

Report on the measurements of the Trinity College harp, 2012

Supplementary material to accompany the publication of the article

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Contents

Introduction	p.1
Part I	
Measurements of the Soundbox	
From the 1974 set	p.3
From the 2002 set	p.3
From Armstrong 1904	p.3
From the 2012 set	p.4
Notes	
1974 measurements	p.4
2002 measurements	p.6
Armstrong 1904	p.7
Measurements of the Forepillar	
From the 1974 set	p.9
From the 2002 set	p.9
From Armstrong 1904	p.9
From the 2012 set	p.9
Notes	
1974 measurements	p.10
2002 measurements	p.11
Armstrong 1904	p.11
Measurements of the Harmonic Curve	
From the 1974 set	p.13
From the 2002 set	p.13
From Armstrong 1904	p.13
From the 2012 set	p.13
Notes	
1974 measurements	p.14
2002 measurements	p.15
Armstrong 1904	p.16
Part II	
Measurements of the harp as given by R. B. Armstrong	p.17
Measurements given in Fig. IX, p. 60	p.18
Reconstructing the profile	p.19
Conclusions	p.22
Appendix I	
BrianBoruHarp.doc (2002 set)	p.24
Appendix II	
HARPINFO.DOC (1974 set)	p.26
Appendix III	
Summary of the Measurements	p.32
Appendix IV	
Sample Images	

Introduction

The following report documents the measurements of the Trinity College harp available to date and the discrepancies between them. These are discussed in light of measurements and photographs of the harp taken by the author in January 2012. These measurements and photographs (hereafter labelled ‘2012 set’) were taken in the Long Room at Trinity College where the harp is now preserved. Lighting conditions were poor and the work had to be completed within a very short space of time. This work was carried out for the sole purpose of clearing up inconsistencies between existing measurements and is not by any means an attempt at a complete survey of the harp. Such a survey has yet to be undertaken and with modern technologies such as 3D scanning, CT scanning, etc. could be expected to yield exact data. The present analysis however, will still operate within a certain margin of error, hopefully less than $\pm 1/16''$. This should be sufficiently precise as to enable a reliable study of the string layout of the harp as it is now and as it was probably originally intended; such is the subject of an article by the author entitled ‘Reconstructing the Medieval Irish Harp’, published in the *The Galpin Society Journal* LXVII, 2014.

Three sets of measurements are analyzed here, measurements of the harp from an unknown source taken in 1974 (hereafter labelled ‘1974 set’) and measurements taken in 2002 (hereafter labelled ‘2002 set’) by harpmaker David Kortier of Duluth, Minnesota and musicians Charlie and Ann Heymann of Winthrop also in Minnesota. Both of these sets were supplied by Trinity College in two separate files, HARPINFO.DOC and BrianBoruHarp.doc. Both files are copied in appendices at the end of this report. The third set of measurements is based on Robert Bruce Armstrong’s survey of the harp, which was published in *Musical Instruments, Part I, The Irish and Highland Harps* (Edinburgh: David Douglas, 1904), pp. 55–62. A list of these measurements and an analysis of Armstrong’s scaled drawings and sketches of the harp can be found in Part II of this report.

The measurements compiled by Michael Billinge and Keith Sanger, which feature in Appendix A of *Tree of Strings* (Temple, Mid-Lothian: Kinmor Music, 1983), p. 212, are not included in this analysis. These measurements were extrapolated from Armstrong’s work and from a cast of the harp made some time during the late 19th c., as such these measurements are not of the harp itself but as the authors state: ‘an attempt to reflect its probable original dimensions’. These measurements are included in tables 1a and 1b in Appendix III for comparison purposes.

Photographs of the harp were taken with a Nikon D60 digital camera and measurements were gathered using a variety of measuring tools – rubber-ended callipers, paper rulers and conventional measuring tapes. A number of the photographs taken include a ruler in the frame and a series of 3D models confirming the measurements and the analysis were created in Google SketchUp v.6.¹ Measurements displayed in these models are software-generated and use the same units as the original sources. The measurements can be

¹ SketchUp software is required in order to view the models, this can be downloaded free from www.sketchup.com.

converted from the imperial to the metric system (or vice versa) or their resolution increased in SketchUp using the 'Model Info' window. The models and the images they contain, are made available strictly for research purposes and may not be copied or disseminated in any way without permission. The models can be found in the 'Resources' folder intended to accompany this report, which can be downloaded from:

<http://www.pauldooley.com/report2012/resources.zip>

Sample images from selected models can be found in Appendix IV.

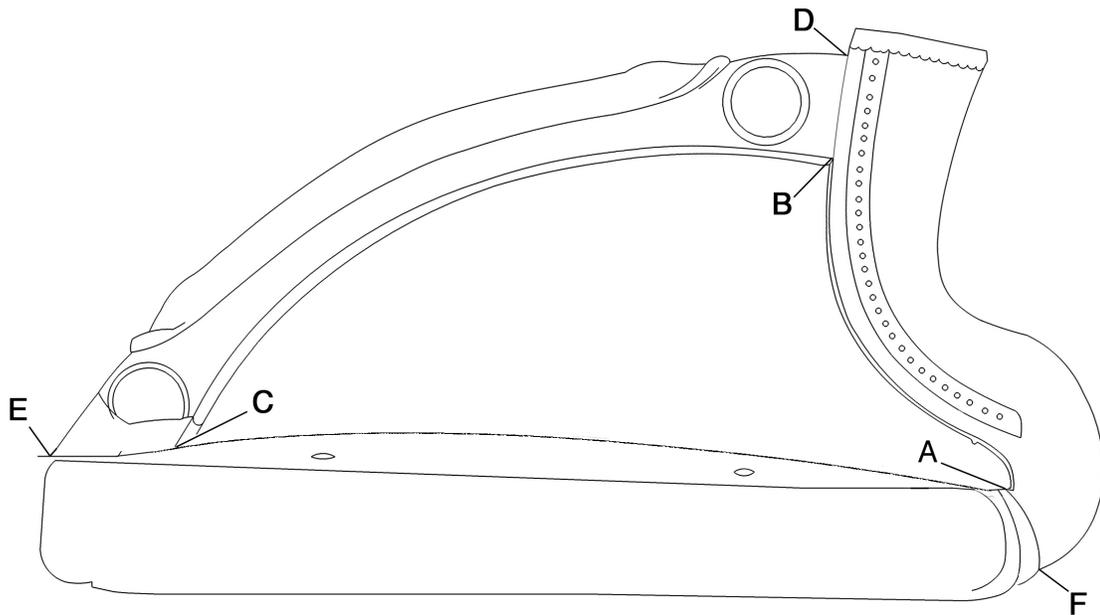


Figure 1. The location of points A, B and C as referred to in the 2002 set and additional points D, E and F.

Part I

Measurements of the Soundbox

From the 1974 set

Soundboard

1. Maximum width: 32cm
2. Minimum width: 12cm
3. Length at side: 74cm
4. Length at centre: 71.5cm
5. Wood thickness (visible in soundhole): c 5.5mm
- 5a. Depth of soundbox: 82–85mm
- 5b. Soundhole (diameter) 1.8cm

Internal space (string area)

10. Length along string holes: 68cm

From the 2002 set

-A to C 27"

-C to top shoe: $24\frac{3}{4}$ " (point where string emerges)

-C to 15th shoe: $12\frac{5}{8}$ "

-C to last shoe: 16mm

-Four soundholes, $\frac{3}{4}$ inch in diameter.

-Soundboard 15mm thick at stringband, 7mm thick at sound holes.

-Distances between shoes (string holes) are consistently 23mm throughout, dropping to 21mm at top 8 strings, and 22mm at bottom 5 strings.

From Armstrong 1904

p. 62

-Soundboard thickness 'rather less than $\frac{1}{4}$ of an inch'

-Thickness of the sides of the soundbox $\frac{5}{8}$ " becoming 'much thinner towards the soundboard'

-Scaled drawings of the soundboard and sides of the soundbox taken from gelatine rubbings are shown on the full-page plate Ancient Harp, Trinity College, Dublin, 'Details R.B.A.' opposite p. 56.

From the 2012 set

- Maximum width $12\frac{5}{8}$ "
- Minimum width $4\frac{3}{4}$ "
- Depth at lower right hand corner² $3\frac{3}{4}$ "
- Depth at lower left hand corner $3\frac{3}{8}$ "
- Depth at upper right hand corner $3\frac{1}{2}$ "
- Depth at upper left hand corner $3\frac{3}{8}$ "
- Measurements of the stringband, sound holes, and of the distance between the string shoes can be gleaned from photographs, see models 4.Sound_holes and 22.Box1–25.Box4.

Notes

1974 measurements

1. The measurement given for the ‘maximum width’ of the soundboard is correct at 32cm or $12\frac{5}{8}$ " although this is slightly narrower than the maximum width of the box itself.

See models 1.Lower_end, tab 1 and 2.Box_1974, tab 1

2. The measurement given for the ‘minimum width’ as 12cm or $4\frac{3}{4}$ " is correct at the point where the semicircular termination of the raised stringband is furthest away from the lower end of the soundboard, in other words the point where the soundboard is at its longest.

See model 2.Box_1974, tab 2

3. The measurement given for the ‘length at side’ on the tuning side³ is probably correct at 74cm or $29\frac{1}{8}$ " measured along the curve from the point where the neck meets the soundbox to the lower end. The length of the side on the tuning side appears to be slightly shorter.⁴

See model 2.Box_1974, tab 3

² With the soundboard facing the viewer. These measurements are approximate, the lower corners were measured 1" in from the edges, the upper corners were measured at the point where the semi-circular termination of the raised stringband meets the edge of the soundbox. These measurements accord with Armstrong’s scaled drawings of the sides of the soundbox on the full-page plate Ancient Harp, Trinity College, Dublin, ‘Details R.B.A.’ opposite p. 56. See model 3.Sides.

