

Tennis Court Surface Analysis

By
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Introduction

All four grand slams (Wimbledon, Australian Open, US Open and the French Open) used to played on a grass court surface. The Championships, Wimbledon, commonly known simply as Wimbledon, or The Championships, is the oldest tennis tournament in the world. It has been held at the All England Club in Wimbledon, London, since 1877 and is played on outdoor grass courts, and since 2009 with a retractable roof over Centre Court. Wimbledon is the only major still played on grass. The United States Open Tennis Championships is a hard court tennis tournament. The tournament is the modern version of one of the oldest tennis championships in the world, the U.S. National Championship, for which men's singles and men's doubles were first played in 1881. The US Open was played on grass (1881–1974), Clay (1975–1977) and on a Hard court surface of DecoTurf since 1978. The United States Tennis Association had installed a retractable roof on the Arthur Ashe Stadium in 2016. After the success of the retractable roof on the Arthur Ashe Stadium, the association re-constructed the Louis Armstrong Stadium in 2018 with a retractable roof. The French Open officially Roland-Garros began in 1891. The French Open was played on grass (1891–1907) and then moved to clay (1908–present). A retractable roof at the French Open is planned for 2020. First held in 1905 as the Australasian championships, the Australian Open has grown to become the largest annual sporting event in the Southern Hemisphere. Prior to 1988 it was played on grass courts at Kooyong, but since then two types of hardcourt surfaces have been used at a new venue of Melbourne Park – green coloured Rebound Ace up to 2007 and, afterwards, blue Plexicushion. It was also the first Grand Slam tournament to feature indoor play during wet weather or extreme heat with its eventually three primary courts, the Rod Laver Arena (1988), Melbourne Arena (2000) and the refurbished Margaret Court Arena (2015) equipped with retractable roofs. All four grand slams are played as outdoor events, but in the event of rain or the heat rule (such as in the Australian Open) a retractable roof may be used to continue play.

A carpet court is a type of tennis court. The International Tennis Federation defines carpet courts as a "textile surface of woven or non-woven nylon, or a polymeric or rubber material, typically supplied in rolls or sheets" and as a removable surface. It is one of the fastest court types second only to grass courts. The use of carpet courts in Association of Tennis Professionals (ATP) competitions ended in 2009, purportedly in order to reduce injuries. Only one Women's Tennis Association (WTA) tournament, the Tournoi de Québec in Canada used to be played on carpet courts in recent years in 2015, however that too ceased to exist after 2016. However, carpet is still being played on Challenger events since 1998 and Future/Satellites events on the men's tour since 2004 and ITF events on the women's tour since 2002.

Hard courts are made of uniform rigid material, often covered with an acrylic surface layer to offer greater consistency of bounce than other outdoor surfaces. Hard courts can vary in

speed, though they are faster than clay but not as fast as grass courts. The quantity of sand added to the paint can greatly affect the rate at which the ball slows down. The US Open is played on DecoTurf while the Australian Open is played on Plexicushion, both acrylic-topped hard court surfaces. Historically for the Grand Slams, hard courts have been used at the Australian Open since 1988 and the US Open since 1978. Acrylic surfaces (not consisting of DecoTurf or Plexicushion) were used in Challenger events on the men's tour only in 2010.

Some tennis courts are indoor, which allows to play regardless of weather conditions and is more comfortable for spectators. Because of the lack of wind, gameplay is considerably different versus outdoor courts. Any court surface may be used indoors. Hard courts are most common indoors, as they are made with the most versatile materials and surface finishes. Clay courts are installed indoors with underground watering systems, and used mostly for Davis Cup matches. The conclusion of the Wimbledon Championships, in 2012, was played on the lawn of Centre Court under the closed roof and artificial lights due to rain. The Halle Open has also seen a number of matches played on its grass court in the Gerry Weber Stadion with the roof closed. Carpet surfaces have been used both on the ATP World Tour and World Championship Tennis circuit, though no events currently use them. Historically, other surfaces have been used indoors such as hardwood at the defunct World Covered Court Championships and London Indoor Professional Championships. Currently, the ATP World Tour Finals event is the most important indoor tennis tournament.

