technology and Analytics Summit presented by the International Tennis Performance Association



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## “The Science of Today is the Technology of Tomorrow”

The growth of technology and analytics in all sports has grown exponentially in the last decade. The tennis industry has embraced many aspects of technology and analytics, but also has many areas that continue to be developed to improve the sport in all the various areas.

### Tennis Needs Innovation

The first step in innovation is understanding where the areas of strength and the areas of opportunity exist. To improve technology and analytics in the sport of tennis, it is paramount to bring together the best minds in the industry and focus on what we currently do well and what we can improve on.

The Tennis Technology and Analytics Summit presented by the International Tennis Performance Association (ITPA) was hosted in Atlanta, Georgia on July 22<sup>nd</sup>, 2018.

The first of its kind, Tennis Specific Technology and Analytics Summit focused on the evidence around quality technologies to help teach, train and test tennis athletes. This summit was a think tank event bringing together some of the top minds in the industry to highlight products followed by panel discussions and moderated sessions focused on how to better utilize current technology/analytics and create a roadmap for the future of the sport to improve the use of technology going forward. Although Tennis Technology crosses all aspects of the tennis industry, this specific summit was limited to applied uses of technologies focused on teaching, training, and testing tennis players at all levels of the game to improve performance and reduce the likelihood of injury.

### **The Summit Had A Few Simple Objectives:**

- Highlight the latest tennis technologies that can assist individuals working with tennis athletes in various areas of performance and injury prevention.
- Provide a vehicle for companies in the technology and analytics space to network with the leading minds in the tennis industry to speed the progress of technological innovations in the tennis industry.
- Provide networking opportunities to spur more research and technology development to improve the quality of products and the implementation of existing products.
- Develop a consensus document at the end of the Summit which will be circulated throughout the tennis industry to stimulate growth, investment and sales in the areas of data driven and research backed technologies that can improve performance and reduce the likelihood of injuries in the sport at all levels of the game.

This white paper is a summary of the summit and the current landscape of Tennis Technology. This summit included presentations and discussions from the world's foremost Tennis Technology Professionals.

### **The Big Questions for the Tennis Industry:**

Beginning an industry wide analysis focused on athlete monitoring software and hardware:

- What's being done with tennis technology?
- What do we want to target?
- Is the tennis industry accepting of the advances in new technologies and providing a network to embrace new technologies?
- Is the tech providing better information and better outcomes than what's been done in the past?

Tennis Technologies that were the focus in this summit were around Player Development at all levels of the game (recreational to professional). This Summit was not focused on fan engagement, media or other areas. The experts at the Summit were in general agreement about the most important areas around tennis technologies:

- 1) Validity and Reliability
  - a. It was pointed out by all experts that bad data is worse than no data. Much of the tennis technology currently lacks robust research on validity and reliability.
- 2) Simplicity
  - a. Ease of use and simplicity was the two main practical aspects of every new technology that need to be addressed if the technology will scale and be embraced by the various stakeholders in tennis.
- 3) Drive revenue
  - a. How does the new technology drive revenue. This may be directly or indirectly (i.e. healthier athlete, better results, etc.)
- 4) Cost Effective
  - a. The technologies need to be at a cost that is appropriate for the marketplace. Understanding that first and second generation technologies may not be at a consumer friendly price-point, but does the product have the potential to be at a price-point that has mass market appeal?

## **Tennis Technologies from a Teaching, Training, Performance and Injury Prevention Perspective Can Be Divided Into Six Categories**

### **1) Racquet Sensors**

Initially, racquet sensors were developed to attach to or replace the butt cap of the tennis racquet. Multiple varieties now exist and the accuracy has improved significantly since the first consumer versions were brought to market. The butt cap type sensors must weigh about the same as the original butt cap (5 grams) so that the racquet's balance does not change significantly. The first generations of smart racquet technology were all butt cap replacements. These sensors claim to measure speed, spin, and

impact points as well as differentiating between strokes. They are usually coupled with a smartphone app where the data can be viewed.

One of the issues discussed at the summit was that while racquet sensors generated a lot of initial buzz, consumers found them to be unreliable and lost interest quickly. This led to the removal of some sensors from the U.S. market.