³ With the soundboard facing the viewer the tuning side refers to the left-hand side and the string side refers to the right-hand side.

⁴ A definite measurement is difficult to obtain here owing to the fact that the neck meets the soundbox at an angle and that the shape of the joint itself is oval, the reading will vary according to what points the measurement is taken from.

4. The measurement for the 'length at centre' given as 71.5cm or $28\frac{3}{16}$ " is correct measured along the curve from the point where the neck meets the soundbox to the lower end including the portion of the soundboard where the forepillar joins the box.

See model 2.Box_1974, tabs 4 and 5

5. The 'wood thickness' at the sound hole could be correct at approximately 5.5mm and might correspond to Armstrong's measurement, which is given as 'slightly less than $\frac{1}{4}$ of an inch' although Kortier gives 7mm for the same measurement. The discrepancy here may be partly due to variations in the thickness of the soundboard at different points or a lack of precision in the measuring methods and devices employed.

5a. The measurements for the 'depth of soundbox' given as 82–85mm are incorrect, this is likely to be a typographical error and should probably read 82–95mm or else these measurements only refer to the tuning side. The width of the side of the soundbox on the tuning side is uniform and measures approximately 85mm or $3\frac{3}{8}$ " except for the portion where the corner has been worn where it is less depending how close to edge the measurement is taken; 82mm here would probably be correct.

On the string side, the depth of the soundbox varies from approximately 95mm or $3\frac{3}{4}$ " at the lower end to 88mm or $3\frac{1}{2}$ " at the top where the semi-circular termination of raised stringband meets the edge of the box.

See models 1.Lower_end, tab 2 and 3.Sides

5b. The measurement given as 1.8cm for the 'sound hole (diameter)' is incorrect. All four sound holes are slightly irregular in shape. Some irregularities caused by damage have been filled. The diameter of the sound holes was probably originally somewhere between 19–20mm or approximately $\frac{3}{4}$ " as given in the 2002 set.

See model 4.Sound_holes

This measurement may have been taken from Armstrong's photograph of the front of the harp shown on Plate I opposite p. 54 in which case it is simply wrong.

See model 10.T-section_width, tab 5

Internal space (string area)

10. The measurement of the 'length along string holes' given as 68cm or $26\frac{3}{4}$ " probably refers to the distance between points A and C and is not quite accurate. The distance between those points is 68.4cm measured along the curve and approximately 68.2cm measured in a straight line.

See model 2.Box_1974, tabs 7 and 8

2002 measurements

-The measurements given for the distances between point C and shoes #1, #15 and #29 are broadly in agreement with Armstrong's scaled drawing of the soundboard⁵ and the measurements and photographs taken in 2012.

C to top⁶ shoe: $24\frac{3}{4}$ " (point where string emerges)

C to 15th shoe: $12\frac{5}{8}$ "

C to last shoe: 16mm

See model 5.Box_2002, tab 2

-The distance between points C and A is slightly shorter than 27" measured along the curve, according to the photographs of the harp taken in 2012 the distance between these points is $26\frac{29}{32}$ " The distance between these points in a straight line is approximately $26\frac{25}{32}$ ".

See model 5.Box_2002, tabs 3–5

-The diameter of the sound holes given as $\frac{3}{4}$ " broadly accords with the photographs taken in 2012 and with Armstrong's drawing.

See model 4.Sound_holes

-The thickness at the sound holes given as 7mm is thicker than that given in the 1974 set or by Armstrong but this may not be uniform at all four sound holes.

-The thickness of the soundboard at the stringband given as 15mm would appear to suggest that the soundboard itself is thicker towards the middle. The raised stringband appears to be no more than 4mm thick leaving 11mm for the soundboard under the stringband.

⁵ Full-page plate Ancient Harp, Trinity College, Dublin, 'Details R.B.A.' opposite p. 56.

⁶ Top shoe refers to shoe #1.

-The distances between the string shoes given in millimetres contradict the measurements given for C to shoes #1, #15 and #29 and are incorrect. According to the measurements given, the distance between point C and shoe #1 would be 63.9cm or approximately $25\frac{1}{8}$ ". This contradicts the measurement given above as $24\frac{3}{4}$ ", which is correct.

‘Distances between shoes (string holes) are consistently 23mm throughout, dropping to 21mm at top 8 strings, and 22mm at bottom 5 strings.’

28spaces

8	*	21mm	=	168mm	(top 8 strings)
5	*	22mm	=	110mm	(bottom 5 strings)
15	*	23mm	=	<u>345mm</u>	(remainder)
				623mm	from shoe #1 to shoe #29
				<u>+16mm</u>	to point C
				639mm	from point C to shoe #1

See model 7.String_holes, tabs 1–4

Armstrong 1904

-The measurements of the depth of the soundbox shown on Fig. IX, p. 60 are probably correct at that particular point. The measurement of the width of the side is taken at a point where the corner has been worn by the players’ hands and is probably correct at $3\frac{3}{8}$ ". The scaled drawings of the sides of the soundbox reproduced on plate I opposite p. 56 appears to be very accurate.

See model 3.Sides

-The thickness of the raised stringband given as $\frac{1}{8}$ " appears to be correct. Close-up photographs seem to confirm this.

See model 25.Box4, tab 5

-The overall depth of the soundbox given as 4" at about the tenth string hole would put the height of the swelling of the soundboard at $\frac{1}{2}$ ". This would be consistent with what can be observed on modern replicas of low-headed harps.

-The measurements of the thickness of the sides of the soundbox and of soundboard given by Armstrong on p. 62 cannot be confirmed at this time but there is no reason to doubt their accuracy.

-The scaled drawing of the soundboard reproduced on plate I opposite p. 56 is remarkably accurate. The position of most of the string shoes on the drawing accords with the photographs taken in 2012 within a margin of less than $\pm 1/32''$.

See models 22.Box1–25.Box4

-The shape and size of the sound holes and their position on the tuning side also accords with the 2012 photographs.

-The position of the sound holes on the string side and the edge of the soundboard however do not appear to correspond with the present shape of the soundbox. This could be due to the lack of reference points on the drawing caused by the missing decoration, distortion resulting from the flattening out of the 'gelatine rubbing' may also have been a factor in this.

See model 6.Armstrong_soundholes

-According to most sources, the soundbox is thought to be made of willow, Armstrong mentions 'black sallow', Petrie 'red sallow'. What can be seen of the wood grain in close-up photographs would appear to confirm this.

See model 29.Conservation_photos, tabs 1–3

-Close up photographs of the lower end of the soundbox show the growth rings to be relatively narrow indicating a slow-growing tree, possibly a goat willow?

See model 29.Conservation_photos, tab 4

-The back panel is made of a ring-porous hardwood, almost certainly oak.

See model 29.Conservation_photos, tabs 5–7

Measurements of the Forepillar

From the 1974 set

Forepillar

6. Outer length: 79cm (of which c 8cm is modern repair)
 7. Thickness (maximum): 8.5 cm
 8. Width (ignoring decorative foredge): 3cm
 - 8a. Length, decorative foredge: 57cm
- Internal space (string area)
11. Length across forepillar: 59cm

From the 2002 set

Point B to point C $23\frac{1}{2}$ "

From Armstrong 1904

From p. 62

Greatest breadth of the T-formation of the forepillar $2\frac{3}{4}$ "

From Fig IX, p. 60

- Distance between the end of the T-section and the upper termination of the forepillar $3\frac{1}{2}$ "
- Width of the narrow section of the forepillar at about the middle of the T-section $1\frac{1}{8}$ "
- Width at the upper end $3\frac{3}{8}$ "
- Overall width including the 'reptile's head' at the top of the forepillar $2\frac{3}{4}$ "

From the 2012 set

- Maximum width of the T-section $2\frac{3}{4}$ "
- D to E $28\frac{5}{8}$ "
- Minimum width of the flat section $1\frac{1}{8}$ "
- Width at the point where the pillar meets the neck $3\frac{3}{16}$ "
- Distance between point D and the beginning of the T-section $3\frac{1}{2}$ "
- Overall width at the upper 'reptile's head' $2\frac{3}{4}$ "

Notes

1974 measurements

6. The measurements of the ‘outer length’ of the forepillar given as 79cm and c[irca] 8.5cm for the modern repair or $31\frac{1}{8}''$ and $3\frac{1}{8}''$ appear to be correct.

See model 8.Forepillar_Curve, tab 2

7. The measurement given for the ‘maximum thickness’ of the forepillar as 8.5cm is incorrect and does not accord with Armstrong’s measurement of the ‘Greatest breadth of the T formation of the forepillar’ which is given as $2\frac{3}{4}''$ on p. 62, this measurement is correct and was confirmed in 2012.

This measurement may refer to the maximum width of the forepillar at the point where it meets the harmonic curve, the distance between points D and B, which measures $3\frac{5}{16}''$ or approximately 8.3cm. Curiously, this measurement wrongly reads $3\frac{3}{8}''$ or approximately 8.5cm on Armstrong’s sketch of the harp shown in Fig. IX, p. 60.

See model 9.Roundel_1, tab 2

8.The measurement of the ‘width’ of the forepillar ‘ignoring decorative foredge’ given as 3cm is broadly in accordance with the measurement shown on Armstrong’s sketch of the harp shown in Fig. IX, p. 60 for the minimum width of flat portion of the forepillar where it is given as $1\frac{1}{8}''$. This measurement varies according to what point on the forepillar it is taken from.

