ERSA Professional Stringer and Master Professional Stringer Study Guide

In 2016 ERSA has replaced the old tests (CS & MRT) and added relevant questions in comparison to the original stringer certification programs initiated in 1986. The tests had not been updated for 30 years so we decided to make our own, better certification system. We had been discussing this for several years with the USRSA but they were adamant about retaining the original tests and we were not allowed to update anything on the test. The ERSA added the Pro Tour Stringer Certification 13 years ago and this has become the industry standard. There will also be a MPS Level 2 for Shop Owners, Shop Managers and Shop Stringers dealing daily in the retail environment. This will include racquet and string technologies, racquet tuning, management, marketing, sales, online shops, accounting, inventories and Social Media.

In addition to tennis ERSA is also teaching and certifying stringers in both badminton and squash.

ERSA and the racquet sports industry will support our education program, competence and expertise by actively encouraging players to seek out ERSA Professional Stringers and ERSA Master Professional Stringers for racquet sales and service.

Racquet technicians who pass all portions of the certification exam will receive a "ERSA Master Professional Stringer" certificate. It is the intention of ERSA that this certificate be considered by:

Consumers, when selecting a racquet technician

Employers, when hiring a new racquet technician

Certification by ERSA (whether as a ERSA Master Professional Stringer, or as a ERSA Professional Stringer) involves a comprehensive written test and a detailed practical test. Both measure your understanding and skills with respect to all facets of racquet service — installing grommets and string, re-gripping, and handle sizing. Additionally, to attain MPS status, you'll be required to demonstrate understanding and customization of weight and balance as well as current frame and string technologies and how those technologies translate to player satisfaction.

ERSA Certification Programs will:

Set a standard of excellence in racquet service and product knowledge

Encourage and promote professionalism in the racquet sports industry

Instill consumer confidence in racquet stringers and technicians

Expand the availability of expert racquet stringers and technicians

Endorse the competence of qualified racquet stringers and technicians

The primary source of material for certification is the Pro Stringer Techniques Guide in the Stringers Digest, which is provided as a benefit of ERSA membership. The information in this Study Guide is best understood in conjunction with the information presented in the Pro Stringer Techniques Guide.

Requirements

MPS status will be good for one full year from testing date. Maintaining MPS status will require passing an annual written test designed to demonstrate understanding of the year's significant new technologies. This test will be open book, and will be administered through the mail.

ERSA Professional Stringer status will carry no expiration date.

Applicants will take a two-part test: a written test (multiple choice and short answer), and a hands-on racquet service test. Applicant is allowed to use a Stringer's Digest or manufacturer's instructions during the stringing section only.

Applicant will supply a strung racquet with traditional grommets. If you have any question about whether your frame will be acceptable, please call the ERSA office in advance for approval. Racquet must be less than three years old and in good condition. The applicant will also supply a new replacement bumper and grommet system for this racquet.

Applicants will cut strings and remove bumper/grommets from a racquet. Applicants will then install new bumper/grommets and string the frame under the observation of the appointed ERSA tester.

Professional machines will be supplied at each test site. Applicants may bring a machine of their choice with ERSA approval. If you have any questions or problems regarding machine use, contact the ERSA. Basic tools and accessories will be available at the test site; however, applicants are encouraged to bring their own tools.

Applicants will string a racquet, installing a monofilament string in the mains and natural gut in the crosses. Applicants will be given 6 metres of monofilament string and 6 metres of natural gut and should be sure to bring a frame that accommodates these string lengths. The frame must also accommodate two lengths of string (with 4 tie-off holes).

All applicants will increase the handle size of their racquet by 1 full size using a provided heat-shrink sleeve. A heat gun will also be provided for shrinking the sleeve. Applicants must also apply a synthetic replacement grip to a racquet. Grips provided will include a self-adhesive backing, eliminating the need for two-sided tape. Staple guns are provided for securing the grip to the butt cap. This is a required procedure for the test.

Grading

Applicants must: Score 80% or higher on the written portion including the racquet evaluation section, achieve a score of 80 on the string/grommet removal and grommet replacement section, as well as on the stringing section and execute building up and gripping a handle without any errors. In addition, the stringing score sheet contains criteria which must be met to achieve a passing score, regardless of the point total. These include: alternating tensioning of mains (no more than 3 strings ahead on one side), pulling one string at a time, avoiding notching of mains during weaving, installing pattern specified by manufacturer, avoiding crossovers at the head, avoiding any mis-weaves in string face, turning in a frame without cracks or broken/cracked/unseated grommets, completing the bumper/grommet removal and replacement within 20 minutes, completing the string job within the allotted time, and completing the handle sizing/grip replacement within 20 minutes.

The hands-on portion will be evaluated by the tester and racquets will then be returned to the applicants.

The ERSA Office will score the written and racquet evaluation portions and evaluate the tester's scores on the hands-on score sheet.

Applicants will receive test results within four weeks of the test date.

Applicants must pass all portions to become a ERSA Master Professional Stringer or ERSA Professional Stringer.

Applicant must complete written test within 90 minutes (1.5 hours).

Applicant must complete bumper/grommet removal and replacement within 20 minutes.

Applicant must complete stringing portion within 60 minutes for ERSA Professional Stringer and 40

minutes for ERSA Master Professional Stringer.

Applicant must complete handle sizing/grip replacement within 20 minutes.

Hands-on procedure

Applicant understands the proper use of a balance board and placement of lead tape.

Locates the balance point of an un-strung tennis racquet.

Translates racquet balance to millimetres head heavy or head light.

Identifies where to place lead tape to meet certain objectives (MPS).

Correctly identifies all racquet service errors in a strung racquet.

Applicant displays proper string cutting & bumper/grommet replacement techniques.