Suggestion: Companies need to spend more time testing and refining the sensors for accuracy and also provide specific education around how to best utilize the sensors for both tennis teaching professionals (greater lesson revenue, etc.) and also the general consumer to help them learn more about their game and also to increase various game based (non-traditional) tennis scoring options that can use the sensor for these various purposes.

So far, racquet sensor technology has not yet made a major breakthrough into the performance industry. This could be due to the lack of validity and reliability studies available to professionals. It could also be due to extremely reliable competition from on-court video analysis technologies used at professional tournaments. However, the newer generations of sensors do show promise and will continue to improve over the next few years.

## **2. Wrist Worn (Bracelet, Watches, Wristband) Sensors**

Wrist worn sensors have been marketed to measure to measure speed, spin, and impact points as well as differentiating between strokes. The validity for all of these metrics - except for differentiation between strokes - is questionable. The relatively low cost of these devices and their ability to count strokes is a valuable tool for measuring stroke volume, especially at the club level for monitoring large groups of players.

Like racquet sensors, many of these wristband sensors have been paired with a smartphone app to view the data. Some of the more advanced sensors have been paired with on-court module systems that incorporate video playback and analysis. The coupling of different tennis technologies can increase their usefulness to coaches and

players. However, like all wrist worn sensors (across sports and health), some metrics have been overstated. For example, many of the brands have tried to measure certain physiological and biomechanical metrics at the wrist that just do not have the validity or reliability (e.g., measuring heart rate during tennis at the wrist is not accurate).

Suggestion: It is important to evaluate what the overall purpose is for each device and whether the technology is appropriate. The concern is the error for these technologies and whether the error is appropriate for the purpose of the measurement. For advanced athletes looking at precise measurements, these can be problematic. However, for the recreational tennis athlete, it can provide a guide as to workload, training, recovery that may provide info that could be motivational or keep them coming back playing more tennis.

### 3) Video Analysis

Video analysis can be subdivided into two categories: Stroke Analysis and Strategy Analysis. Video can be captured by a single smartphone camera, wide angle camera positioned well above the net post or back of the court, or a multi-camera system.

Stroke Analysis is usually done by a coach using a smartphone app or smartphone camera coupled with a computer program at both club and professional levels. It should be noted that drones with downward facing cameras have allowed analysts to get a bird's eye view in recent years. Coaches can look at the video frame by frame, and isolate where a stroke mechanic is breaking down.

While this type of analysis has been in tennis for at least fifteen years, advances in smartphone camera quality and simple app technology has allowed this to be very cost effective and accessible to all. The next generation of video analysis for strokes and movement on court involves linking these technical aspects with various other metrics including: physical screenings, data driven metrics for performance and potential injury, tactical linkages with technical flaws and other areas that can be applicable.

At the professional level, three dimensional biomechanics labs are used to analyze strokes in further detail. This technology has not made it to the club level due to prohibitive cost and technical expertise required.

Strategy Analysis is a service that is sometimes still done with pen and paper at the club and professional level where high quality video recording is unavailable. When it became computerized, it was originally available only at the professional level. In recent years, the adoption of on-court camera monitoring at tennis clubs has made it available to consumers. After the video data is collected, there are many options for analysis. Some facilities have standalone on court systems that can accomplish some of this. There are also tennis analytics companies that are available that will analyze uploaded match footage and provide in-depth reports. Many professional players use these services, but now they are available for the general player at all levels of the game in a cost effective manner.

Suggestion: This technology is free or very inexpensive and should be incorporated into most tennis related activities (teaching, training, competition, etc). It provides a level of information that is valuable at both the professional and competitive levels, but also as a great teaching and education tool.

#### **4) Athlete Monitoring Hardware**

Athlete monitoring hardware can be in the form of a wristband, chest strap, ring, biometric clothing, pulse oximeter, and various other hardware devices. These forms can use technologies such as global positioning systems (GPS), heart rate monitors (HRM), electromyogram (EMG), accelerometers, force plates, and sleep monitors.

GPS technology has developed significantly and does provide good macro data for global external workload. However, it is still limited in picking up the very small movements that we see on the tennis courts.