Alternatively this measurement could refer to the thickness of the forepillar, which it appears, varies between approximately 1" along the inside curve and $1\frac{1}{2}''$ at the lowest point on the outside curve. These measurements are unconfirmed and based on Armstrong’s scaled drawing of the inside curve and photographs.

See models 1.Lower_End, tab 3 and 8.Forepillar_Curve, tab 5

There is also a strong possibility that the measurements given in 7. and 8. are based on Armstrong’s photograph of the harp shown on Plate I. ‘Perspective and Front’ opposite p. 54 in which case both are simply wrong.

See model 10.T-section_Width, tab 1

With the scale of the photograph based on the lower end of the soundboard being 32cm wide as given in 1. above, the maximum and minimum width of the forepillar appear to be 8.5cm and 3cm respectively. Regardless of the exact viewing angle, the bottom of the soundboard and the two sections of the forepillar in question are on different planes. Consequently the widest portion of the T-section will always be closer in the frame and appear wider in comparison to other parts of the harp.

See model 10.T-section_Width, tabs 2–4.

8a.The measurement given for ‘length, decorative foredge’ (T-section) as 57cm is consistent with the measurement of the ‘outer length’ along the curve given in 6. above and is probably correct.

See model 8.Forepillar_Curve tab 3

11.The measurement given for the ‘length across forepillar’ as 59cm or approximately $23\frac{1}{4}$ " in what is termed here the ‘internal space or string area’ corresponds to the distance between points B and C and is correct on the string side.

See models 8.Forepillar_Curve, tab 6 and 20.Full_model, tab 2.

With the scale of the image based on the longest or thirtieth string being $25\frac{3}{4}$ " or 65.4cm, this measurement also coincides with the distance between points B and C on Armstrong’s drawing of the ‘Probable form of the Harp before it passed through the hands of the restorers’ (Fig. X, p. 60).

See model 19.Strings_1974, tab 3

2002 measurements

The only measurement of the forepillar given in the 2002 set is for the distance between points B and C, this is given here as $23\frac{1}{2}$ ".

This measurement varies according to which side of the harp it is taken from and is longer on the tuning side owing to the curvature of the forepillar. On the string side the measurement is approximately $23\frac{1}{4}$ " and corresponds to the measurement given in the 1974 set in 10. as above. On the tuning side the measurement is approximately $23\frac{3}{8}$ ".

See model 20.Full_model, tabs 2 and 3

Armstrong’s measurements

-The measurement given on p. 62 for the ‘greatest breadth of the T formation of the forepillar’ as $2\frac{3}{4}$ " is correct.

-The measurements of the forepillar shown on Fig. IX, p. 60 are all correct and confirmed in photographs taken in 2012 with one exception. The measurement given as $3\frac{3}{8}$ " for the width of the forepillar at the point where it meets the neck, the distance between points B and D, is slightly wide of the mark and should read $3\frac{5}{16}$ " or $3\frac{9}{32}$ ".

See model 9.Roundel_1, tabs 3 and 4

-Armstrong's scaled drawings of the four roundel decorations shown on plates III–VI, p. 57 are accurate.

See model 26.Roundels.

The forepillar is made of what appears to be a close-grained (diffuse-porous) hardwood. Most of the wood grain is obscured by the elaborate decorations, making further identification difficult but close-up photographs confirm that the forepillar is not made of oak as stated by George Petrie in his 'Memoir of an ancient harp preserved in Trinity College', published in Bunting's 1840 volume. This was also remarked on by Armstrong in a footnote on p. 55.

Cracks on the front of the T-section and the sides of the forepillar would seem to indicate that the pith runs through the middle of the piece of wood it is carved out of. In other words it might have been made out of a curved branch as opposed to having been cut out of a plank.

See model 29.Conservation_photos, tabs 8–11

Measurements of the Harmonic Curve

From the 1974 set

Neck

9 Length (soundbox to inlay): 46cm

9a Length (soundbox to inlay - top of inlay): 41.5 cm

Internal space (string area)

12. Length (straight) from pin 1 to pin 29: 30cm

Inlay area

13. Maximum height: 11.5cm

13a. Surviving crystal: 56mm x 27mm

From the 2002 set

-A to B: $12\frac{1}{2}$ "

-top peg to last peg: $11\frac{7}{8}$ "

-A to 1st peg: $2\frac{3}{8}$ "

-A to last peg: $14\frac{1}{8}$ "

-C to 1st peg: $26\frac{1}{4}$ "

-C to 15th peg: $22\frac{3}{4}$ "

-C to last peg: $25\frac{7}{8}$ "

-Distances between tunings pegs vary from 10m to 12 millimetres

From Armstrong 1904

Fig. IX, p. 60

Overall length 18"

Overall width $4\frac{1}{2}$ "

From the 2012 set

Pin 1 to pin 29 $11\frac{3}{4}$ "

Overall length from point F to top of the silver end cap $16\frac{1}{2}$ "

Overall length from point F to the bottom of the silver end cap 18"

Maximum thickness at about point D 49mm or $1\frac{15}{16}$ "

Notes

1974 measurements

9. The measurement of the harmonic curve given for the 'length (soundbox to inlay)' as 46cm or 18.11", where it would appear that 'inlay' refers to the silver end cap fitted on to the end of the harmonic curve, is longer than that given by Armstrong as 18". The measurement may refer to the distance between point F and the point furthest from this on the end cap and not the lower corner, which measures $18\frac{3}{16}$ ", this was confirmed in 2012.

See model 12.Neck_profile, tab 4.

9a. The measurement given here for the 'length (soundbox to inlay – top of inlay)' as 41.5 cm or $16\frac{3}{8}$ " is $\frac{1}{8}$ " shorter than that measured in 2012. Alternatively, the measurements given for 9 and 9a could be based on Armstrong's drawing of the harp Fig. X, p. 60 with either the distance between pins #1 and #29 or the longest string to scale.

See models 13.Armstrong_neck, tabs 1 and 2 or 19.Strings_1974, tab 4.

It should be pointed out that the silver end cap is not permanently fixed to the harp and is not currently in the same position as it was in 1904. So these measurements cannot be definitive.⁷

See model 11.End_cap_movement

Internal space (string area)

12. The measurement given for the 'length (straight) from pin 1 to pin 29' as 30cm is $\frac{1}{16}$ " longer than the distance between the pins at the point where the strings are attached. Because pin #29 is not parallel with pin #1, the distance between the pins increases towards the tuning side where it is approximately $12\frac{3}{32}$ " at the ends of the pins. 30cm is probably the correct at the points where the tuning pins emerge from the neck on the string side.

See model 14.Tuningpegs_angle

Inlay area

13. and 13a. The measurements given for the 'maximum height' as 11.5cm of the 'inlay area' and the dimensions of the 'surviving crystal' as 56mm x 27mm are in accordance with Armstrong's scaled drawing of the silver end cap.

See model 17.End_cap

⁷ My thanks to Michael Billinge for bringing this to my attention.

2002 measurements

-The measurement given for the distance between points A and B as $12\frac{1}{2}$ " is incorrect. This is possibly a typographical error and should read $12\frac{1}{16}$ ", as measured in 2012.

See model 12.Neck_profile, tab 2

It should be noted that the curve of the neck and the protruding tuning pins make it impossible to measure the distance between those points in a straight line with a ruler or a measuring tape.

-The measurement given for the 'top peg to last peg' as $11\frac{7}{8}$ " is probably correct through the theoretical middle of the harmonic curve.

See model 14.Tuningpegs_angle

-The measurement given for the distance from point 'A to 1st peg' as $2\frac{3}{8}$ " is correct taken at an angle from the centre of the end of the tuning pin to the point where the neck meets the soundbox nearest the middle. The distance in a straight line between those points through the theoretical middle of the harp is slightly less, $2\frac{5}{16}$ ".

See model 12.Neck_profile, tab 3

-The measurement given for the distance from point 'A to last peg' as $14\frac{1}{8}$ " is also correct. It is not possible to take this measurement in a straight line. This would be the distance between those points through the middle of the harp.

See model 12.Neck_profile, tab 3

-The measurement given for the distance from point 'C to 1st peg' as $26\frac{1}{4}$ " is incorrect. With point C placed at 16mm or $\frac{5}{8}$ " from the point where the string emerges from the 29th stringhole this distance measures 26". With point C placed at the point where the forepillar actually meets the soundbox (the reconstructed portion of the forepillar is stepped in order to avoid the lowest string shoe) the distance is $26\frac{3}{16}$ ".

See model 20.Full_model, tab 3

-The measurement given for the distance from point 'C to 15th peg' as $22\frac{3}{4}$ " appears to be correct measured from point C 16mm or $\frac{5}{8}$ " from the point where the string emerges from the 29th string hole.

See model 20.Full_model, tab 3

-The measurement given for the distance from point 'C to last peg' as $25\frac{7}{8}$ " is incorrect; this also contradicts the length of the longest string given as $25\frac{3}{4}$ ", which is itself

incorrect. With point C placed at 16mm or $\frac{5}{8}$ " from the point where the string emerges from the 29th string hole this distance is approximately $25\frac{5}{8}$ ". With point C placed at the point where the forepillar actually meets the soundbox the distance is $25\frac{7}{8}$ " to the top of the 29th tuning pin.

See model 20.Full_model, tab 3

-The 'Distances between tunings pegs' vary from 10.2mm to 14.4mm and not 10mm to 12 mm with the tuning pegs being closer towards the middle, although this may be different on the tuning side.

See model 15.Peg_spacing

Armstrong's measurements

The measurements of the overall length of the harmonic curve and the maximum width at the silver end cap given as 18" and $4\frac{1}{2}$ " respectively are correct.

Note that the current location of point F on the harmonic curve was lower in Armstrong's time, nevertheless the measurement is the same.