Removes string and grommets using proper technique without scratching or marring frame.

Inspects and prepares frame for new bumper/grommet installation.

Installs bumper/grommet properly without scratching frame or damaging grommets. Must complete bumper/grommet removal and replacement within 20 minutes. Applicant displays proper stringing techniques.

Inspects unstrung frame.
Mounts frame in machine to prevent any marring, distortion or frame damage.
Inspects string and pre-stretches natural gut properly.
Installs string according to frame manufacturer's specifications in accordance with ERSA guidelines. Ensures string clamps are adjusted to avoid slippage and/or crushing string.
Maintains integrity of string and frame throughout stringing process.
Produces top quality string job within 20-40 minutes for maximum point value. Must complete string job within 60 minutes for ERSA PS and 40 minutes for ERSA MPS.
Applicant displays proper handle sizing and gripping techniques.

Cleans and prepares handle surface.
Properly applies build-up sleeve (with butt cap left in place). Aligns build-up sleeve within 3 mm. of the butt end (butt cap is built up).
Trims any excess build-up material and ensures bevels are maintained.
Properly staples grip to butt to prevent slippage (required).
Aligns grip end with butt edge (no more than 2mm space).
Completely covers build-up sleeve with replacement grip.
Wraps grip for right-hander with appropriate overlap (no more than 2mm).
Properly trims and secures grip end neatly with finishing tape.
Must complete handle sizing/grip replacement within 20 minutes.

Customer Service

Racquet Selection

(ERSA Master Professional -Stringer applicants only)

No one racquet is for everybody. In determining the needs and wants of a player, you'll need to gather as much information as possible. Whether fitting a tennis, squash or badminton racquet, there are key questions you'll want to ask your customer to ensure he is satisfied and happy

about the racquet you've sold him. Among the questions you'll want to ask are, why do you want to change racquets? Which racquet do you currently use? What do you like and dislike about it? Do you prefer a midsize or oversize racquet? How much would you like to spend? You'll also want to know how many times per week he plays, his playing level and playing type, whether he has any arm or shoulder injury problems, if he's looking for more power or control, if he has loyalty to one particular brand and which court surface (tennis) he plays on. Next -DEMO- DEMO-DEMO!!!!!! After you've narrowed the choices to a few racquets, have the customer take out a demo for a few days. Maximum of two different racquets so he can compare their performance and feel. Be sure these demos have good strings and grips.

String Selection

When selecting strings you need the same amount of time and questions to find the right string and tension. The racquet sale earns you a one-time profit, whereas stringing profits are regular and more frequent. Take the time needed to fit your customer with the right string and the right tension. Whether you're stringing a newly sold racquet or someone's favorite, the right string and tension will determine how that racquet plays. Make a list of questions you need to ask and for your other employees so all the customers are correctly serviced.

Many of the same questions asked to select a racquet will help fit the player with the right string and tension. We hear "Same String, Same Tension" all the time. Get your regular customers to try new strings. Let them know about the new strings in your inventory. Keeping accurate records will assist in determining whether a player is restringing often enough. It can also provide information on tensions, grommet replacement, grip replacement and any special needs.

You can service a player with a sore arm by: lowering tension, using a "softer" or multifilament string or natural gut, using a thinner string, checking and possibly altering grip size, adding a softer grip, possibly adding weight to the frame (to dissipate shock) and finally, encourage them to restring frequently enough. Many players pride themselves on not restringing for a year or more, believing the only time to restring is when a string breaks! Inform your customers about strings losing their resilience, requiring them to do more work with their arm. Most are only aware of strings losing tension over time (which can lead to a loss of control), but explaining the loss of performance will provide further incentive for a player to restring.

String Technology

The term "synthetic gut" no longer carries much meaning. It does not mean that a string has a specific construction or playability characteristics like natural gut. It simply means the string is made

of synthetic fibers. Most synthetic strings are constructed of nylon in a variety of ways to modify playability and durability. Some claim to duplicate natural gut's resilience (providing maximum power and feel) at a fraction of the cost. Synthetic strings tend to be easier to install than natural gut. When stringing with natural gut, it's important to avoid kinking the string as this could cause premature breakage. Elasticity refers to a strings ability to return to its original shape and condition after ball contact. Typically, elasticity will govern a string's ability to return energy to the ball. Elongation is the measure of a string's elasticity and is closely related to the power potential of a string. It also is a measure of a string's ability to absorb incoming ball shock during impact. All things being equal, the greater a string's elongation, the greater its ability to absorb incoming ball shock. Elongation can be used to compare strings of different materials, gauges and constructions. But, when comparing the elongation of different strings, make sure they are both pulled at the same tension. Generally, multifilament strings with no center core have the greatest elongation of nylon strings. As a result of this characteristic, some multifilament strings lose tension faster than center core constructed strings. Pre-stretching can reduce short-term tension loss and some manufacturers recommend pre-stretching for this reason. It also helps reduce the string's tendency to re-coil during the stringing process, making handling easier.

Dynamic resilience of a stringbed will determine how well it can deform (absorb energy), return upon ball impact and provide the greatest energy return. The more dynamically resilient the string (or string plane), the greater the deformation and therefore the greater the energy return. Over a period of time and play, string tends to lose the ability to conform to its original shape, gradually imparting a different feel to the racquet and ultimately playing "dead."

Tensile strength is the force required to break the string during a straight pull. Generally, strings with higher tensile strength will have a higher breaking point. One of the biggest challenges for a racquet technician is dealing with string wear and string breakage. Chronic string breakers have increased in numbers since the introduction of wide body or stiffer racquets, larger racquet heads, spin string patterns. wide body or stiffer racquets tend to be stiffer than standard width frames. As a result when balls hit the strings very close to the frame, they can cause shearing or overload breakage. Although this type of string breakage near the frame can also be caused by worn or cracked grommets. Open string patterns also allow more string movement and cause frictional notching — the main reason for string breakage among tennis players who hit with spin.

