ANTONIO

SAM ZYGMUNTOWICZ examines one of Stradivari's finest golden-period instruments, using both traditional and high-tech methods

The f-holes show disciplined workmanship, and their upright style is characteristic of many Stradivari violins

INSTRUMENT PHOTOS TUCKER DENSLEY

STRADIVARI

The 'Titian' Stradivari of 1715 has long been counted among its maker's finest golden-period violins. In the hands of soloist Cho-Liang Lin, its current player, it has revealed itself to be a formidable concert instrument of unusual power and scope, remarkable for its focus and resilience under the bow.

As a caretaker of this violin, I have a dual role as conservator and pit-stop mechanic. As a violin copyist, I want to take measurements and details from this extremely successful example. And as a maker who wants to move forward, I want to understand the violin's underlying functions, and to use those variables with greater freedom and confidence.

We presume that this violin represents an amalgam of the design styles, techniques and accumulated experience at the time of its making, plus the interventions of restorers and years of active use. However, it is not obvious which aspects and details are significant for sound — let alone why — and which are more a matter of style. Until proven otherwise, we should assume that every aspect of this violin has some effect on sound and structure. So how do we go about untangling form and function, causes and effects?

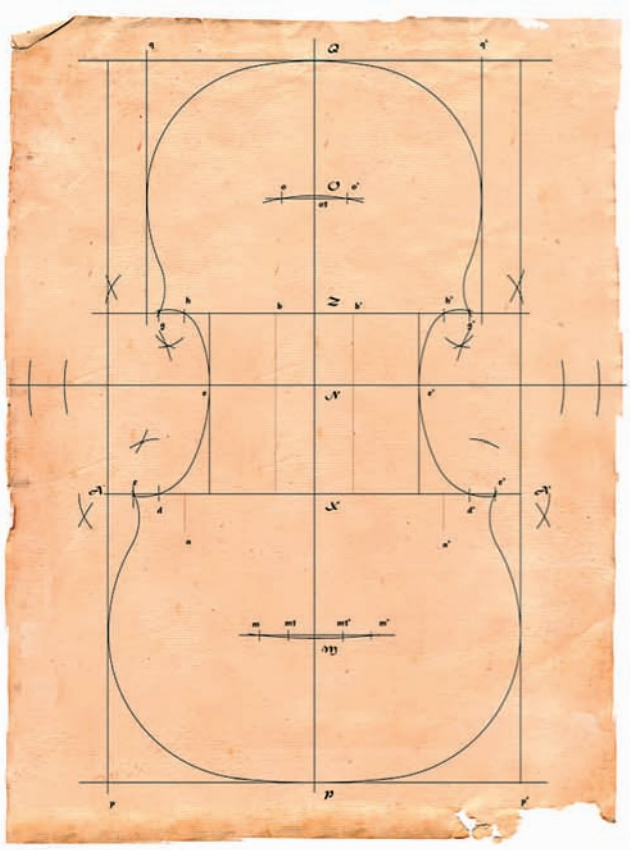
With the 'Titian', we are fortunate to have an unusually diverse trove of documentation, gathered as part of the Strad3D project which George Bissinger and I developed. The 'Titian', the 'Wilmotte' Stradivari of 1734 and the 'Plowden' Guarneri 'del Gesù' of 1735 were our three test violins, and as well as the usual measurements and photos, our research included computed tomography (CT) scans, sound tests and modal analysis, all of which extend the scope of observation, and provide additional data for scientific analysis. (See 'A Scanner in the Works', *The Strad*, January 2009 for more details of the Strad3D project.) Further interpretation is by nature speculative, and I offer such ideas as my opinions only.