The neck and the soundbox appear to be made of the same type of wood. Armstrong also remarks on this on p. 55. Close-up photographs show that the wood grain runs across the neck from end to end and does not follow the curve.

See model 16.Grain_direction.

Part II

Measurements of the Trinity College harp as given by R. B. Armstrong

The measurements of the Trinity College harp given by Robert Bruce Armstrong in *The Irish and Highland Harps* are few and difficult to interpret. In his description of the instrument and commentary the author seems to be generally more concerned with the decoration scheme than with precise dimensions. Although it is possible to reconstruct a reasonably accurate profile of the harp as it was in 1904 based on the information supplied by Armstrong, the process is less than straightforward. Some of his drawings are remarkably precise but others are not to scale and lack in detail.

Some measurements are given in the text on p. 62 as follows:

- Shortest string 3" *Originally* probably $2\frac{3}{4}$ "
- Longest string $27\frac{1}{2}$ " *Originally* probably $25\frac{3}{4}$ "
- Soundboard thickness rather less than $\frac{1}{4}$ "
- Thickness of the sides of the soundbox $\frac{5}{8}$ " becoming 'much thinner' towards the soundboard
- Greatest breadth of the T formation of the forepillar $2\frac{3}{4}$ "

Armstrong then refers the reader to Fig. IX, p. 60 for 'other measurements of the harp in its present state'. More measurements can be gleaned from the scaled drawings on pp. 57–8, figures III–VIII and the drawings taken from gelatine rubbings of the soundboard and sides of the soundbox shown on the full-page plate 'Ancient Harp, Trinity College, Dublin, "Details R.B.A."' opposite p. 56.

Measurements given in Fig. IX, p. 60

- Maximum height from the back of the harp to the end of the harmonic curve $18\frac{5}{8}$ "⁸
 - Distance between the point where the forepillar meets the soundbox and the lower extremity of the silver ornament on the end of the harmonic curve $28\frac{1}{4}$ "⁹
 - Overall length of the harmonic curve 18"
 - Maximum width of the harmonic curve at the pillar end or the height of the silver ornament $4\frac{1}{2}$ "
 - Width of the side of the soundbox at about string-hole #10 $3\frac{3}{8}$ "
 - Thickness of the string band at that point $\frac{1}{8}$ "
 - Overall thickness of the soundbox at that point including the swelling of the soundboard 4"
 - Width of the forepillar at that point $2\frac{3}{4}$ "
 - Overall height at that point $18\frac{1}{8}$ "
 - Distance in a straight line between the lower termination of the forepillar and beginning of the T-section 8"
 - Distance between the end of the T-section and the upper termination of the forepillar $3\frac{1}{2}$ "
 - Width of the narrow section of the forepillar at about the middle of the T-section $1\frac{1}{8}$ "
 - Width of the forepillar at the upper end $3\frac{3}{8}$ "
-

⁸ The hand-written number is difficult to read but $18\frac{5}{8}$ " seems to be consistent with the other measurements.

⁹ Exactly where this line should terminate is not clear from the drawing.

Reconstructing the profile

The following analysis shows how a ‘reasonably accurate’ profile of the harp could be reconstructed based solely on the information provided by Armstrong. This is now largely redundant in light of what has been outlined in Part I of this report and it is merely presented here for the sake of curiosity.

It would be tempting to enlarge the sketches provided by Armstrong on p.60 following the measurements given and use the resulting outlines to reconstruct the harp but there are major pitfalls associated with this method. A cursory examination of Fig. IX, shows that the proportions of the drawing do not accord many of the measurements shown.

See model 21.Armstrong_Fig.IX, tabs 1 and 2

This sketch is evidently derived from the photograph ‘Ancient Irish Harp, Trinity College, Dublin, Left Side’, shown on the full-page plate opposite p. 58 and as such it is probably not intended to represent an actual two-dimensional plan of the harp.

See model 21.Armstrong_Fig.IX, tab 3

When an outline of the photograph is superimposed onto Fig. IX, the harmonic curve and the upper end of the soundbox are a near perfect match but at the lower end the tracing extends much further to the left. Hence it would appear that the proportions of the drawing have been re-scaled along the horizontal axis.

See model 21.Armstrong_Fig.IX, tabs 4 and 5

When the outline of the photograph is re-scaled by 2.5% along the horizontal axis from the left, this new outline matches the drawing perfectly.

See model 21.Armstrong_Fig.IX, tabs 6 and 7

The reasons why the proportions of the drawing would have been altered are unknown. It could be that Armstrong did intend to show an accurate representation of the profile of the harp as it was and felt it necessary to re-size the horizontal aspect of the drawing in order to cancel out the effects of perspective. However, comparing the length of the soundbox on Fig. IX with the scaled drawing of the soundboard on the full-page plate ‘Ancient Harp, Trinity College, Dublin, Details R.B.A.’ opposite p. 56 shows both drawings to be at odds with one and other.

See models 21.Armstrong_Fig.IX, tab 8–10

In fact comparing the drawing of the soundboard with the original photograph reveals that the sketch should have been stretched in the opposite direction in order to correct the aspect ratio. Had it been re-scaled in this way, Fig. IX would indeed represent a more accurate two-dimensional profile of the harp as it was in 1904.

See model 27.Photo_scale, tabs 1 and 2

Armstrong's drawing of 'The probable form of the harp before it passed through the hands of the restorers' Fig. X, p. 60 is resized in the same way as Fig. IX and as a consequence the overall proportions of this drawing are also wrong. In addition, Armstrong excluded the metal collar from this drawing and effectively 'shortened' the upper termination of the soundbox, beyond what the reality could ever have been, making the outline of this sketch completely unreliable as a possible aid to reconstruction.

Preserving the exact proportions of an object is difficult if not impossible with a photograph. The harmonic curve was noticeably tilted in Armstrong's time¹⁰ and it probably should not be possible to see the underside of the curve had the harp been photographed with the stringband perpendicular to the lens. As this is visible, albeit barely, it seems possible that the photograph could have been taken with the stringband at a slight angle in order to present a more 'head on' view of the harmonic curve.

See model 29.Underside

Indeed comparisons with the 2012 photographs show that Armstrong's photograph gives a very good representation of the curve. It seems therefore possible that the slight discrepancy in the aspect ratio of the photograph (~1.5%) could be explained in this way.

To sum up, it is possible to reconstruct a viable two-dimensional plan of the harp based solely on the information supplied by Armstrong. By combining the drawing of the harmonic curve as shown on Fig. IX and the scaled drawing of the soundboard for the horizontal aspect of profile, the only remaining uncertainty would be the distance between points B and C and the shape of the lower end of the forepillar and this can be gleaned from the measurements given in the text for the longest string.

See model 28.Armstrong_profile, tabs 1–7

The resulting profiles could therefore be deemed 'reasonably accurate' representations of the harp in its then 'distorted' state or as it might have been in its heyday but their accuracy would rely on the relationship between the scaled drawing of the soundboard and the measurements shown on Fig. IX being consistent. With no other way to corroborate this, there would always have been some doubt as to their correctness.

¹⁰ 'Plate I, Perspective and front', full-page plate opposite p. 54.

All of Armstrong's measurements accord with those taken in 2012, which would seem to indicate that the harp has not shrunk in the last hundred years or so but there is one exception to this. The measurement given as $3\frac{3}{8}$ " for the width of the forepillar at the point where it meets the harmonic curve would appear to be an error. Although more or less consistent with the drawing this presently measures $3\frac{9}{32}$ " and could be rounded up to $3\frac{5}{16}$ "¹¹ but as the measurements appear to be given to the nearest $\frac{1}{8}$ " we would expect the figure to be rounded down to $3\frac{1}{4}$ " instead. This could simply be a typographical error. However, the distance between the same points on the cast of the Trinity College harp now preserved at the National Museum of Ireland Collins Barracks (DF:1886.1) is approximately $3\frac{1}{2}$ ", suggesting that this portion of the harp at least might have shrunk considerably since the cast was made, sometime between 1853 and 1886.

¹¹ See Part I, Measurements of the forepillar and also model 9.Roundel_1, tabs 3 and 4.

Conclusions

Having assessed all the measurements of the harp previously available in light of those taken in 2012 the following conclusions have been reached:

With the exception of the measurement given as $3\frac{3}{8}$ " on Fig. IX, p. 60 for the width of the forepillar at the point where it meets the neck, which is approximately $\frac{3}{32}$ " wide of the mark, all the measurements provided by Armstrong appear to be correct. The scaled drawings of the silver end cap and the roundel decorations of the forepillar (pp. 57–8 figures III–VIII) and those shown on the full-page plate opposite p. 56 are remarkably accurate, particularly in respect of the distances between the string-shoes on the drawing of the soundboard, most of which appear to be within $\frac{1}{32}$ " of the correct values.¹² Considering the number of layers involved in the production of such a drawing and the potential for error in each of these, the level of precision achieved by Armstrong and his engraver at all stages of the process is nothing short of astonishing.

In contrast, the sketches of the harp shown on p. 60 appear to have been re-scaled along the horizontal axis, distorting the shape of the harp. The reasons for this are unknown, it may just be the result of a simple error on Armstrong's part but a most uncharacteristic one and very much at odds with the otherwise meticulous nature his work.

It is difficult to come to any firm conclusions as to how the measurements given in the 1974 set were gathered. Some measurements would appear to be of the harp while others seem to have been taken from Armstrong's photographs and drawings or possibly copied from other sources. The measurements of the strings allegedly 'made in 1974' are clearly not of the strings on the harp but taken from Armstrong's distorted Fig X sketch. Other measurements appear to be reasonably accurate. The measurements of the forepillar are most intriguing. Those given for the outer curve of the forepillar including the modern repair seem to be correct and can only have come from the harp while the rest appear to have been taken from the photograph of the front of the harp, Plate I 'Perspective and front', full-page plate opposite p. 54 and are clearly wrong.¹³ So it would seem likely that these measurements were collated from at least two different sources.