Keep this information in mind when recommending a racquet for excessive top-spinners. While they'll love the extra bite on the ball that an open pattern allows, they'll blame you for breaking strings every week! There are a few ways to cure the chronic string breakage. First, a thicker version of their string (if available) will offer similar playing characteristics but with slightly less feel. String savers are another way of reducing the friction or sawing action of the mains against the crosses and can be used with their string of choice (Roger Federer uses them). Next, try using durability oriented synthetic strings. Finally, various hybrids (two different types or gauges of string in the same racquet) can be used to extend string life while still keeping costs reasonable.

Some players may ask you to tell them how much longer their strings will last with different string or hybrids. Keeping accurate records is a great way to address this situation. However, simply inspecting the strings for notching and a “wear pattern” may provide you with the knowledge you need to approximate whether the strings will last through the next match or the next month.

With the advent of stiffer racquets, a problem has developed; shear breakage or shearing of string near the frame. As frame cross-sections increased, so did frame stiffness, along with stiffer materials, requiring the strings to accept more load during ball impact. Consequently, racquet sports players are sometimes paying the price of off-center hits by having to restring more often. Using a thicker gauge or a multifilament string can help. Remember that increasing string thickness by one gauge can add 5 or more grams to overall racquet weight. A typical coil of 16-gauge nylon string weighs 15-20 grams. If a customer is chronically breaking strings in the upper hoop near the frame, be sure to check the grommets for telltale wear or cracks. However, if the grommet barrels and bumper are in good condition, you might want to tube the center 6-8 mains at the head and/or consider a different string for your customer.

Frame Technology

(MPS applicants only)

A variety of methods are used to manipulate stiffness, weight, balance and swingweight. Pre-wide-body frames relied solely on material placement in determining the stiffness of a frame. Some frames were stiffer in the shoulders, some stiffer at the tip as a result of placing higher modulus graphite in these areas. Manufacturers can adjust beam height or cross- section to make a frame stiffer or more flexible. Materials aside, increasing the cross section of a frame during production is the most effective way to increase stiffness. Increasing stiffness will increase frame shock and frame vibration. Frame shock is the force felt at the moment of impact. Frame vibration is the lasting movement or noise after the ball has left the strings. The most effective way to reduce shock is to add weight to a frame.

Weight, balance and swingweight have moved to the forefront in frame design as manufacturers seek ways to improve performance. Most conventionally weighted tennis frames feature added weight at the butt end, ranging from 30 to 60 grams. This helps counter the predominance of weight in the hoop area resulting in a head-light balance. Conversely, most lightweight, head-heavy frames remove weight from the butt end to reduce overall weight, while retaining a similar swing weight of a conventionally weighted and balanced frame. To increase a racquet’s torsional stability (resistance to twisting), a manufacturer or a technician can increase grip size, add weight to 3 and 9 o’clock positions, make the hitting surface of the racquet head wider, or apply a high-friction grip.

Longer racquets can offer players a variety of benefits, including more reach, more power, more spin and reduced torque. Each additional inch increases power by 10%, all other things being equal. Longer racquets also generate more racquet head velocity, thus creating the potential for more spin. A racquet that is one inch longer can increase a player's court coverage by about 5%, while a two-inch longer racquet can increase court coverage by about 13%. Contrary to intuition, longer racquets can actually reduce the amount of torque, or twisting, experienced by off-center hits.

Not all players will benefit from longer racquets, so extensive play testing is recommended. Be sure each player who play-tests a long racquet uses it in a match situation, hitting a variety of different shots.

Basics of Technology

Factors that Determine Stringbed Stiffness

When you talk tension with customers, you're actually talking stringbed stiffness. But tension is just one piece of the puzzle that determines how a stringbed feels to a player. A player normally feels one of three distinct stringbed sensations: loose (springy or lively); tight (hard, jarring, stiff); or dead (elongated, mushy, or "bagged out"). Many separate factors cumulatively determine overall stringbed stiffness and therefore the player's perception of power, feel, and control.

Head Size/String Length

While most stringers are aware that head size variations affect stringbed stiffness, most players aren't as savvy. If a customer changes from a midsize to an oversize frame and asks for the same tension, how should you respond? Most manufacturers do take head size differences into account when determining tension ranges. String length is a major factor. Longer strings must be strung at a higher tension to achieve the same stringbed stiffness as with shorter strings. According to Dr. Howard Brody, to change from one frame size to another (while retaining similar playing characteristics from the strings), the tension-divided-by-string-length ratio must be similar. (Sixty pounds of pull [machine] tension on an oversize frame's main string will produce a lower actual tension than the same 60 pound pull tension on a midsize frame's main string.) So when that customer who's just changed from a midsize to oversize frame says, "String it at 60 pounds, like before," you can explain why he might want to increase tension by a few pounds. Why then are shorter cross strings looser than longer main strings? Other factors come into play here, mainly the friction of the crosses being pulled through the mains. It's not uncommon for a racquet to have main strings with 55 pounds of tension and crosses with 40 pounds. Matching main and cross string tensions would require increasing tension on the crosses to the point of deforming and probably damaging the frame. Also, the resulting stringbed stiffness would certainly be too high for most players. So, when that same customer shows up with a Stringmeter demanding to know why the crosses are so much looser than the mains, you can confidently explain why.