According to violin expert Christopher Reuning, the French dealer Albert Caressa dubbed this violin the 'Titian' because its clear orange–red colour reminded him of the work of the famous Venetian painter. The violin was owned by successive noblemen and collectors, and had little major concert use. From 1923, the important violinist Efrem Zimbalist owned it for two years before it again passed into a private collection. The instrument's most recent owner was the late Irwin Miller, and Lin has performed on the 'Titian' since 2002. I met the 'Titian' for the first time when Lin brought Miller to my shop, and presented the violin for adjustment. The instrument had not been used in major concerts for quite a long time, and it was exciting to hear the sound begin to open up that day.

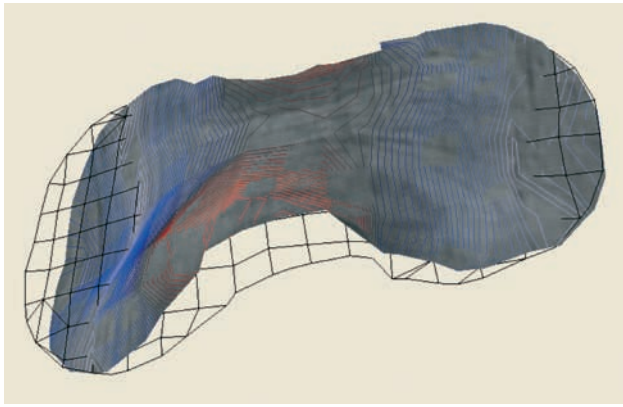
On first look, the violin seems strong and solid, with its smoothly worn patina, sturdy arching and edgework, and immaculate finishing with virtually no visible trace of the hand — all is pure architecture, with the execution almost completely subsumed. The patina shows careful use, with the edges rounded and the varnish smoothed to a luminous film.

Based on investigations by François Denis, it is possible to say that the 'Titian' was probably built on Stradivari's P form, for which the original mould can be found in Cremona's Civic Museum. This medium-size model was the principal golden-period form, compact and comfortable to play.

The flattened curves of the bouts and the rather square C-bouts add to the instrument's solid appearance, together with the blunt ▸



François Denis's sketch of Stradivari's principal golden-period pattern, the P form



One of the modal animations of the 'Titian' created by the Strad3D project

Modal animations reveal an amazing variety of motions, some eerily reminiscent of a bird in flight or an undulating manta ray

corner, which makes a less inviting target for the bow and right forefinger. Compared with earlier Stradivari instruments such as the 'Betts' of 1704 with its long, drawn-out corners and purfling, the 'Titian' gives a more rugged impression. However, its underlying rib structure is similar, but with the corner blocks less hooked, and the impression is completed by a full edge overhang and a greatly shortened corner end, with shorter purfling mitres to match.

The maple two-piece back has typical tight growth and is very exactly quartered. The mild, slightly irregular flames are not overtly showy, but are highly reflective and mobile under the varnish. Prominent in the treble-side upper bout is a long pin knot, which is directly visible on the surface and creates a daring frisson next to the refined model and finish. Such small knots are often not apparent until work is well progressed, and a less confident or less busy maker might have discarded the piece, but here it is an appealing flourish.

Similarly, the spruce top has occasional grain deviations, which hint of some internal figure. Indeed, several large bolts of mascio or 'bear-claw' figure do emerge to streak across the bass side of the top, especially in the upper bout. By contrast, the treble side of the top seems comparatively plain, almost suggesting a different tree. However, the small grain deviations are there as well, hinting at further hidden bear-claw figures.

A CT scan of the top reveals much of this same internal figure, with a slight increase in local density on the 'claws', which may suggest increased cross-grain strength. Using CT, Bissinger has calculated an approximate top density of 0.36g/cm^3. The CT scan of the back shows the pin knot clearly, as well as bands of density variation. The back density varies in bands spanning several years, while the top shows more variation year by year, which can be seen in the individual grain lines.

John Topham's dendrochronological study of the 'Titian' indicates that the spruce on the top matches other Stradivari tops of the period, likely from the same tree. His findings also suggest that the 'Titian' spruce was cut not more than 13 years before its use.