Unlike those given in the 1974 set, the measurements in the 2002 set are of the harp, apart from the measurement of the longest string, which is given as $25\frac{3}{4}$ ". While this coincides with Armstrong's estimate it contradicts the other measurements given in the set. The longest string presently measures $25\frac{1}{8}$ " and this broadly accords with the rest of the set. The measurement of the distance between points A and B given as $12\frac{1}{2}$ " could be a typographical error and should probably read 12", the distance between these points being just slightly over 12" in reality. It seems that a number of measurements in this set may have been taken with a flexible measuring tape (such as the type used in the tailoring industry) and that this was not fully stretched, giving a false reading and leading to slightly longer measurements. This would account for most of the discrepancies between this and the 2012 set.

¹² See models 22.Box1–25.Box4.

¹³ See model 10.T-section_width.

Once it can be established exactly where the points being measured to and from are located on the harp, all three sets of measurements are reasonably consistent. In most instances, the discrepancies can be attributed to typographical errors while some differences between one set of measurements and another will be due to a lack of precision in the equipment used. What would appear to be irreconcilable differences between all three sets and the harp itself stem from the fact that none of the measurements of the strings given are of the actual strings and that all are incorrect.

Armstrong gives the measurements of the longest and shortest strings on the harp as it was in 1904 and estimates that 'originally' they were probably $25\frac{3}{4}$ " and $2\frac{3}{4}$ " respectively. His measurements of the 1904 reconstruction are most probably accurate but the present shape of the harp is very different. All the measurements of the strings given in the 1974 set are incorrect and although they coincide with Armstrong's estimate, the measurements of the strings given in the 2002 set are also incorrect. At present, string #1 measures 68mm or $2\frac{11}{16}$ " just $\frac{1}{16}$ " shy of $2\frac{3}{4}$ " and string #29 measures $25\frac{1}{8}$ ".

The measurements given in the 2012 set are as accurate as can possibly be, within the error margins of the methods used to collect them. They are of the harp in its present state and do not represent the shape of the instrument as it would have been when it was first strung. A certain amount of interpretation is required in order to arrive at a reconstruction of the harp in its original state. Shrinkage and the fact that the limbs of the harp have warped under the tension of the strings over the course of its playing life have to be accounted for. The 2012 set of measurements should not therefore be thought of as definitive but as a solid foundation upon which such a reconstruction could be built.

Appendix I

Measurements of the harp supplied by Trinity College

-BrianBoruHarp.doc (2002 set)

The contents of the file are copied from the original received from Trinity College. The original formatting, spelling, etc. has been retained. The page number in square brackets is not part of the original.

DAVID KORTIER

HARPMAKER

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Measurements- Trinity College Harp

collected by David Kortier, Ann and Charlie Heymann

January 2002

We selected as arbitrary reference points for measurements the following triangle:

- A) the point where the neck (harmonic curve) meets the soundbox
- B) the point where the neck (harmonic curve) meets the vertical pillar
- C) the point where the pillar meets the soundbox

Most measurements were taken in relation to these points. The intent was to provide a check, in conjunction with the accompanying photos, to establish the accuracy of any subsequent drawings made of the harp.

Distance in inches, unless otherwise indicated-

A to B: 12-1/2

A to C: 27

B to C: 23-1/2

top peg to last peg: 11-7/8

A to 1st peg: 2-3/8

A to last peg: 14-1/8

C to 1st peg: 26-1/4

C to 15th peg: 22-3/4

C to last peg: 25-7/8

Shortest string: 2-3/4

Longest string: 25-3/4

C to top shoe: 24-3/4 (point where string emerges)

C to 15th shoe: 12-5/8

C to last shoe: 16 mm

B to 15th shoe: 13

Comments:

29 tuning pins, probably brass, handworked, not uniform, 3-1/4 to 3-1/2 inches in length, 4-1/2 to 5 millimetres in diameter where they emerge from the neck on the string side.

Thin brass bands connecting tuning pins, decorated, held in place with small nails.

Four soundholes, 3/4 inch in diameter.

Soundboard 15 mm thick at stringband, 7 mm thick at sound holes.

29 string holes in soundbox, with shoes that appear original, top three are a different design and appear somewhat crude in comparison.

Distances between tuning pegs vary from 10 to 12 millimetres.

Distances between shoes (string holes) are consistently 23 mm throughout, dropping to 21 mm at top 8 strings, and 22 mm at bottom 5 strings.

Harp has been blocked inside to correct deformed box, and overcoated with a gloss finish.

Appendix II

Measurements of the harp supplied by Trinity College

-HARPINFO.DOC (1974 set)

The contents of the file are copied from the original received from Trinity College. The original formatting, spelling, etc. has been retained, page numbers in square brackets are not part of the original.

*Characteristics of the College harp are that although an early Irish harp it is described as an 'advanced developed harp' (Roslyn Rensch) and is of the small low-headed type, with a hollowed-out wooden sounding board (of which the essential parts are all of one piece of wood, though the cavity -or the aperture - is covered over with a separate piece of wood) (Roslyn Rensch).

*The origin of the College harp is obscure and legendary. It seems to have been played in the streets of Limerick in 1760 by Arthur O'Neill (around which time an O'Neill coat of arms, now lost, was added to the forepillar), to have been presented to Trinity College in 1782 by the Right Honorable William Burton Conyngham in a dismembered state, and to have been placed by College in the University Museum. It was restored by Dr Robert Ball, of Dublin University Museum, inexpertly (but by analogy with other harps) before July 1853. It was shown in the Dublin Exhibition of 1853 as the oldest known specimen of an Irish harp, and as 'commonly called the harp of Brian Boroimhe'.

An anonymous poet of 1810 records its appearance at that time in his notes to his poem Erin (London: Hamblin & Seyfang, for the author, 1810): It is thirty-two inches high, and of extraordinary good workmanship. The sounding-board is of oak, the arms of red sally; the extremity of the uppermost arm is part capped with silver, extremely well wrought and chiseled. It contains a large crystal set in silver, and under it was another stone, now lost &c. This harp has twenty-eight strings ... The foot-piece, or rest, is broken off, and the parts, round which it was joined, are very rotten. The whole bears evidence of an expert artist.' and then he records the traditional or legendary history as follows Brien [ie Brian Borumha]'s son Donagh, having murdered his brother Teighe, fled to Rome, carrying with him the regalia and this harp, which he gave to the Pope, in order to obtain absolution for the murder of his brother. It was kept in the Vatican until the reign of Henry VIII to whom the Pope sent it. Henry gave it to the first earl of Clanricard. In his family it remained till the beginning of the last century. A lady of the De Burgh family brought it into the possession of MacMahon of Clenagh, in the county of Clare. After his death Commissioner Macnamara of Limerick had it. By him it was presented to the Right Honourable William Conyngham, who deposited it in Trinity-College Library.'

* A harp in gold with silver strings on a blue background has been used as the heraldic symbol of Ireland since medieval times, later - from the 1790s - on a dark olive green background, later still on a lighter green.

It is also used on coins and emblems and government stationery. The same design is also the arms of Leinster, one of the four provinces of Ireland. The design of the harp, as used in such heraldic contexts in

the Republic of Ireland, has in recent times always been based on the College harp. However neither the harp as such nor the design based on the College harp have constitutional or statutory status as symbols of Ireland.

*Below are measurements of the strings of the College harp. These show the harp as reconstructed in the British Museum Research Laboratory in 1961 (when a recording was made by the BBC; ref LP 27038), and again in 1971, ref : British Museum RL file 2231 of 3 December 1971.

Further information about Irish harps is available in

Joan Rimmer, *The Irish harp* (Dublin: Mercier Press, 1969 and later reprints);

in Edward Bunting, *The ancient music of Ireland arranged for the pianoforte* (Dublin: Hodges Smith, 1840: note edition) especially pp 40-43 and plates opposite pp 37, 40, 43;

in Robert Bruce Armstrong, *Musical instruments part I: the Irish and the highland harps* (Edinburgh 1904), pp 55-62 (and the plates between these pages);

in Roslyn Rensch, *The harp: its history, technique and repertoire* (London: Duckworth, 1969) pp 84-5, 89,

and in Roslyn Rensch, *Harps and harpists* (London: Duckworth, 1989);

in Christine Rolin Y Delyn and others, *Cláirseach, la harpe irlandaise: aux origines de la harpe celtique* (Plounéour-Ménez: Hent Telenn Breizh, 1998), which has a bibliography, mainly of French works and mainly concerning the Queen Mary harp;

and in Séamas Ó Brógáin, *The Irish harp emblem* (Dublin: Wolfhound Press, 1998)

Older information and speculation is to be found in Charles Vallencey, *Collectanea hibernica* (Dublin 1786), II pp 32-37, and VI p 7;

Eugene O'Curry, *On the manners and customs of the ancient Irish* (London: Williams and Norgate, 1873), III (lectures vol II), pp 263-280, especially 266-70.;

George Petrie, 'Memoir of an ancient harp preserved in Trinity College', often cited as 'Memoir' or as 'Essay' in Bunting op cit ;

Samuel Bunting, 'Dissertation on the antiquity of the harp and bagpipe in Ireland' in Bunting, op cit ; on the silver hand once attached to the forepillar see R Day, 'The O'Neill badge', in JRSAl 21 (1890-1891), pp 282-283; in TK Abbott, 'The Library' in The book of Trinity College Dublin (Belfast 1892), pp 171-2.