Pattern Density and Staggered Strings

Many frame makers have been redesigning string patterns on new racquets to meet specific objectives. Some increase string density in wide bodies to help maximize string life. Many also assert that a denser string pattern increases control for certain types of players. Or designers may increase string spacing to offer players more spin potential. Generally speaking, a more open string pattern yields lower stringbed stiffness than a dense pattern. Whether either one provides more control depends on style of play (for tennis players). Spin players may claim increased control on an open pattern because the strings can embed deeper into the ball, whereas a flat hitter finds more control with a dense pattern due to the increased stringbed stiffness. Players using open string patterns should be prepared to restring more often though. The increased string movement can cause notching and premature breakage. Denser patterns have become more popular in wide bodies to help increase string durability. In badminton, dense patterns allow stringing at very low tensions, while maintaining a reasonable stringbed stiffness. When stringing badminton frames, it's best to use the smaller badminton clamps to accommodate these denser patterns and not damage the string.

Several manufacturers have introduced models that feature staggered string patterns in the past and some are still found on squash and racquetball frames. Offered under a variety of names, each of these string systems is slightly different from the next, but all are similar in concept. Each string enters the frame on a different level, or plane, than the previous string. Due to the increased angle of each string entering the stringbed, string vibration is reduced. Also, overall stringbed stiffness is increased when tensioned the same as a conventional string pattern. Consequently, recommended tensions for staggered string racquets are typically lower compared than conventionally strung racquets. Another effect of these string systems is that cross strings alternate between "easy" and "hard" weaves that result in decreased tension on every other cross string. When stringing staggered string racquets, it's important to lock in the top cross with a "hard" weave. Otherwise, the outer mains and crosses will be floating, causing excessive vibration and not achieving their desired effect.

String Gauge

When you string two identical racquets with different gauge of the same strings and perform the palm test with the strung racquets; the thinner gauge will have a higher "ping." Most people would logically assume the thinner string is tighter. Even though little difference is found when measured statically (i.e., RA Test), the racquet with thinner gauge may feel less stiff in play, due to the greater elasticity of the thinner string. Generally, a 17 gauge string will be about twice as elastic (100%) as a 15 gauge string, all other factors being equal. This increased elasticity results in lower dynamic stiffness (meaning the strings will feel more elastic) during ball contact. A player changing to a thicker string (for greater durability, for example) may complain that the "ping" isn't the same as with his thinner gauge string. However, increasing tension to reproduce that harmonic pitch would probably result in a stringbed stiffness too hard for his liking. So string for feel, not for the "ping."

Below are the gauge standardization specifications. The ERSA recommends only using millimeters as gauges overlap and one company's 17gauge is another company's 16L

U.S.	INT'L	DIAMETER (mm)
13	12	1.65-1.80
14	11	1.50-1.65
15	9.5	1.41-1.49
15L	9	1.33-1.41
16	8.5	1.26-1.34
16L	8	1.22-1.30
17	7.5	1.16-1.24
18	7	1.06-1.16
19	4	.90-1.06
20	3.5	.80-.90
21	3	.70-.80
22	2.5	.60-.70

String Type

Stringbed stiffness differences between nylon and monofilament strings are well known. Monofilaments are generally stiffer. To compensate for the lesser elongation of string, most companies recommend decreasing overall tension settings by 10%. This may concern players trying a hybrid for the first time, but assure them the reduction is necessary to maintain the most acceptable playing similarities. The strings run in stiffness from stiffest to least stiff - Aramid (Kevlar), monofilaments, Nylons to Natural Gut.

Machine or Pull Tension

The machine's tension setting can have the greatest overall influence on stringbed stiffness. When you tell your customer 60 pounds, make sure your machine is giving you
60 pounds. Our rule of thumb: recalibrate every 20 to 25 string jobs, when making large tension adjustments, or whenever you move your machine.

Stringing Machine Type

Expect a stringbed stiffness difference between racquets strung on spring tension and continuous tension machines. Continuous pull machines, whether drop-weight or electronic (Babolat, Prince, Alpha, Gamma, etc.), will normally produce a firmer stringbed than identically calibrated spring tension machines. A continuous tension machine (as the name implies) maintains a constant tension on a string to compensate for elongation and clamping, which generally results in a 10% firmer stringbed.

Stringer Technique

Finally, all stringers have different techniques. Tensioning string from varying distances, double pulling and pre-stretching all contribute to affect overall stringbed stiffness. Such varying techniques may be one explanation for small deviations in stringbed stiffness that occur even between two different stringers working in the same shop on the same machine. For example, we recorded single pulling and double pulling techniques (on a 1.25 mm nylon), using a spring tension machine — with varying results.

Conclusion

Test results indicate that pulling tension, head size, and string density have the greatest impact on overall stringbed stiffness. String gauge apparently makes the least difference in static testing, though most good players can feel the difference during play. What we refer to as “tension” is really the complex result of the seven interacting factors discussed here. Changes in any of these variables may affect the feel of a racquet and the way it plays. By knowing these factors and how they can affect stringbed stiffness, you can bring out the best in any frame and be a more knowledgeable advisor to all of your clients.

Rules of Tennis

Official Code of International Tennis Federations (ITF) Rule

4 (excerpt): The Racket

Rackets failing to comply with the following specifications are not approved for play under the Rules of Tennis:

(a) The hitting surface of the racket shall be flat and consist of a pattern of crossed strings connected to a frame and alternately interlaced or bonded where they cross; and the stringing pattern shall be generally uniform, and in particular not less dense in the center than in any other area. The strings

shall be free of attached objects and protrusions other than those utilized solely and specifically to limit or prevent wear and tear or vibration and which are reasonable in size and placement for such purposes.

(b) The frame of the racket shall not exceed 29 inches (73.66 cm) in overall length, including the handle and 12½ inches (31.75 cm) in overall width. The strung surface shall not exceed 15½ inches (39.37 cm) in overall length, and 11½ inches (29.21 cm) in overall width.