Given that tennis is focused around the four grand slam events, should all surfaces in men's and women's tennis both on the Main Tour and Challenger/Future/Satellite events on the men's tour and ITF events on the women's tour consist of the four current grand slam surfaces of grass, DecoTurf, Plexicushion and clay? In particular, is it necessary to be using a carpet surface on Challenger/Future/Satellite events on the men's tour and ITF events on the women's tour given that carpet could be replaced by DecoTurf or Plexicushion (as present in the US Open and the Australian Open)?

Court Speed

The author wrote an article 'A Rarity in Tennis', where by analysing predictions in men's tennis in 2011, a rather unusual scenario occurred where Roger Federer was the favourite against Novak Djokovic and Rafael Nadal on a grass court surface, Djokovic was the favourite against Federer and Nadal on a hard court surface and Nadal was the favourite against Federer and Djokovic on a clay court surface. This is reflected by their number of grand slam wins as represented in table 1. Federer has won the most number of Wimbledon titles of all time (8 in total) play on a grass, Nadal has won the most number of French Open titles of all time (12 in total) played on a clay surface and Djokovic has won the most number of Australian Open titles of all time (7 in total) played on hard court. Therefore, having the four surfaces in grand slams is important to tennis to establish player fairness.

	Federer	Djokovic	Nadal
Wimbledon	8	5	2
US Open	5	3	4
Australian Open	6	7	1
French Open	1	1	12
	20	16	19

Table 1: The number of each grand slams won by Federer, Djokovic and Nadal from the end of 2019

The physics of the court surface is defined by when the ball interacts with the court surface for a split second that affects court speed. The factors that affect court speed as outlined in 'The Physics and Technology of Tennis' by Howard Brody, Rod Cross and Crawford Lindsey are the coefficients of friction and restitution, the angle of incidence and the spin of the incident ball. Wimbledon is played on grass, the US Open is played on court hard (known as DecoTurf), the Australian Open on hard court (known as Plexicushion – although from 1988 to 2008 was played on a Rebound Ace hard court surface) and the French Open is played on clay. The main factor that distinguishes between different grand slams is the court surface. It is documented in Furlong (1995) that Wimbledon on grass is a fast surface and the French Open on clay is a slow surface. It may be that the speed of the court has an influence on various match statistics, in particular the percentage of points won on serve, since a fast surface would make it more difficult for a player to return serve. Table 1 represents the percentage of points won on serve for the four grand slams from 2000-2005, along with the averages for each grand slam. There is clear evidence that men are winning a higher percentage of points on serve compared to women. There is some indication that the speed of the surface at the Australian Open was faster in the year 2000 compared to the following years. Overall there is some indication that on average the US Open is faster than the Australian Open. The statistics are even more significant on the winning percentage on the 1st serve as indicted on p111 'Mathematical Modelling in Hierarchical Games with Specific Reference to Tennis'. A synthetic surface such as DecoTurf or Plexicusion can be adjusted in terms in terms of court speed with an understanding by the author that the speed of the surface must be within a certain range and cannot be a faster surface than grass or a slower surface than clay. There is also a fundamental ordering of courts (grass, hard court, clay), such that if a player performs best on a particular surface, then their next best surface will be in terms of court speed. For example, if a player performs best on grass or clay, then their next best performance is expected to be on hard court (a fast hard court if their best performance is on grass and a slow hard court if their best performance is on clay). If a player performs best on hard court, then their next best surface could be either on grass or clay. This is explained in more detail from p107 'Mathematical Modelling in Hierarchical Games with Specific Reference to Tennis'. The author's understanding is that the speed of the surface for the US Open on DecoTurf is adjusted by the United States Tennis Association (USTA) and the speed of the surface for the Australian Open on Plexicushion is adjusted by Tennis Australia (TA). Hence the USTA and TA could adjust the speed of the surface to best suit their players from the US and Australia that are best suited to a particular court speed. Hence a fairer process of adjusting the court speed should be from the three governing bodies of tennis, namely the ATP, WTA and the ITF. Ideally you want consistency from year-to-year in the court speed at either the Australian Open or US Open and one of these grand slam hard court events should be consistently faster. From table 1, there is evidence to suggest that the Australian Open has been playing faster than the

US Open since the Australian Open moved to Plexicushion in 2008, which was not the case in the years 2001-2004 from table 2. An analysis of the percentage of points won on serve at both the US Open and Australian Open from the years 2008 would provide further validity for the speed of these two grand slam events.