There are descriptions in other languages in Trésors d'Irlande (AFAA, Paris'1982),

Treasures of Irish art (Dublin: Royal Irish Academy) translated into German and Dutch as < Irische Kunst aus drei Jahrtausenden (Mainz: Philip von Zabern 1983) and as Ierse kunst (Philip von Zabern 1983); in Danish in Louisiana revy of 1984.

The College harp is shown on p 32 of Joan Rimmer's book and is described on p 33 and pp 77-8; and in a French context in Christine Rolin Y Delyn op. cit supra, cover and p 20.

The Castle Otway harp which is also in Trinity College Dublin Library is shown on p 50 and described on p 77 of Joan Rimmer's book; it is also described in pp 73-79 of RB Armstrong's book and illustrated in plates opposite pp 74, 77 and on p 76; and in Roslyn Rensh's book it is described on pp 114-120 and shown in figure 76; and in Christine Rolin Y Delyn op. cit supra, pp 16 and 23 (and a modern copy of it is illustrated on p 54). A harp belonging to Patrick Quin (c1745-1812) is shown in the painting The blind harper by (or after) Thomas Robinson; this harp made in 1707 by Cormac O'Kelly of Ballynascreen Co Derry, was played in Belfast in 1792 at the Harp Festival, and thereafter went to Dublin with Patrick Quin and eventually to Castle Otway Up in arms Ulster Museum exhibition catalogue 1998, p 130).

College (Brian Boru) Harp : measurements

Soundboard

1. Maximum width: 32cm
2. Minimum width: 12cm
3. Length at side: 74cm
4. Length at centre: 71.5cm
5. Wood thickness (visible in soundhole): c 5.5mm
- 5a. Depth of soundbox: 82-85mm
- 5b. Soundhole (diameter) 1.8cm

Forepillar

6. Outer length: 79cm (of which c 8cm is modern repair)

- 7. Thickness (maximum): 8.5 cm
- 8. Width (ignoring decorative foredge): 3cm
- 8a. Length, decorative foredge: 57cm

Neck

- 9 Length (soundbox to inlay): 46cm
- 9a Length (soundbox to inlay - top of inlay): 41.5 cm

Internal space (string area)

- 10. Length along string holes: 68cm
- 11. Length across forepillar: 59cm
- 12. Length (straight) from pin 1 to pin 29: 30cm

Inlay area

- 13. Maximum height: 11.5cm
- 13a. Surviving crystal: 56mm x 27mm

College (Brian Boru) Harp : measurements of the strings made in 1974

String Length (centimetres)
number

1	6.0
2	6.9
3	7.7
4	8.8
5	9.7
6	11.1
7	12.5
8	13.8
9	15.6
10	17.1
11	18.8
12	20.6
13	22.6
14	24.7
15	26.8
16	29.0
17	31.1
18	33.5
19	36.0
20	38.4

21	41.2
22	43.8
23	46.5
24	49.0
25	51.7
26	54.4
27	57.0
28	59.8
29	62.5

Appendix III

Summary of the measurements

Tables 1a and 1b below highlight the differences between all the measurements collected. Measurements shown in **bold black** have been measured in 2012 and are also confirmed in the photographs taken and in the 3d models, those shown in **bold indigo** are also confirmed in photographs including a ruler in the frame. Measurements shown in **bold blue** are only confirmed in the 3d models.

Measurements shown in **bold maroon** are within $\pm 1/8''$ of the correct value, those shown in **red** are more than $1/8''$ wide of the mark.

Armstrong's measurement of the longest string given in table 1b is based on the thirtieth string having been $25\frac{3}{4}''$ when it was added. It must be assumed that the measurement given in Tree of String also refers to the 29th string as this coincides with Armstrong's estimate even though the total number of strings is given as thirty.

The 2012 measurements are given to the nearest $1/16$ inch, more precise values may be obtained by increasing the resolution in the models where applicable.

Table 1a Measurements of the Harp

Measurements	Armstrong 1904	1974 Set	Imperial equivalent	2002 Set	2012 set	Notes	Tree of Strings
Soundbox							
Max. width		32cm	12.6		12-5/8"		12-1/2"
Min. width		12cm	4.72		4-3/4"		4-3/4"
Length sides		74cm	29.93		74cm		
Length Center		71.5cm	28.14		71.5cm		28-1/4"
Depth min.	3-3/8"	8.2cm	3.22		3-3/8"	and 3-1/2" top	3-3/8"
Depth max.		8.5cm	3.34		3-3/8"	and 3-3/4" bottom	4"
C to shoe 1				24-3/4"	24-3/4"		
C to shoe 15				12-5/8"	12-5/8"		
C to shoe 29				16mm	16mm		
Sound holes		1.8cm	0.7	3/4"	3/4"	1.9cm	
Neck							
Soundbox to inlay		46cm	18.11		18-3/16"	to furthest point	
Soundbox to inlay top		41.5cm	16.33		16-1/2"	to top corner	
Max length	18"				18"	to lower corner	18"
Thickness					49mm		
Forepillar							
Outer length		79cm	31.1		79cm	8cm for modern repair	
Maximum Width T	2-3/4"	8.5cm	3.34		2-3/4"	7cm	2-3/4"
T section length		57cm	22.44		57cm		
Min width mid-T	1-1/8"	3cm	1.18		1-1/8"	Excluding T-section	
Width at the top T	2-3/4"				2-3/4"	Including T-section	
Width at the top	3-3/8"				3-5/16"		3-5/8"
Top to T-section	3-1/2"				3-1/2"		
Silver End Cap							
Max height	4-1/2"	11.5cm	4.52		11.5cm		
Crystal height		5.6cm	2.20		5.6cm		
Crystal width		2.7cm	1.06		2.7cm		
Other							
Pin 1 to pin 29		30cm	11.81	11-7/8"	11-3/4"		
Pin 1 to pin 15					6-7/16"		
Pin 15 to pin 29					6-1/4"	(6-15/64")	
A to B				12-1/2"	12-1/8"		
B to C		59cm	23.22	23-1/2"	23-1/4"	23-3/8" on the tuning side	
C to A				27"	26-15/16"		27 3/8"
D to E					28-5/8"		
C to pin 1				26-1/4"	26"		
C to pin 15				22-3/4"	22-3/4"		
C to pin 29				25-7/8"	25-5/8"		
B to shoe 15				13"	12-3/4"		
A to pin 1				2-3/8"	2-3/8"		
A to pin 29				14-1/8"	14-1/8"		
Shoe 1 to 29					24-1/8"		
Along string holes		68cm	26.77		26-15/16"		
Roundels					2-3/4"	diameter	

Table 1b Measurements of the Strings

Measurements	Armstrong 1904	1974 Set	Imperial equivalent	2002 Set	2012 set	Notes	Tree of Strings
Strings							
Longest (29th)	24-5/8"	62.5cm	24.60	25-3/4"	25-1/8"		24-5/8"
Shortest	2-3/4"	6cm	2.36	2-3/4"	2-11/16"		2-7/8"
String 15		26.8cm	10.55		~11"		

