



Analysis of CT Scans of the Stewart-Jones Hockey Stick  
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Report prepared for  
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Technical Information for the CT scans  
St John Regional Hospital  
GE Medical Systems Revolution CT

Date of Acquisition 03/03/ 2019  
lung convolution kernel  
X&Y pixels = 0.488mm  
0.625mm slice thickness  
512\*512 pixel array  
helical mode  
current – 179mA  
70 kVp

- also captured in GE GSI dual energy mode; 70 & 140 kVp calcium(iodine) Stnd and iodine(calcium) sequences reconstructed
- note that the Iodine(Calcium) series is slightly truncated, clipping the handle end of the stick
- original data on 7 CDs
  
- the scans were analyzed using ORS<sup>SI</sup> and Dragon Fly software (<https://www.theobjects.com/index.html>)

Density measurements:

Bag of saline

mean = 65.47 Hu

min = -86.7 Hu

max = 169 Hu

std deviation = 61.28

H value for water should be 0. Saline will be slightly elevated. Therefore, this value is consistent with a well calibrated scanner. (Hu = hounsfield units – units of gray scale used on clinical CT scanners)



Name Plate

mean = 178.5 Hu

min = -158 Hu

max = 1837 Hu

std deviation = 479

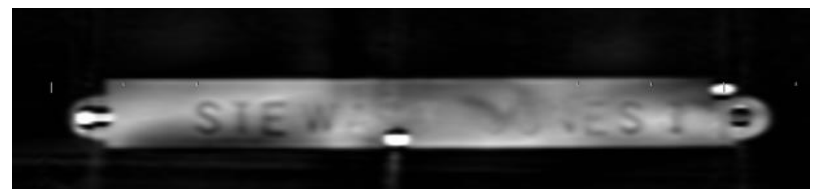


Brousseau's EDS analysis suggested that the plate is high quality cast aluminum. A recent scan of an aluminum square .65mm thick yielded a mean Hu value of 628.5 (std dev = 668.5). This plate is 1.2mm thick – so one would expect a comparable value. The mean for the name plate is within 1 standard deviation of the aluminum square, but it is lower. This may indicate that there is some corrosion of the plate that is not visible.

3D rendering of the name plate from the CT scans



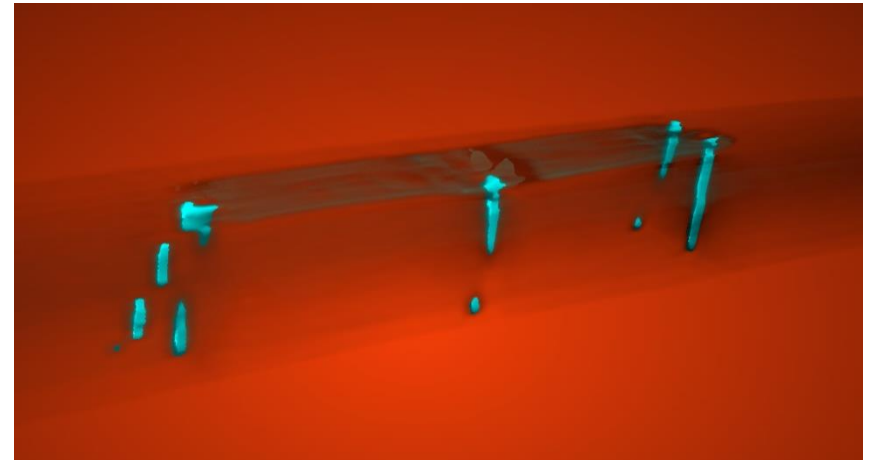
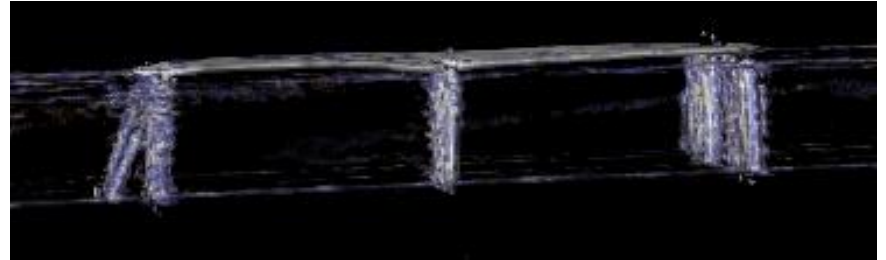
Slice view of the name plate shows that it is of uneven thickness



## Name Plate continued

3D renderings of the nails show that the metal that they are made of is denser than the aluminum plate. HU values determined from an ROI in the center of one nail yields a mean Hu value of 1875 (std dev 1065). A recent scan of a steel square .74mm thick yielded a value of 886.5Hu (std dev Hu 732.8. These nails are, on average, more dense than the steel square, but the values are within a standard deviation of each other. Thus, the densities are consistent with Brosseau's EDS analysis suggesting that they are iron.