(c) The frame, including the handle, shall be free of attached objects and devices other than those utilized solely and specifically to limit or prevent wear and tear or vibration, or to distribute weight. Any objects and devices must be reasonable in size and placement for such purposes.

(d) The frame, including the handle and the strings, shall be free of any device which makes it possible to change materially the shape of the racket, or to change the weight distribution, during the playing of a point.

While it is not easy to tell from reading Rule 4, one aspect of the rule limits the placement of vibration dampeners. Vibration dampeners may only be placed below the bottom cross string, above the top cross string, or outside the outermost main strings. In other words, vibration dampeners may not be placed within the woven surface of the string bed.

Manufacturer Technologies

(MPS applicants only)

The following is a compilation of information taken directly from industry product catalogues and technical manuals. No ERSA endorsement of any product or claim is intended.

Babolat Technologies

Aero Modular Technology — New frame concept with high modulus graphite, varying beam profiles at 3 strategic locations offering power and control, while increasing head speed. Thinner cross- section at tip to increase power. Standard cross-section at side of head to improve stability. Wide cross-section at throat to increase control and allow a faster swing. Creates maximum penetration of the racquet through the air to increase the hitting power and spin.

Cortex System — throat system designed to filter out vibrations, which interfere with feel, in order to enhance the feel of the ball.

Elliptic Geometry — optimal cross-section shape designed to offer best resistance to torsion. Makes frame 20% stiffer for more power.

Evo Beam — Varied thickness of the beam for less torque at ball impact and better responsiveness. Flex Carbon — New technology featured in the Pure Control line. It has less density of carbon fibers for more flexibility and offers more control at ball impact.

Frame String Interaction Technology (FSI) — New frame technology that provides a tighter stringing pattern in the redefined sweet spot area (slightly higher than the traditional center of a racquet), along with an optimized woofer system, to offer more control and consistency on all strokes.

Stabilizer Technology — A hybrid frame construction and stiff carbon fiber for improved torsional stability at ball impact to make precise shots.

Strike Hybrid Frame Construction — A mix of square and elliptic construction offering more responsiveness at ball impact than any other racquet on this segment.

Responsive Woofer — Provides energy restitution thanks to a new material, PEBAX® injected into the grommets and bumper.

Woofer System — The first technology to enable the frame and strings to interact each and every time a player hits a ball. Woofer provides 25% longer contact time creating greater precision and sensation.

X-Sider — New frame design increases the sweet spot by 10% to bring forgiveness on off-center hits. Boris

Becker Technologies

DeltaCore — delta-shaped arrangement of the individual molecules, finely meshed network, enhanced tube structure resistance in all three dimensions, less expenditure of energy and more power, increased stability and enhanced shock absorption. Tube structure is more compact and solid. The DeltaCore material can be processed very finely and used throughout the frame.

Dynamic PCP (Power Control Pattern) — provides a dense string pattern in the racquet's sweet spot and ensures that power is controllable. Balls hit outside the sweet spot maintain optimal power thanks to the more open string bed.

Energy Box — improved overall all stability with the addition of DeltaCore in the 5 & 7 o'clock regions.

Energy Shaft — shaft design resembles a triangle for increased power. With the addition of DeltaCore, the Energy Shaft becomes even stronger and more powerful.

Sensor Plus Handle System — TPR and an additional EVA layer give the maximum comfort with vibration and shock absorption.

Dunlop Technologies

3-Dom Grommets — Each grommet pod is lined with a low-density plastic material that is 40% softer than the grommet itself, acting as both a cushion and a recoil mechanism on impact. It acts as a dampening system around the frame and adds power. Inspired by human cartilage. 3-Dom is a play on freedom.

Aeroskin CX — inspired by sharkskin, unique surface application strategically applied to create localized turbulence and smooth airflow over the racquet surface. Reduces aerodynamic drag by up to 36% for faster racquet speed and more power.

AFG (Anti-Friction Grommets) — comprised of small ridges in each grommet pod that allow the string to sit on top of only the ridges, minimizing actual contact with the grommet, and thus reducing friction for greater string movement. This increases power and spin. Inspired by the sandfish skink, which has a unique scale structure that allows it to swim through sand by minimizing friction.

Anatomic Construction — structural feature at top of the handle inspired by human bone structure to reduce twisting and increase stability on off-center impacts.

BioFibre — Plant material fibers woven into the layup at the throat of the racquet increasing vibration dampening by up to 18% providing a clean and solid feel.

Biomimetic — an all-encompassing science taking lessons from nature and engineering these lessons to improve a product's performance in all regards. Biomimetic currently includes Aeroskin, HM6 Carbon and Viper Dry.

Cx Technology — more aerodynamic frame geometries to minimize the co-efficient of drag and make racquets more efficient through the air, adding power and spin. Inspired by wing shapes in birds of prey.

iDapt — a revolutionary frame technology that allows players to choose how their frame, feels, plays, and even looks. Players are able to choose their head size and look, followed by their feel, which is driven by the Shock Sleeve™, which is available in Firm, Medium, or Soft feels. From there the player is then able to choose their grip size and handle length, and the dealer assembles the racquet in minutes. iDapt allows 432 different combinations to be built from just 12 racquet heads.

MoS2 Grommets — Allows 27% more string movement and are 40% more durable than traditional grommets and bumper guards.

Viper Dry — Inspired by the deadly Sand Viper which lives in the desert, the ViperDry grip has an incredible ability to absorb moisture through micro perforations on the surface to create an ultra dry, tacky feel in all conditions. The result is a durable grip that gives ultimate control suitable for aggressive and attacking styles of play.

Gamma Technologies

Advanced Aerodynamic Cross Section — Aerodynamic frame shape reduces air resistance and allows easier maneuverability. Also gives the perfect amount of flex in the head to store power for maximum ball speed.