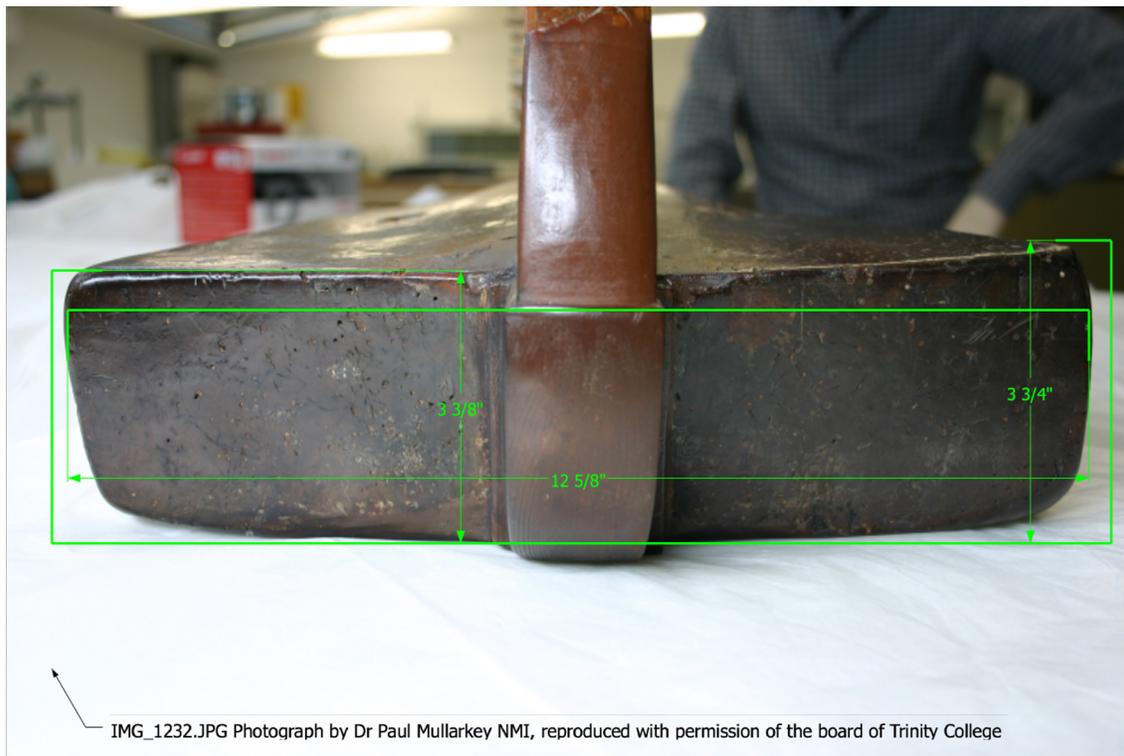
Appendix VI

Sample Images

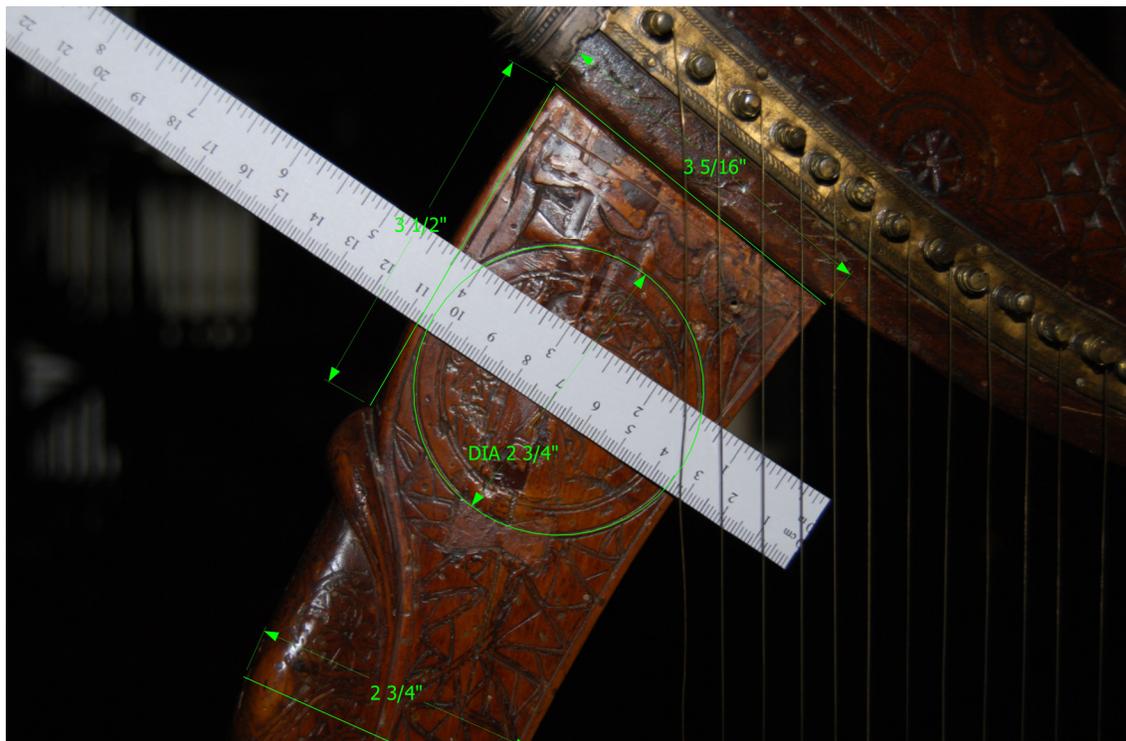
The images shown here are derived from some of the SketchUp models referred to in this report and serve to illustrate the methods used to analyze and compare photographs and drawings of the harp with various measurements. It may be necessary in some cases to zoom in on the sample image in order to view the measurements and the annotations. The photographs of the harp featured in the models are reproduced with permission of the board of Trinity College Dublin and may not be copied or disseminated in any way. The original models can be found in the 'Resources' folder accompanying this report, which can be downloaded here:

<http://www.pauldooley.com/report2012/resources.zip>

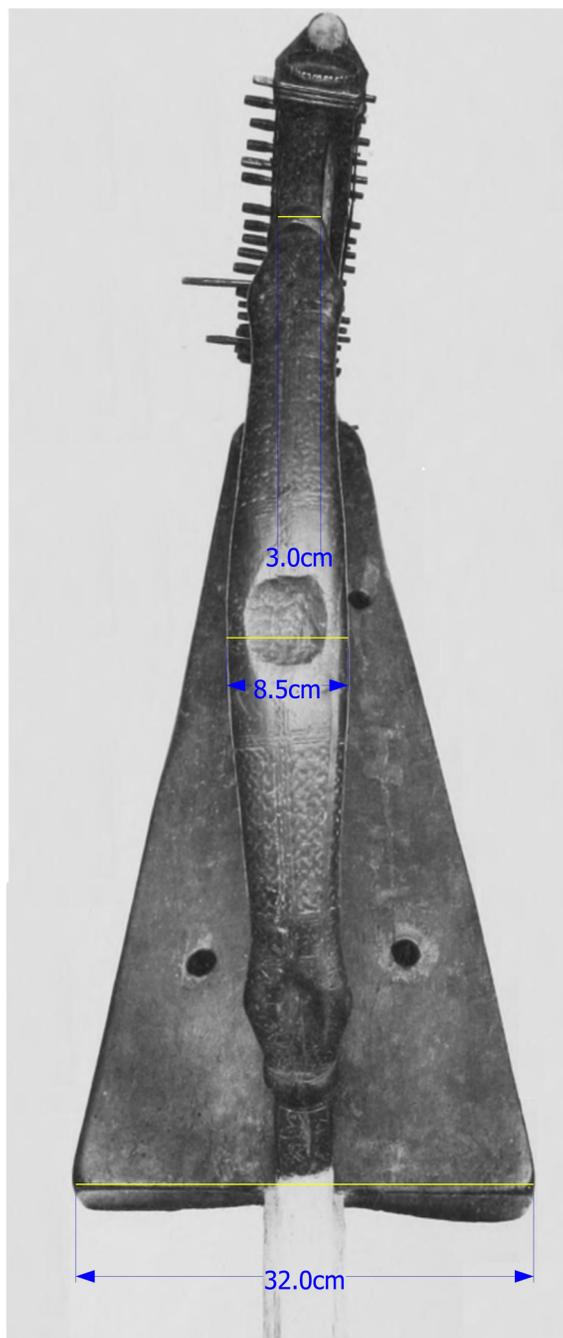
SketchUp models of the configurations discussed in the article 'Reconstructing the Medieval Irish Harp' are also included and can be found in the 'Configurations' sub-folder.

Sample 1

Model 1.Lower_end, tab 2, showing the underside of the soundboard and the varying width of the sides, photograph by Dr Paul Mullarkey NMI, reproduced with permission of the board of Trinity College Dublin.

Sample 2

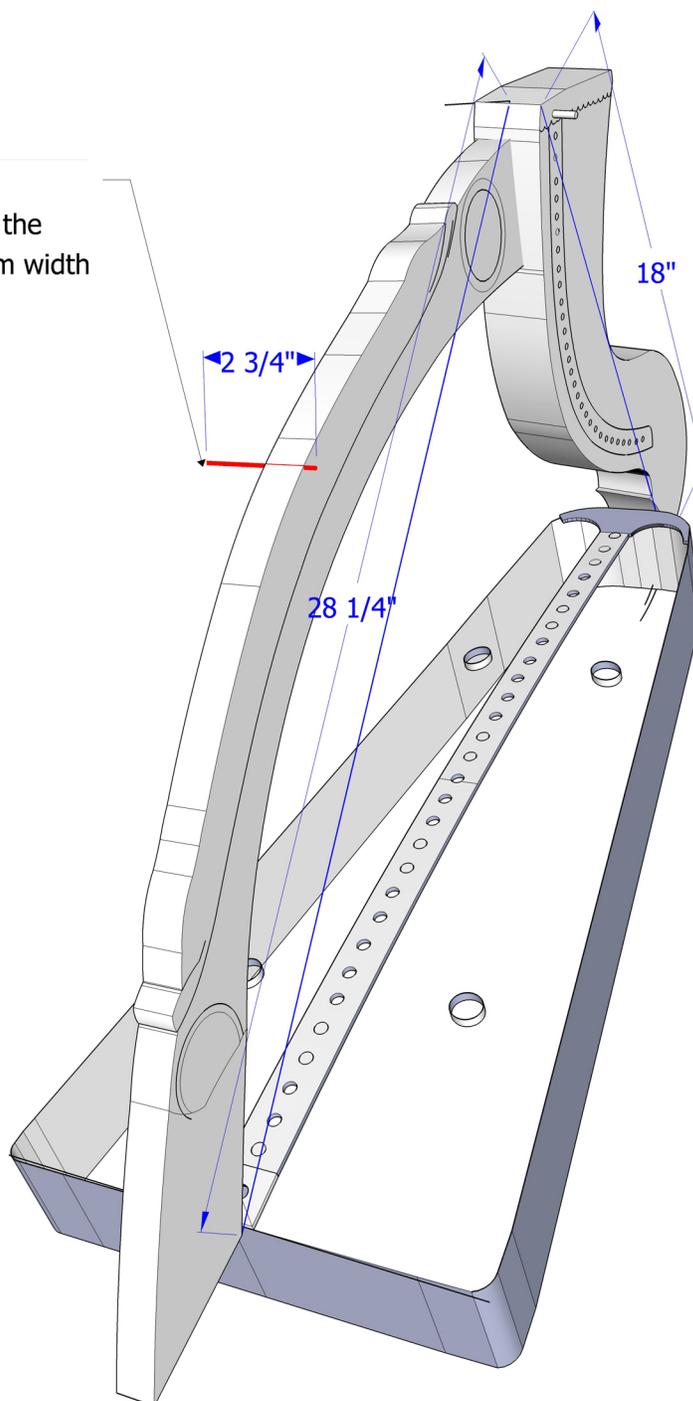
Model 9.Roundel_1, showing the measurements of the upper end of the forepillar. Photograph by the author, reproduced with permission of the board of Trinity College Dublin.