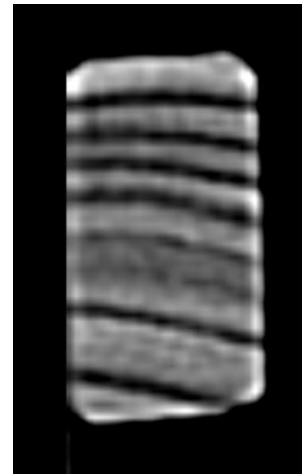
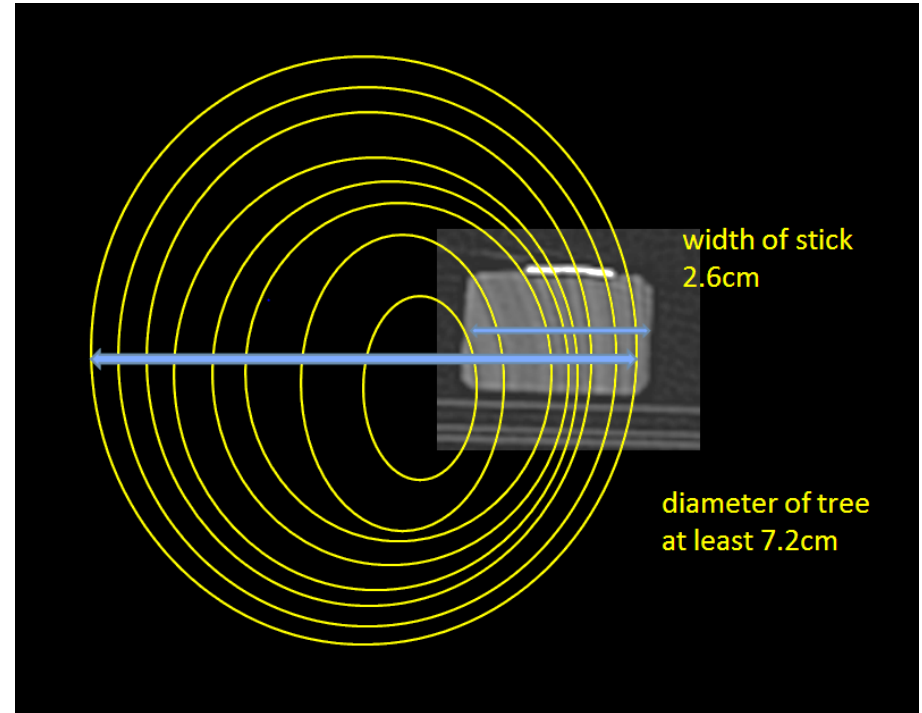
Note that there are fragments of iron visible deep in the wood that do not connect with the nail heads visible in the name plate. This suggests that this, or another, name plate had previously been attached to the stick, and the nails broke during removal, leaving fragments behind.