Minimized Voids — Process that removes entrapped air from the composite matrix to minimize voids between fiber layers that can lead to fatigue of the frame.

Multidirectional Layering — Carbon sheets are layered at pre-calculated directions to ensure optimum strength and stiffness throughout the racquet.

Recessed Bumper Guard — Bumper system built into the frame for a seamless blend with frame. This creates less drag and faster racquet head speed.

Tapered Bridge Beam — Unique geometric shaped bridge designed to deflect and streamline airflow around the frame at any angle.

HEAD Technologies

Adaptive String Pattern (ASP) — Allows racquet to be strung with 2 different patterns (16×19 and 16×16) utilizing two exchangeable grommet inserts. Changing the number of cross strings changes the spacing between the strings in the center of the sweet spot. This gives the player options making the racquet adaptable to what they want.

AnTi.Torsion — utilizes a crossbar in the throat to improve torsional stability on off-center hits.

D3o — a member of the smart materials category can change its behavior during impact. Integrated in the lay-up and positioned in the shaft area of HEAD's YOUTEK tour racquets, d3o is able to sense the needs of the player during different strokes. On high-speed impacts (aggressive shots), the smart molecules lock together within nanoseconds and dramatically increase the stiffness of the racquet to provide maximum power. On low-speed impacts (slices or drop shots), the material stays in its relaxed state absorbing the impact to provide a softer touch for better feel and control.

Extreme — increased head width, which can allow the ball to slide further across the string bed for unmatched spin generation for players with a modern playing style.

FlexPoint — features two precisely engineered control holes in the racquet's head. This creates a new point of flex, which cups the ball and improves control without losing power.

Graphene™ — the world's strongest and lightest material. It enables a redistribution of weight from the racquet shaft to the tip and grip. The optimized redistribution of weight generates more kinetic energy using less effort providing better maneuverability and more power.

GrapheneXT™ — Allows for an extreme redistribution of weight from the shaft to the tip and grip to increase swing weight and raise the sweet spot to maximize power in the modern game. Up to 30% stronger and 20% lighter and producing up to 10% more energy transfer.

Head Stabilizer — located in the shaft of the racquet — HEAD uses a metal mass between a rubber elastomer to counteract the frame's oscillation on impact and eliminate racquet vibration and ensure the ultimate in comfort on every shot.

Innegra — world's lightest high performance fiber integrated into the lay-up of HEAD racquets. Vibration upon impact is reduced by 17%. HEAD's new hybrid composite structure considerably extends the performance of a racquet at the highest level over the enter life of the frame.

Intelligence — special Intellifibers at 4 & 8 o'clock take the mechanical energy created by contact and convert it into electrical energy, which is used to stiffen the frame providing power, comfort and dampening.

ISD (Integrated String Dampener) — an integrated string dampener fixed onto the grommets at the throat to reduce string vibration.

Liquidmetal — this material has a unique liquid atomic structure that does not deform on impact. Results in little to no energy loss giving ultimate energy return, which translates into pure energy and perfect power (29% more power).

LMS (Longer Main String) — by lowering the bridge section in a new throat design, creates a larger hitting surface without making the racquet any bigger.

Metallix — made of a specially designed matrix of carbon fibers and a new crystalline metal alloy. This alloy's grain-size is 1000 times smaller than that of a typical metal. The decreased grain size results in a lighter, stronger, and more powerful racquet.

MicroGel — a new silicone-based material with the lowest density of any material. Combined with stiff and strong composite fibers to create a racquet with incredible responsive qualities. On ball impact, MicroGel uniformly distributes the impact load around the frame to provide the most rock- solid feel and superior touch.

PowerFrame — features an innovative cross-section design with dual rounded bubbles in the throat and shaft area of the racquet, reducing weight and increasing torsional rigidity.

QuadFace — extends the string bed at key points providing longer strings and an enlarged sweet spot resulting in maximum power.

S-Tech Grommets — allow greater string movement, which provides a larger sweet spot and less vibration. The result is a more dampened feel and increased comfort.

Total Sweet spot Construction (TSC) — utilizes corrugated construction to increase torsional stability in the racquet head. This extends the sweet spot throughout the entire racquet head providing excellent control.

YOUTEK — incorporates different technologies to give you the individual benefits you need to match your playing style.

PACIFIC Technologies

AirDamping — grip damping system located in the shaft minimizes vibrations and protects the arm.

BasaltX — fibers made from Basalt (volcanic natural material) offer optimal combination of stiffness and flexibility in specific areas to reduce torque, enhance power and feel, reduce shock and vibration. Basalt fibers are environmentally friendly, completely recyclable, and a virtually inexhaustible resource.

BasaltX2 (BX2) — Provides: 30% more basalt fibers within the same material. 20% Lighter in overall weight, 28% stronger, 20% more vibration dampening.

F.A.S.T — Full Acceleration Shaft Technology — construction and beam design with rounder shaft/throat to make the frame more rigid and stable upon instant impact, allowing maximum energy return to the ball. As frame geometry transitions upward from the shaft/throat, a reduction in the rounder cross-section adds the cupping of the ball on the string bed to hit with maximum and heavy spin.

Fischer Technology — assurance of high quality and continuation of Fischer racquet technologies now joined with PACIFIC, bringing a new level of performance possibilities under one brand.

PSS (Pacific Stability System) — gives sides of racquet face greater stability resulting in maximum ball control even on off-center hits. Directional control of the ball is enhanced in all situations.

Precise Grip System — Injection mold handle system which ensures exact handle size, sharper (more defined) bevels, exact weight and precise material stiffness.

Speed++Zone — delivers maximum ball acceleration combined with a high level of control.

Zero Tolerance — guarantee that you always have 100% identical racquets.

Prince Technologies

Cross-Bar Stabilizer — Located in the mid-shaft area of the racquet, increases the stability of the frame.