Tournament	Year	Men (%)	Women (%)
French Open	2001	60.1	54.1
	2002	60.4	
	2003	60.1	53.4
	2004	59.4	53.0
	Average	60.0	53.5
Australian Open	2000	63.8	57.0
	2001	61.9	54.9
	2002	61.7	54.4
	2003	61.7	54.9
	2004	63.0	55.3
	2005	62.2	54.8
	Average	62.4	55.2
US Open	2002	62.6	55.9
	2003	63.6	56.1
	2004	62.1	56.2
	Average	62.8	56.1
Wimbledon	2001	64.5	57.1
	2002	63.8	57.0
	2003	64.4	58.0
	2004	65.6	57.2
	Average	64.6	57.3

Table 2: Percentage of points won on serve for grand slams from 2000-2005

Indoor surfaces

Any court surface may be used indoors. Hard courts are most common indoors, as they are made with the most versatile materials and surface finishes. Carpet is regarded as one of the fastest surfaces only second to grass and was discontinued on the main tour for men after 2009 and on the main tour for women 2015-2016. Carpet was often played on an indoor surface, at least being the case for the year ending ATP Finals for men 2005-2007.

Table 3 represents the percentage of tournaments wins for Nadal, Federer and Djokovic across the different surfaces as of 9/10/2019 as given by OnCourt software.

<http://oncourt.info/>

Surface	Nadal	Federer	Djokovic
All matches	1035/1257=82.3%	1284/1573=81.6%	1013/1229=82.4%
Clay	468/517=90.5%	228/302=75.5%	276/340=81.2%
Hard	414/521=79.5%	569/688=82.7%	470/549=85.6%
Indoor Hard	66/98=67.3%	216/259=83.4%	148/191=77.5%
Carpet	16/30=53.3%	79/104=76.0%	20/31=64.5%
Grass	71/91=78.0%	192/220=87.3%	99/118=83.9%

Table 3: The percentage of tournaments wins for Nadal, Federer and Djokovic across the different surfaces as of 9/10/2019

As explained above, there is a natural ordering in a player's performance based on the court speed - grass being the fastest surface, followed by carpet, hard/indoor hard and the slowest surface being clay. Clearly Nadal plays best on clay (winning 12 French Opens) and hence from table 3, 90.5% of match wins overall on clay. Nadal has won 78.0% of matches on grass (including 2 Wimbledon titles). Therefore, the match wins on the other surfaces hard, indoor hard and carpet should be between 78.0% and 90.5%. But yet carpet is proportionally very low at 53.3% of match wins and indoor hard at 67.3% of match wins. Given that a proportion of matches on carpet are played indoors it appears that Nadal struggles on indoor surfaces (explanatory variable independent of court speed). All four grand slams are played as outdoor events, but in the event of rain or the heat rule (such as in the Australian Open) a retractable roof may be used to continue play. Based on the evidence that Nadal struggles on indoor surfaces, suggests that Nadal could be disadvantaged at grand slams events when a retractable roof is used. The ATP Finals is the second highest tier of annual men's tennis tournament after the four Grand Slam tournaments and is played on an indoor hard court surface. Federer has won a record of 6 titles, Djokovic with 5 titles and Nadal has won 0 titles. This is further indication that Nadal struggles on indoor surfaces. Also, given that all three surfaces of hard court, grass and clay are equally important to the game of tennis (given that Djokovic performs best on hard court, Federer performs best on grass and Nadal performs best on clay), suggests that a rotation process of these three surfaces for fairness should be used at the ATP Finals. Hence, Federer and Nadal are both disadvantaged at the ATP Finals, and indicates further why Nadal has been unable to win any titles (given that he performs best on clay with a record 12 French Open titles).

References

The Mathematics of Tennis

<http://strategicgames.com.au/book.pdf>

The Physics and Technology of Tennis

<https://www.amazon.com/Physics-Technology-Tennis-Howard-Brody/dp/0972275908>

Mathematical Modelling in Hierarchical Games with Specific Reference to Tennis

<http://strategicgames.com.au/PhD.pdf>

J.D.G. Furlong, The service in lawn tennis: how important is it?, In Science and Racket Sports, T. Reilly, M. Hughes and A. Lees eds. (1995), London: E&FN Spon, 266–271.

A Rarity in Tennis

<http://strategicgames.com.au/article98.pdf>