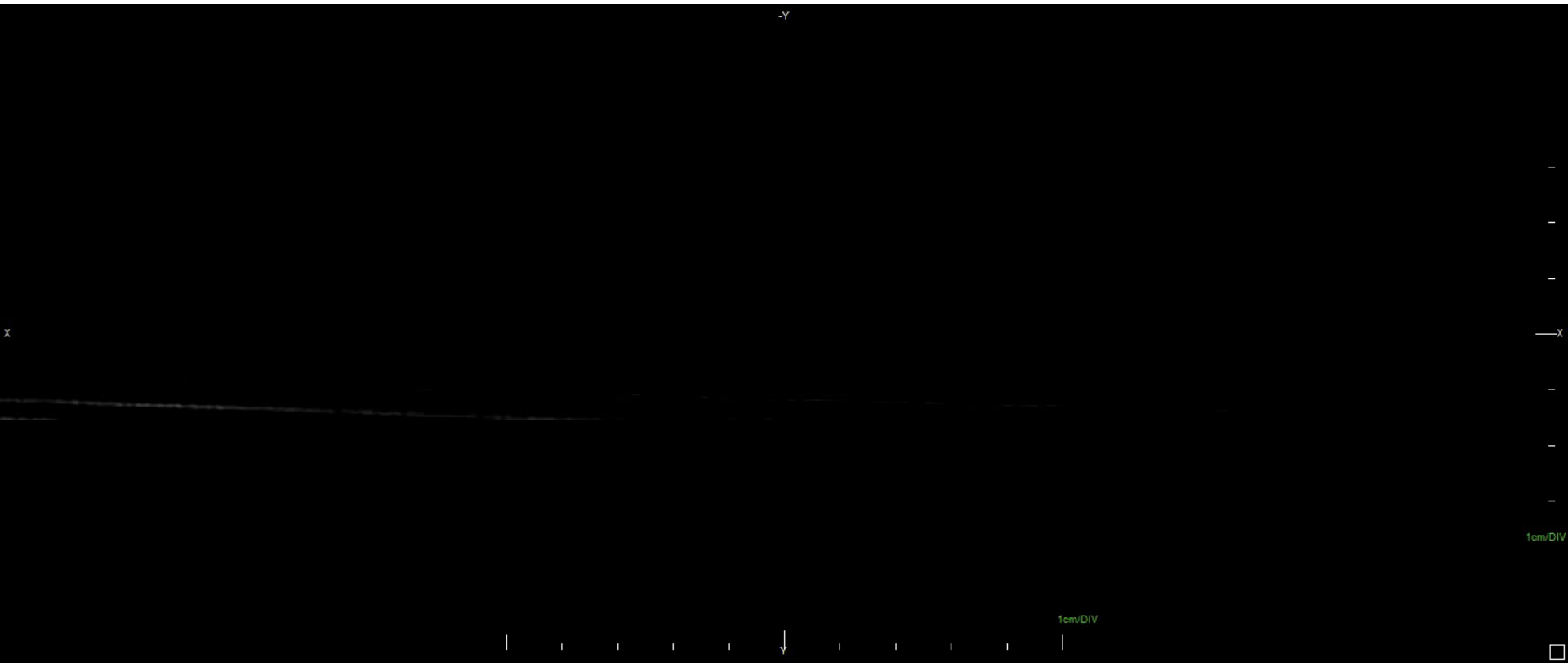


## Rings

Extrapolation of the tree rings suggests that the tree from which this stick was made was at least 7.2cm in diameter with slightly eccentric rings.

Pilon identified the wood as Elm (*Ulmus*), but she did not identify a specific species. The rings of this stick are very porous, which is consistent with the soft elm species rather than the hard elm species (see <https://www.wood-database.com/wood-articles/elm-wood-hard-and-soft/>)





hit play to start video

A scroll down the length of the shaft shows:

- that rings can be followed the length of the stick. This observation is consistent with steam bending to achieve the angle of the blade
- a very thin and uneven “rind” (thin layer of increased density) on the surface of the wood. This is consistent with shellac or varnish that has been partially rubbed off
- the bright flashes on the upper surface of the stick are artifacts of the metal name plate and nails.
- the water bag appears to the right in the video