*Chest strap HRMs* are more reliable than wristband HRMs, and heart rate metrics provide a very valuable internal physiological load metric that is very valuable for many tennis players from both a performance perspective, but also to monitor calorie expenditure in traditional tennis but also “cardiotennis.” There are also arm and calf band HRMs in development but the reliability and validity of these are unknown and more opportunities are coming on the market over the next few years.

Suggestion: A cautionary warning was provided by all experts in regard to inconsistent validity and reliability of the wrist worn heart rate monitors. It is recommended that chest strap heart rate monitoring is the preferred and more accurate way to measure heart rate for tennis players.

*Biometric clothing* can be used to capture three dimensional movements using accelerometers, as well as other metrics like heart rate, breathing rate, and EMG. This is an exciting area that is more advanced in other sports with less movement variables (i.e. baseball swing and pitch, golf swing, etc). However, the technology is rapidly improving and is valuable in many respects that can help tennis coaches and athletes at all levels of the game.

*Force plate* technology has developed from large platforms to small plates that can be embedded in shoes. Traditional research based force plates have been used for over 40 years in lab settings. They have seen a resurgence over the past five years and are now used in many training facilities around the world to help evaluate ground reaction forces, asymmetries in power production and various other metrics. Traditional force plates are expensive and are somewhat limited in planes of motion and data provided. Due to the high cost and limited scope, many facilities that work exclusively with tennis may find it difficult to justify the cost. Some new technologies that are promising are focused around shoe inserts that can now measure force and pressure and can be useful in asymmetrical sports like tennis, but more fine-tuning is still needed with these products.

*Accelerometers and 3D Gyroscopes* embedded with weight training equipment can be used to measure repetitions, velocity, and power output. The implications of fully validated and reliable iterations of this hardware could be useful from a coaching

perspective at all levels, as well as biomechanics research and fan/athlete engagement. These technologies are practical, relatively low cost and very applicable to the needs of tennis players.

*Sleep* monitoring technology can come in the form of a chest strap, biometric clothing, ring, smartphone, or wristband. Some products measure variables like heart rate, breathing rate, and body motion. These devices should be validated against sleep laboratory polysomnography for use at the professional level. Sleep monitoring is a very important way of monitoring individuals (athletes and non-athletes) recovery during off hours.

## **5) Athlete Monitoring Software**

Integration of many types of data is key for athlete monitoring software. It must include objective and subjective data from tennis players and their teams. It should be able to integrate objective data from athlete monitoring software, video analysis software (technique and strategy) and other aspects related to on-court and off-court training. If a program can accomplish all of this, it can drive revenue at the club level, and increase performance and reduce the likelihood of injury at the competitive level and professional level. The largest challenge today with athlete monitoring software is the complexity for the user and coach. This is the next evolution. Also, with all the new hardware options and monitoring tools available, the athlete monitoring software companies that will survive and prosper will be open-sourced and allow for easy interaction with various technologies that monitors athletes in real-time and speaks directly to the software. This removes the human interaction and saves considerable time. This is the major need for athlete monitoring software to be successful in the medium and long-term.

Suggestion: The use of athlete monitoring software can be valuable and helpful for tennis players. The scope and complexity changes with the level of athlete and the number of individuals that are coaching and training the athlete. However, it is recommended that some form of athlete management system is incorporated with athletes to help speed improvement and monitor progress.

## 6) Athlete Recovery Hardware

Recovery techniques and technologies is a major requirement for tennis players at all levels of the game. Keeping athletes healthy should be a bigger goal of all tennis coaches, trainers, facility owners and other individuals in the tennis industry. A healthy tennis player will play more, spend more dollars competing, travelling, training and especially on equipment. However, one aspect that came through from the Summit was the lack of emphasis on tennis-specific recovery across many aspects of the tennis industry. This is a large opportunity and will help the overall greater tennis market if done correctly. Many techniques and technologies exist, but a warning was sent to the consumer that many do not have quality research highlighting real benefits. Below are some of the most commonly utilized.