Double Bridge — Thermoplastic rubber elastomer located at the top of the throat and in direct contact with frame and string. Reduces frame shock and string vibration.

EXO3 — A high tech patented racquet design utilizing large holds and string suspension inserts to deliver a superior effective hitting area compared to conventional racquets with the same head size.

EXO3 String Suspension Inserts — Suspends the string bed from the racquet allowing the strings to be completely liberated from restrictive, response strangling grommets, allowing the strings to respond more freely

Extreme String Pattern (ESP) — More open and aggressive string pattern designed to deliver up to 30% more spin. ESP racquets are designed specifically for different player types by adjusting the head size, weight, balance, swing weight and stiffness along with the string pattern to achieve the best performance.

O3 —Giant ports replace traditional size string holes. O Ports are designed to significantly increase the sweet spot and improve racquet head speed, even at the outer edges of the string plane for balls you may hit off-center).

Sweet Spot Expansion — Slotted grommets allow maximum freedom of movement for strings resulting in a larger sweet spot.

TeXtreme® - Frames utilize this high-tech material by positioning it in the shaft and lower hoop with a 45° orientation resulting in 25% less twisting without increasing stiffness or swing weight. This provides more power and plow-through by reducing energy loss at impact. It also provides more control and accuracy by maintaining good racquet face positioning at impact. Lower stiffness reduces overall racquet vibration and shock to the arm during play improving comfort and feel.

Triple Threat — a unique balanced weighting system utilizing increased weight in 3 locations; 10 o'clock, 2 o'clock, and the handle. This creates a larger sweet spot in every direction, ultimate stability for increased power and control, and reduced arm shock.

Prince gives each of its racquets power level ratings (determined by a formula incorporating head size, stiffness and length), which increase as the power level of the frame increases.

Tecnifibre Technologies

Armor Cap: A thicker, wider and longer bumper guard providing better protection with more durability.

Dynacore: Frame construction featuring unmatched combination of flexibility and torsional stability. Solid construction for long lasting performance. A softer feel for muscle integrity and less fatigue. Better and quicker communications to your hand.

EZ Lock Eyelet: Extra flat and larger grommets on tie-off holes ease stringing and improve tie-off knot.

Synergy Link — The use of polyurethane in the bumper, which offers 18% additional shock absorption and more comfort.

Velocity Shaft Design — 11% less beam size on the shaft, which allows for more speed and spin versus a standard elliptic beam.

Volkl Technologies

Big Grommet — Big Grommets allow greater string movement for an increased sweet spot. This results in more power, especially on off center hits. Big Grommets can increase the sweet spot by up to 15 square inches.

Bio Sensor - Counter Vibration Dampening System which provides the player unmatched feel and a 15% increase in dampening (vs. Sensor Tour Handle). A pin is placed in the butt cap with a mass to "swing" against vibration.

Bio-Sensor Grip Pin — Handle system featuring 3 different dampening pin lengths and materials for 3 different player profile groups —Recreational (Red Soft Pin, 7.72 cm); Intermediate (Yellow Medium Pin, 7.72 cm) and Tournament (Black Hard Pin, 3.81 cm)

Catapult-effect — Frames utilize graphite springs built into the grommet strip to increase power, improve comfort, and reduce shock and vibration. The graphite springs increase the "receive-time" for more control ["control-phase"] and because of a faster resetting of the springs ["power-phase"] power is increased. End result is 30% more power and control.

DNX — a unique material structure featuring high-strength micro tube construction that is 25 times stronger than regular carbon fibers. It is integrated in strategic areas to add strength to the frame.

Dynamic PCP (Power Control Pattern) — provides a dense string pattern in the racquet's sweet spot and ensures that power is controllable. Balls hit outside the sweet spot maintain optimal power thanks to the more open string bed.

Optispot — Highly visual and contrasting optic field (at 12, 3, 6, and 9) helps the eye focus on the hitting zone and keep your attention on the ball.

Organix — DNX based material, with integrated cellulose material, implemented at the 3, 6, 9, and 12 o'clock positions. Offers more dampening, higher response and added stability.

Power Arm — being structurally decoupled from the racquet head, the Power Arm is pulled backwards upon ball impact. The ball plunges deeper into the string bed. At the moment when the ball changes direction, the Power Arm recoils dynamically and leads to extreme acceleration of the ball.

Power Bridge — innovative construction integrating DNX material and increased specific material density, which considerably increases the stability the yoke (6 o'clock). It makes the entire racquet more powerful and dynamic.

Sensor Handle System — The interaction of two materials, TPR and EVA in the handle, ensures the best comfort, with excellent vibration and shock absorption properties.

Sensor Tour Handle System — a Sensor Handle System with a thinner layer of EVA layer to give players greater feel.

Speed Grommet — Shaped grommets allowing string movements in all possible directions with no friction at the grommet wall and no energy loss.

Super Grommet — Speed grommets with V-Sponse Material. Provides more control by extending receive time, increases sweet spot and produces more speed by providing the best energy return.

Twin Absorber Handle System — specially developed for tournament racquets, it is comprised of a two part racquet shaft injected with an integral foam. Reduces torsional shock by 60% and vibration by 40%.

Vibration Control Handle System — features an EVA (Ethyl Vinyl Acetate) sheath surrounding the handle. Designed to help dampen vibration and provide some added protection for arm muscles and joints. This technology can actually be seen through the butt cap of the racquet.

V-Sponse® Technology — Is a visco-elastic polymer material, similar to sorbathane, now used in the patented Volkl SUPER grommet system and bio-feel dampening pin. It is 20% more flexible than standard grommet and pin material. Provides additional dampening to the bio-feel grip pin. Generates an increased “spring effect” in the grommets. Has the lowest energy loss factor of all thermoplastic elastomers. V-Sponse provides the best dampening and energy return

Wilson Technologies

AGT (Articulated Grommet Technology) — a ball-in-socket joint system allowing for an extraordinary 76 degrees of string movement.