The arching adds to the robust impression of the instrument, rising quickly from the channel without much recurve, especially so in the horizon arch of the top. The arch shows little distortion, with no sinkage on the bass-bar side, and only a moderate rise in the treble-side f-hole area.

CT views of the arching show the coordination between the visible arch and channel, and the interior contours, with the concave curve of the channel reflected in the convex interior, which has a classic bell curve shape. An exception is in the long horizon arch, where the top arching stays full to the block, and the interior contour cuts in more distinctly to follow the exterior. These linked shapes create a fluid transition from the full edge thickness to a thinner area well in from the edge on the back, and a gradual thinning to the central area of the top.

The f-holes show disciplined workmanship, completely in service to the design. Their upright style is seen in many Stradivari violins, such as the 'Cessole' of 1716 and the 'Betts' of 1704. The scooping on the f-hole wings is deep and continues the entire length of the hole, blending in above it and highlighting the edges, without disturbing the full arch of the bridge area. With a touch of the scraper the uneven texture of the spruce is revealed in the modelling of the rippled surface visible in the reflections.

The full sculpting of the 'Titian' arching and f-hole areas probably adds stiffness to the top plate. As with the central area of the top, the f-hole wings are vital to the sound and particularly active in the mid- and high-frequency ranges (approximately

The two-piece maple back has mild, irregular flames that are highly reflective and mobile under the varnish

1,000Hz–2,500Hz). Modal animations of the 'Titian' reveal an amazing variety of motions in this area, differing for each frequency, some eerily reminiscent of a bird in flight, an undulating manta ray, or a sheet blowing in the wind.

The top thicknesses, as measured with a Hacklinger magnetic gauge, are relatively uniform, if slightly thinner in the upper bouts. Of course the soundpost patch added later gives localised stiffness to the post side of the top, increasing the effective asymmetry. As seen in the CT scans, the bass-bar is quite substantial. While patches and current bass-bars are not original to Stradivari, they are ubiquitous and do affect the sound and response as we experience it today.

The back thickness is generous, with a thick central area that spans the areas bounded by the upper and lower corners, and remaining strong out to the C-bouts. The back also shows minor asymmetry, with a small thin spot in the middle of the bass-side lower bout. The upper bouts are slightly thicker than the lower bouts.

The purfling shows some variation in thickness, mostly in the dyed pearwood black strips (actually closer to black–brown, with the medullar flecks still visible). The thin areas of black are not distributed randomly, but are predominantly seen in the convex purfling curves – where it is easy to scrape a bent strip of purfling and fit it into a slightly tight channel. Conversely, where the channel is inadvertently too wide, the purfling can be pressed into place, swelling to fill the gap, resulting in a subtly varied calligraphic line. The white purfling strip is of poplar or a related species – a relatively malleable wood which can be compressed or expanded to fit any variations in the purfling groove.

The purfling mitre style is similarly adaptable, and allows the use of varied corner widths and lengths. The 'Titian' corners are rather wide and short, but the outer strip deflects to form perfect mitres without increasing the overall edge margin. As is customary, the bee-sting kink in the point is eased by one or two small straight cuts.

The wood surfaces have an astonishing level of finish, with few visible tool marks. The spruce top shows almost no 'corduroy' texture – it is only visible where the varnish is very gradually worn, leaving minute traces of colour in the grain lines. Similarly, the maple is extremely well finished with almost no trace of tooling. Only with enlarged photographs or a magnifying loupe did I notice some small finishing traces in the back channel and corners, with regular, narrow-spaced striations. I wonder what technique was used – perhaps horsetail reed, some form of sandpaper or shark skin?

The scroll shows the same highly finished surface, with virtually no visible tool marks other than a few knife marks on the underside of the head, and traces of scraper marks on the back fluting. Wear and use have further burnished the edges, but the result is fluid and slender, with no sharp edges.