*Electrical muscle stimulation (EMS), compression, hyperbaric technology, cooling techniques, heating techniques, transcutaneous electrical nerve stimulation (TENS), and vibration* are some of the major technologies used in athlete recovery at all levels. Many products involve a combination of these modalities. Compression and cooling are a particularly common combination.

TENS usually comes in a small battery powered pack with two to four surface electrodes that provide stimulation to nerves and cause muscle contractions. This can decrease pain signaling to the brain and increase blood flow locally. While TENS can reduce the pain associated with delayed onset muscle soreness (DOMS), it has not been shown to affect the recovery of muscle strength.

*Compression* can come in many forms, including light to middle intensity sleeves worn around various body parts. For example, the arm sleeves are used as a treatment for medial or lateral epicondylitis (golfer's or tennis elbow). Mid-compression activewear has been seen in a near full body implementation at professional tournaments to help with overall recovery. Light compression sleepwear is also on the market. Compression socks and leggings are a well-accepted form of increasing blood flow during plane travel when motion is restricted.

*Cooling* recovery technology circulates ice water or coolant circulated through a sleeve that is wrapped around an extremity. This technology is commonly combined with compression using pockets of air filled by a small air compressor. Cooling techniques vary in value for tennis athletes. As an analgesic (mild pain reliver), cooling has strong evidence. However, for specific recovery purposes, cooling may impede inflammation in the short term, but this may be counterproductive for longer term recovery. Active recovery modalities are based on the opposite physiological premise and has been shown to provide better benefits for general recovery in most instances.

*Active Recovery* is still one of the most researched and most beneficial ways for an athlete to recover. This could be as simple as riding a bike for 15 minutes after tennis play at a low speed. This increases blood flow to the working muscles. Technology has allowed for this active recovery to be performed in different ways. *Electrical Muscle Stimulators (EMS)* are a class of technologies that provide an easy and portable method to accomplish this. These technologies can be used when sitting, driving or flying and can be used for multiple hours if using a technology that provides a non-fatiguing wave form.

*Vibration* technology can be found in the form of a vibrating plate for whole body vibration, or a ball or gun type instruments for more targeted local vibration. Vibration therapy has been found to help maintain range of motion post exercise and perceived pain from DOMS.

Medical devices (requiring the administration by a medical doctor or an approved healthcare provider) is a class of technologies that was not discussed at this Summit.

There is a lot of recovery hardware on the market. Research supporting the different types varies greatly. One aspect that was discussed at the Summit was the impact of the Placebo effect. Every athlete has a difference response and when using multiple technologies, it is important to also get the subjective feeling from the tennis player as well.

## Discussion

Many technologies in the tennis industry come to market without a lot of high-quality research, and many companies struggle to find a market strategy. There was agreement that the first generation of racquet sensors were pushed to market too quickly. These products' initial inability to differentiate between some strokes showed that there was not enough reliability and validity testing for even the beginner tennis consumer to use them for improved performance. Due to the large variety in tennis stroke mechanics, a calibration period is probably necessary for any racquet sensor technology. While they have developed to be more reliable, some professionals feel that the skepticism created by the first generation may be hard for the next generations to overcome without a large marketing campaign. However, the newest generation of sensors are vastly improved and have significant value when used appropriately. This technology is improving greatly and should be around for a long time providing very valuable information.

The professionals at the summit agreed that ***SIMPLICITY*** was the most important factor for a technology to be adopted by tennis coaches at any level. It would be advisable for any technology to have the ability to turn quantitative data into actionable information that can be easily combined with qualitative data, as tennis coaches tend to be more visually oriented. Any technology needs to make a coach or player's life easier – only then will they adopt it into their training routine. At the same time, the tech needs to give useful quantitative data to a more tech minded individuals in the tennis industry.

**In conclusion, the future is bright for Technology and Analytics in tennis. The International Tennis Performance Association thanks all the experts and attendees at the Tennis Technology and Analytics Summit for sharing their expertise and experiences which has helped to move the tennis industry forward. It requires forward thinking individuals with a passion for excellence to help us all achieve high performance results.**

*Please reach out to us at the International Tennis Performance Association if you have an interest in Tennis Technology and Analytics [www.itpa-tennis.org](http://www.itpa-tennis.org)*