Amplifeel — a 3-part handle system designed to reduce harsh vibrations for even better feel. 6 graphite and basalt “planks” are inserted into the handle foam to increase racquet feedback to the player.

Amplifeel 360 — Features a full Basalt expanded handle for enhanced feel with increased racquet power and reduced weight.

Basalt Fibers — key component of BLX, which filter out unwanted high frequencies before they reach the hand to deliver a perfect feel.

BLX — racquet technology engineered with Basalt Fibers combining proprietary frame, grommet and grip technologies for the perfect feel. The key component is Basalt Fibers. There are 9 secondary

technologies used in variable combinations with Basalt Fibers to make up the complete BLX racquet technology.

Braided Graphite + Basalt — An elastic and reactive material combination that improves the flex of the racquet. This evolution of Wilson's BLX technology increases the ball's contact with the strings to provide enhanced feel and greater control.

Braided Graphite + Kevlar — Provides a pure, solid, and consistent feel that players have loved for decades. This strong construction also dampens vibration and enhances touch and control.

Double holes — bigger holes allowing 26 degrees of string movement for a bigger sweet spot.

Hammer — weight is taken out of the handle of the racquet and maintained in the head of the frame. The result is increased power and stability for lighter weight racquets, as well as a higher and larger sweet spot.

High Performance Carbon Fiber — Developed for aggressive swings, this premium modulus carbon graphite provides increased frame stiffness for explosive power.

Parallel Drilling — Drilling the grommet holes parallel to each other to allow for increase string movement, which increases the sweet spot size by up to 27%. This provides more comfort, responsiveness, and a forgiving feel.

Perimeter Weighting System (PWS) — extra weight is placed at 3 and 9 o'clock for increased torsional stability.

Power Holes — special string holes for 56-degree string movement to increase sweet spot and power.

Sony Smart Tennis Sensor — Sensor attaches to the racquet to gather data about shots and strokes allowing the player to analyze and visualize play in real time.

Spin Effect Technology (S.E.T.) - The first racket system that actually increases ball RPM without players needing to change their swing. The net seems lower and the court feels longer on every shot. Spin Effect is a patented technology comprising a unique combination of main strings and cross strings allows for 3.3 times more string movement and 69% faster string snapback which produces
200+ more RPMs of spin on the ball.

Triad — 3-piece racquet system where hoop and handle are separated with Iso-Zorb providing the ultimate in comfort and soft feel.

X2 Shaft — Engineered for today's modern play, the X2 shaft combines a longer handle for increased feel and leverage on two-handed backhands and a rounded and narrower shaft to enable quick grip changes and optimal feel for the opposite hand on forehands.

Yonex Technologies

3D Vector Shaft —deeper grooves in the shaft improve racquet stiffness and reduce twisting of the frame for 20% more face stability than a conventional racquet. It also delivers precise control at impact and greater bite for the most efficient transfer of power.

Aero Shape — creates more frame thickness for higher repulsion. Compared with a conventional frame, the Aero Shape creates a thinner, more flexible shaft that increases topspin.

Dual Shut System —Shockless grommets at the bottom of the frame reduce impact vibration and Quake Shut Gel, which is embedded inside the handle, removes even the subtlest discomfort from the frame resulting in a 50% reduction in vibration compared to conventional models. Improves comfort and control with every stroke.

Integrated Power Weight System (IPS) — places weight strategically at 3 and 9 o'clock to help reduce torque and compensate for off-center hits.

Isometric Head Shape — allows for more strings of equal length, creating a larger sweet spot. Micro

Core — higher density foaming urethane is "baked" into the graphite of frame at 11 & 1 o'clock during manufacturing, which adjust the racquet weight and provides face stability and power.

Neofade — part of the Quad Power System. A new material, which absorbs impact shock and reduces vibration, is inserted along the sides of the racquet face.

New Isometric — Evolved Isometric Technology with improved grommet system applying both deep and shallow grooves inside of the frame. This new Isometric technology provides a maximum sweet spot.

New OPS (Oval Pressed Shaft) — Features rounder shaft corners providing an ideal level of flex, whilst a wider shaft face increases stability resulting in extended ball dwell time for optimized ball spin and directional control.

Oval Pressed Shaft (OPS) — gives a racquet more spin, control, and feel for the ball by flexing on impact and increasing the time the ball is on the strings.

Quad Power System — provides exceptional stability and enlarged sweet spot, creating an "Explosion Zone" in the string bed that enhances your natural power.

SD Grid — shock dampening grid sheet is inserted into shaft to absorb vibrations between the two tubes within the grip.

Shockless grommets — soft grommets placed in the throat and the 3 & 9 o'clock positions to absorb vibration, reduce shock, and optimize feel.

Super Cushion Grip — the cushioned underside layer of this grip reduces vibration, further enhancing the soft feel at impact provided by Shockless Grommets.

Trans-Weight System — Integrates new Nanometric material, which improves the bonding strength between carbon fibers at the center and bottom of the frame, which reduces the weight shift to the top of the frame. This results in a racquet head that reacts faster for quicker maneuverability and produces the fastest swing speed in Yonex history.

X-Fullerene — Special material in the resin, which bonds the carbon fibers into a cross-link construction. Provides 5% higher repulsion and 15% greater frame stability.

Yonex also recommends that racquet technicians string its racquets at different tensions for different grip sizes. The recommended tension range for a racquet will be found in the throat of the racquet because even with the same model, a 4½-inch grip will have a higher recommended tension range than a 4¼-inch grip.