Sample 3

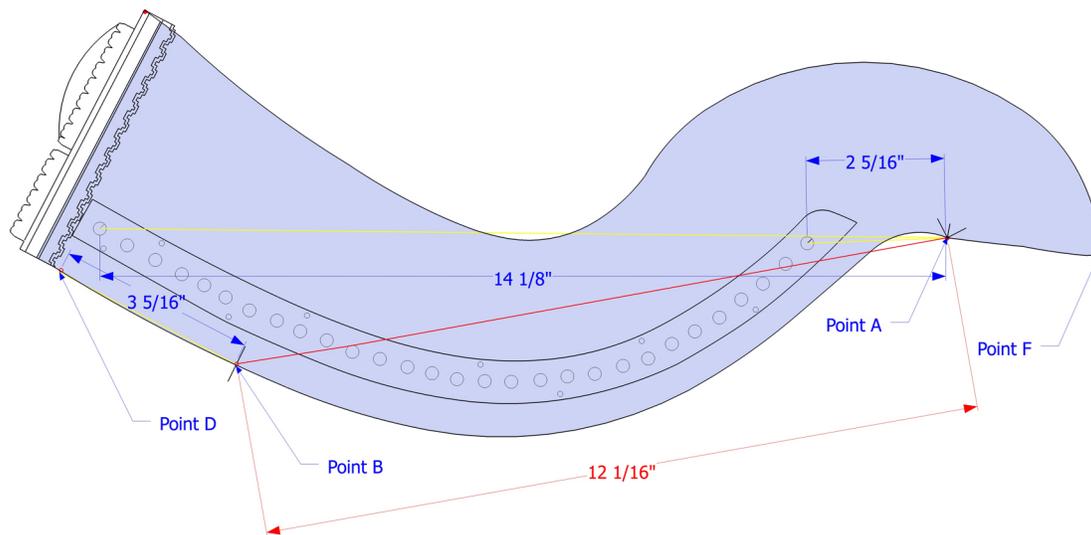
Model 10.T-Section_width, tab 1, showing how the measurements of the width of the forepillar given in the 1974 set were probably derived from Armstrong's photograph of the front of the harp.

Sample 4

3D model of the harp
in its pre-1961 state showing the
measurement of the maximum width
of the forepillar at $2\frac{3}{4}$ "

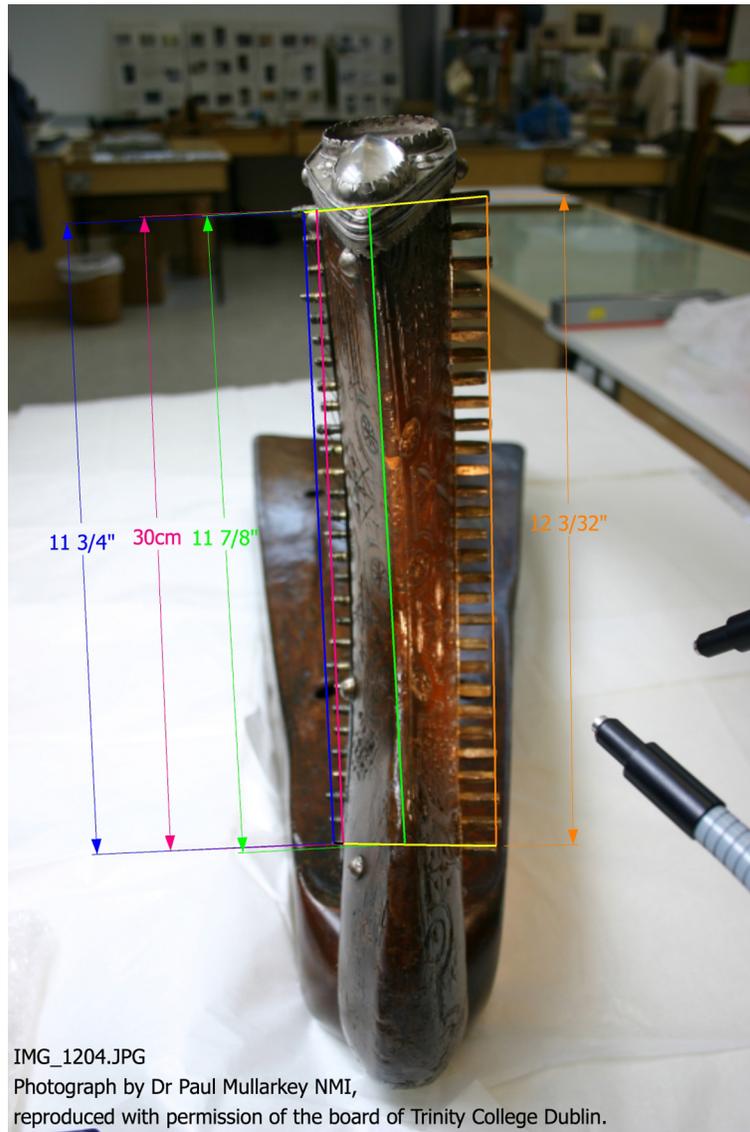


Model 10.T-Section_width, tab 3, showing the correct measurement of the width of the T-section of the forepillar in perspective. Note that the limbs of the harp are shown here for reference and that this model does not take account of their present distorted shape.

Sample 5

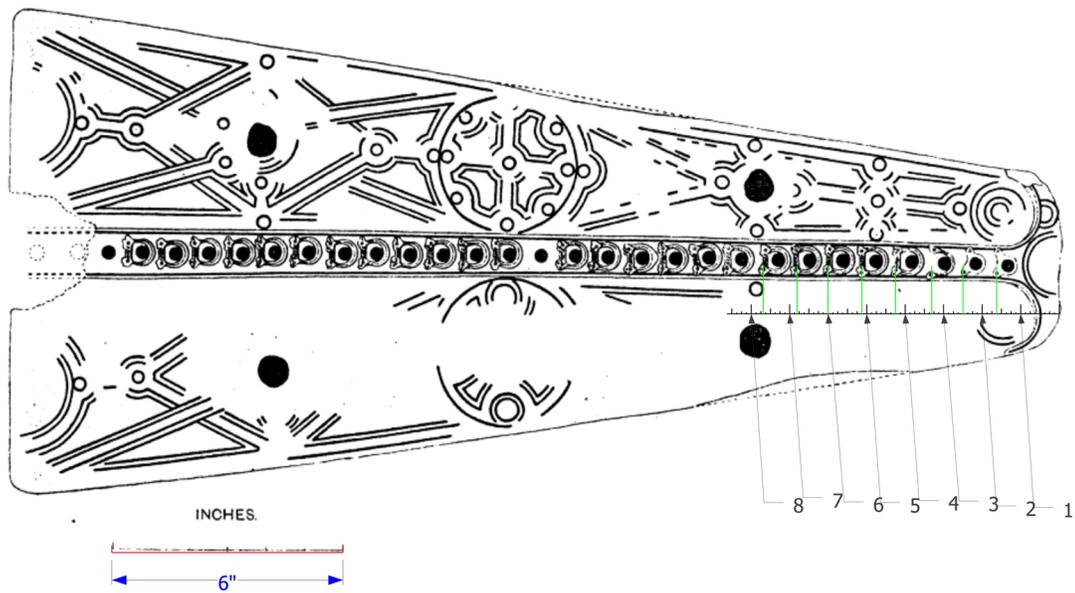
Model 12.Neck_profile, showing some measurements of the harmonic curve.

Sample 6

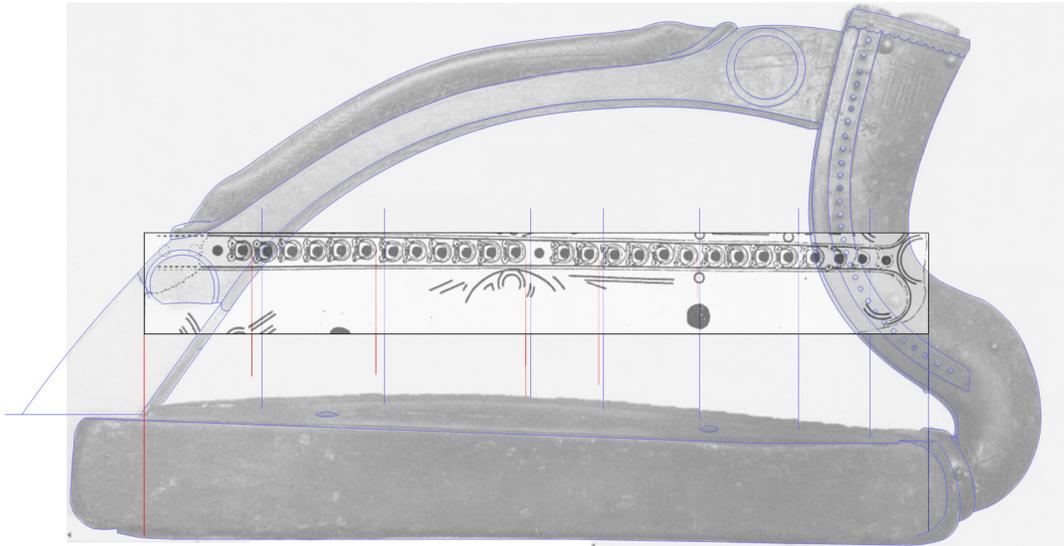


Model 14.Tuningpegs_angle, showing the distance between the tuning pegs at various points. Photograph by Dr Paul Mullarkey NMI, reproduced with permission of the board of Trinity College Dublin.

Sample 7



Model 24.Box3, showing the position of the upper string shoes on the harp and on Armstrong's drawing of the soundboard, photographs of the harp by the author, reproduced with permission of the board of Trinity College Dublin.

Sample 8

Model 27.Photo_scale, tab 2, showing the mismatch between clearly identifiable points on the scaled drawing of the soundboard (red) and the same points on Armstrong's photograph (blue).