The importance of the highly worked wood surface is apparent when examining the varnish, and seeing how it lies directly on the wood, very thin and bright, with no obvious underlayer. However, the varnish surface is smoothly worn to a sunny golden–orange, and it is difficult to access fully the colour or texture it would have had when new. The varnish still shows its very high colour intensity in any small indentations or marks, and in the pores of the maple. My single favourite square millimetre is a little chip in the back wood, just to the left of the centre line and slightly higher than the lower corner, which is filled with a tiny splash of nail-polish red. For all the strong colour, the varnish has not stained ▹

The scroll shows virtually no tool marks and has been burnished by wear

the flames or the spruce end-grain, and the wood remains remarkably reflective and lively.

Perceptions of sound are by nature subjective, and it is difficult to find a shared vocabulary, so I will use my own terms here. When Lin first brought the 'Titian' into my shop, the sound seemed a bit thin, without much bloom — I expected something more. After some experimentation I was surprised to find that fitting a slightly shorter soundpost was effective. I set it out almost to the edge of the bridge, and moved it back as well — a set-up that I might expect more with a strong Guarneri 'del Gesù' violin. Soon Lin was able to get deeper into the sound, and gain more body and 'pop'. Adding a lighter bridge brought more 'cut' and 'sizzle' on the high end, at the top of the E string.

The type of adjustments that proved successful here indicate a robust structure that can carry its own weight, unlike many fine old instruments that benefit from additional support in their adjustments, indicating a more flexible structure. By contrast, the 'Titian' behaved more like an assertive new violin, but with added 'cushion' for a softened transient on the bow attack, and secure tracking of the bow. This gives a satisfying feeling of mass as one pulls the bow, and a resistance to pressure without the sound 'cracking', as well as the ability to play with very little bow pressure when required.

The sensitivity of the tone to even minor adjustment demonstrates how the same violin may sound quite different with differing set-ups — even a different chin rest, and certainly with different players. Variations in the playability attributes discussed above have largely resisted scientific analysis so far, presenting some stubborn challenges to current testing methods, but other aspects of tone colour and response are more easily tracked.

It is interesting to compare two response spectra taken a week apart, before and after adjusting the soundpost. These show a slight shift in the main B1 mode (a strong resonance, around C sharp on the A string), from 550Hz, lowering to about 543Hz, with some similar shifts in other modes.

When comparing the spectral response of violins, a typical reference point is Dünnwald's seminal research which suggested that the response averages of old Italian violins showed a marked dip in their resonance peaks from 1,000Hz to 1,800Hz, which Dünnwald called the 'nasal' range, before increasing again above 2,000Hz. However, the 'Titian' shows relatively strong resonance peaks in the 800Hz–1,400Hz region, a feature common to many soloist-type instruments as well as many modern instruments — and a trend noted by other researchers. In excess, this is associated with stridency, but in the right dose gives presence and power.

George Bissinger ran extensive tests on the 'Titian' as part of his ongoing VIOCADEUS research project, an analysis of violins both good and bad. To mention just a few preliminary findings, the 'Titian' and the two other Strad3D violin tops do appear to have lower densities than was found in Bissinger's other study instruments, their Helmholtz air mode was stronger, and response curves in general more even across the range. Otherwise, their spectra were rather diverse.

Among the entire sample, the 'Titian' had the highest directivity, or ratio of sound radiating from the top compared with the back, and the highest ratio of out-of-plane pumping vibration to relatively inefficient in-plane vibration. However, the 'Plowden' Guarneri 'del Gesù' was in the middle of that range, and the 'Wilmotte' Stradivari was the lowest in the scale for these attributes, which points to differences between individual instruments rather than defining 'old Italian' characteristics.

Perhaps the most significant 'finding' of the Strad3D study was that no one singular difference was documented between the Cremonese violins and other fine violins, and that the old instruments for the most part differed from each other as much as they differed from other examples. Rather than look for a unifying characteristic in the great old violins, it seems better to focus on the inner workings of a particular instrument such as the 'Titian', and to pay close attention to all the subtle variations that make the differences in sound and appearance. ■

For more information on the Strad3D project, visit www.strad3d.org