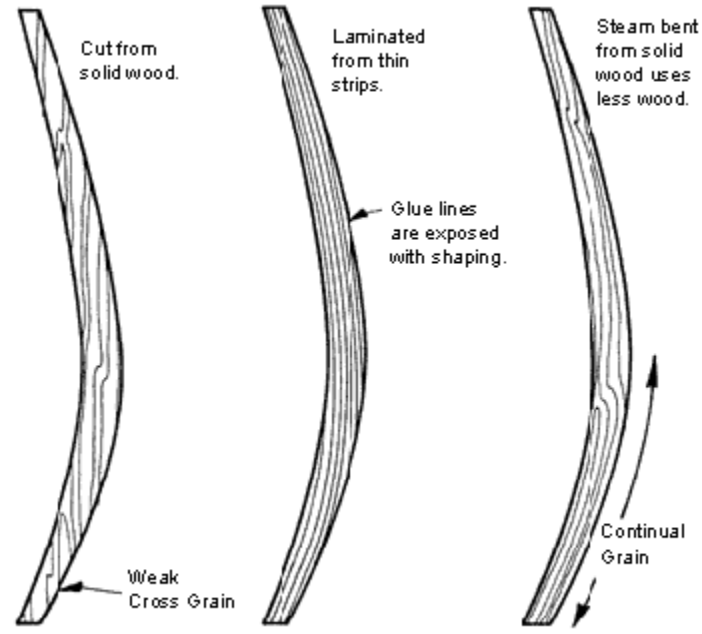
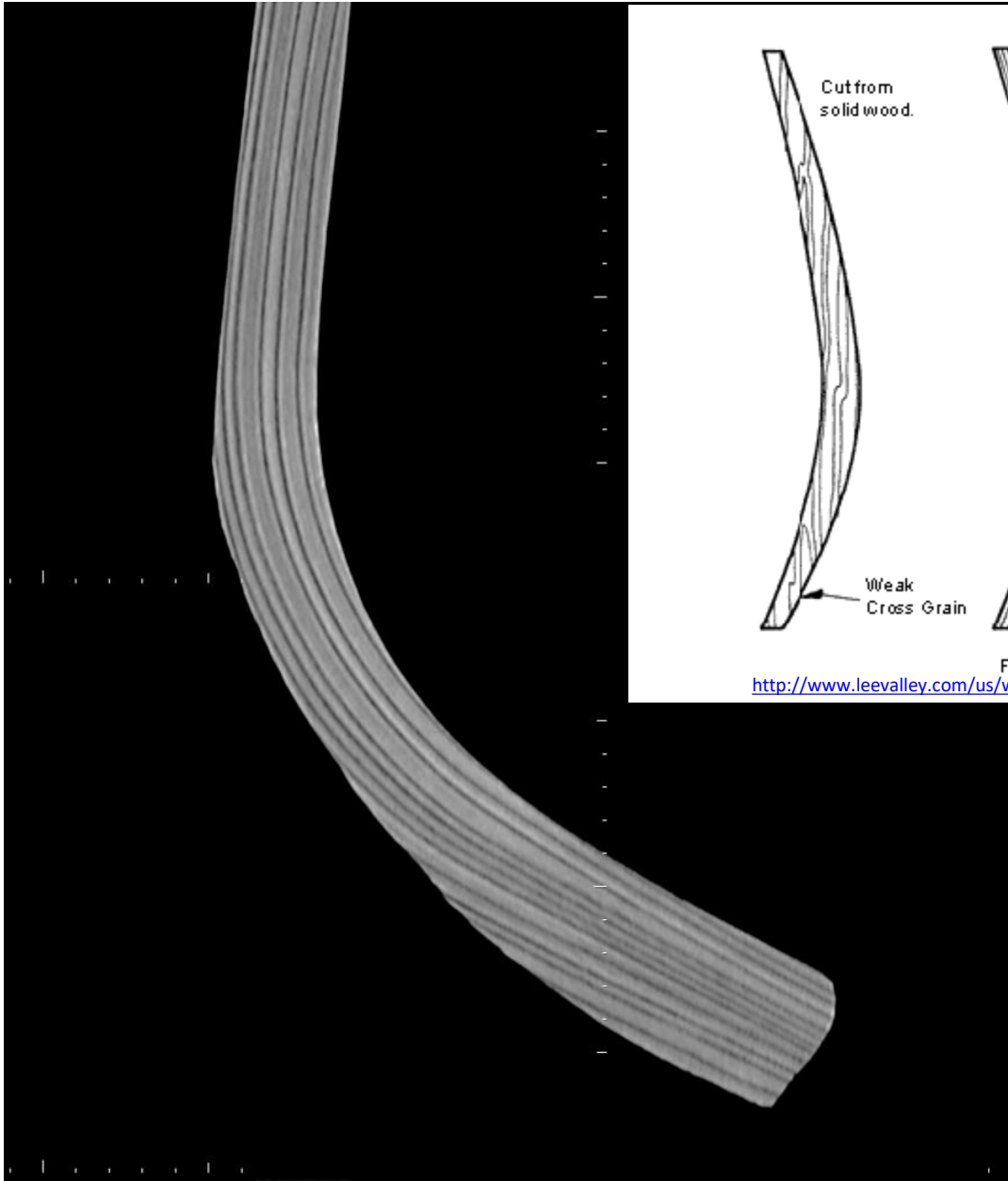
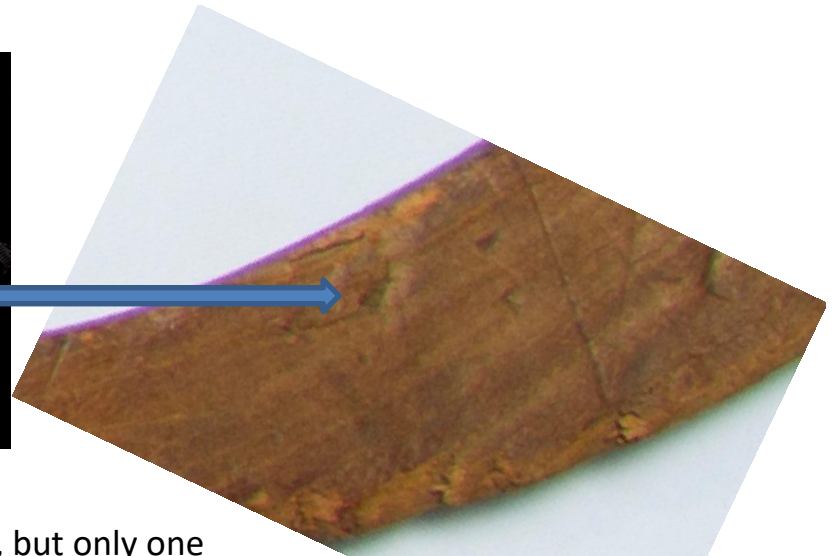
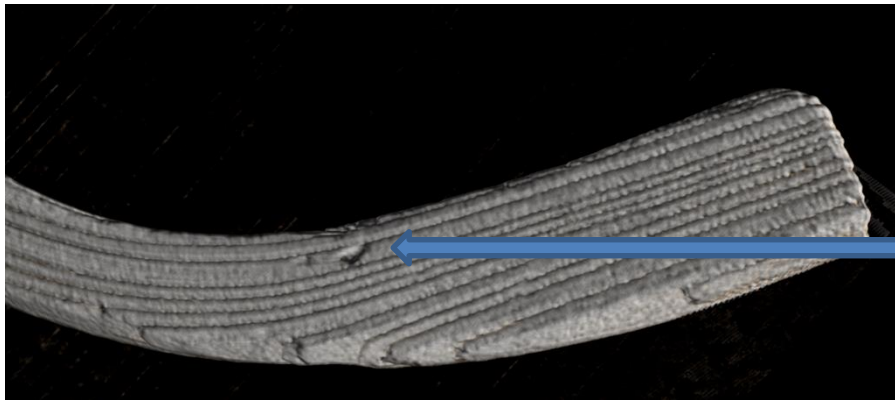
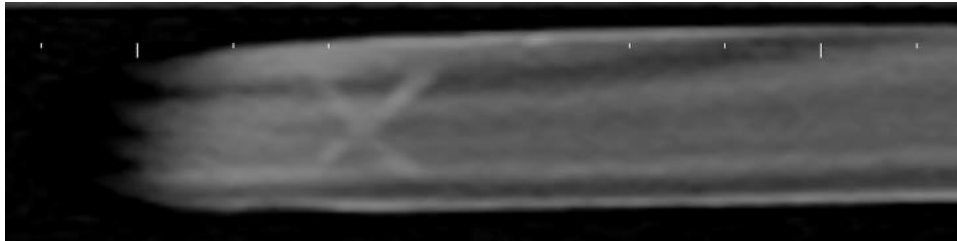


Figure 4

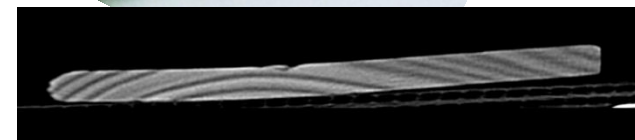
<http://www.leevalley.com/us/wood/page.aspx?p=45869&cat=1,45866,45867>

The continuity of grain along the shaft and around the heel to the blade is consistent with the use of steam to bend the wood.

This image shows the increased density under the owner's X mark. This is caused by slight crushing of the wood matrix, making it appear more dense.



There are several linear features on the blade of the stick, but only one defect that is visible on the scans. That suggests that they were caused by an impact or action less forceful than that which made the X on the handle. There is nothing visible on the photo or on the scan data that would suggest an impact with a hard puck.



Cross-section of the defect





hit play to start video