Investigating oboe manufacturing consistency by comparing the acoustical properties of five nominally identical instruments

Conference or Workshop Item

Investigating oboe manufacturing consistency by comparing the acoustical properties of five nominally identical instruments

Adrien Mamou-Mani[1], David Sharp[1], Thibaut Meurisse[2] and William Ring[3]

[1] Acoustics Research Group, The Open University

[2] Université Pierre et Marie Curie, Paris

[3] Howarth of London

Introduction

- What is consistency?

*"With a **hand-built** guitar, you want every guitar to be different and have its **own sound**. But with **a production model**, you want to **standardize** shape, quality, and performance"* Glen Dominick, Senior Manufacturing Engineer, Fender

→ Increasing the ability to produce instruments that have the exact same qualities is a constant aim for large scale musical instrument manufacturers

- Our methodology

Combination of acoustical measurements, geometrical observation and perceptive testing of instruments of the same model:

  - Acoustics: Input impedance
  - Geometry: Bore profile, holes and pads, potential leaks
  - Perception: Discrimination tests (2-AFC) in playing situation

→ Already shown its efficiency for comparing two Pearl River low cost trumpets (Applied Acoustics, 2010)

Introduction

- Oboes under test: Five Howarth S10 student oboes
  - Body made from African Blackwood
  - Thumbplate system
  - Closed hole model with all covered holes

- Are these oboes acoustically, geometrically and/or perceptively different?

First stage – pilot playing test

- Preliminary blindfold playing test by one amateur oboist (me!) suggested there were small but perceptible differences in the playing properties of the five oboes.

- Differences most apparent when trying to play notes at the higher end of the instrument’s range, in particular F6.

- Five oboes ranked by oboist in terms of how easy it was to produce F6 cleanly.

- Easiest and hardest to play instruments (oboes A and C) selected for use in larger scale playing test.

Discrimination playing test

- Protocol
  - 2 alternative forced choice (2-AFC) with two S10 oboes
  - 9 musicians: 4 professionals, 4 intermediates, 1 beginner
  - Free to play, 30 sec, 20 trials
  - Being considered as able to discriminate the two instruments if number of correct answers at least 16 out of 20 (1% significance level).

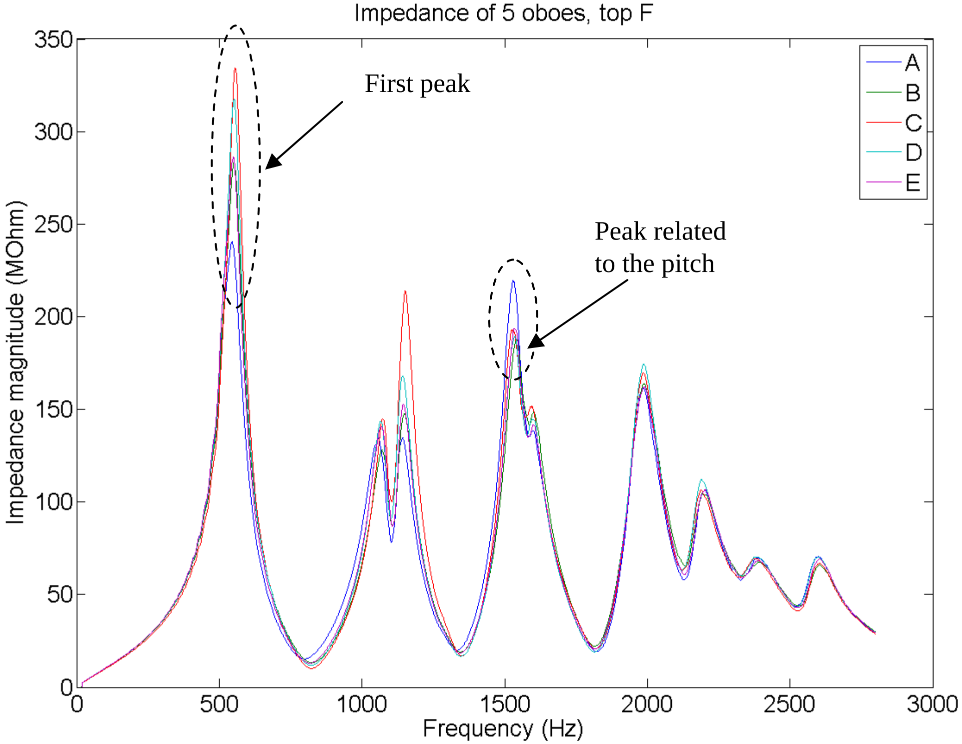
- Results
  - 6 musicians out of 9 were unable to discriminate the two oboes (all achieved 12 or less correct answers).
  - 2 musicians out of 9 were able to discriminate the two oboes by comparing the top F (F6) playability (19 or more correct answers).
  - 1 musician out of 9 was able to discriminate the two oboes just by playing in the lower register of the instruments (16 correct answers). He commented that oboe C had a brighter sound than oboe A.

Input impedance

- Input impedance measurements carried out on the five oboes using BIAS system with custom-made adapter.
- Measurements made for every note from Bb3 to F6.
- 32 fingering combinations applied per instrument.
- 32 x 5 = 160 sets of impedance data in total !

Acoustical differences for F6

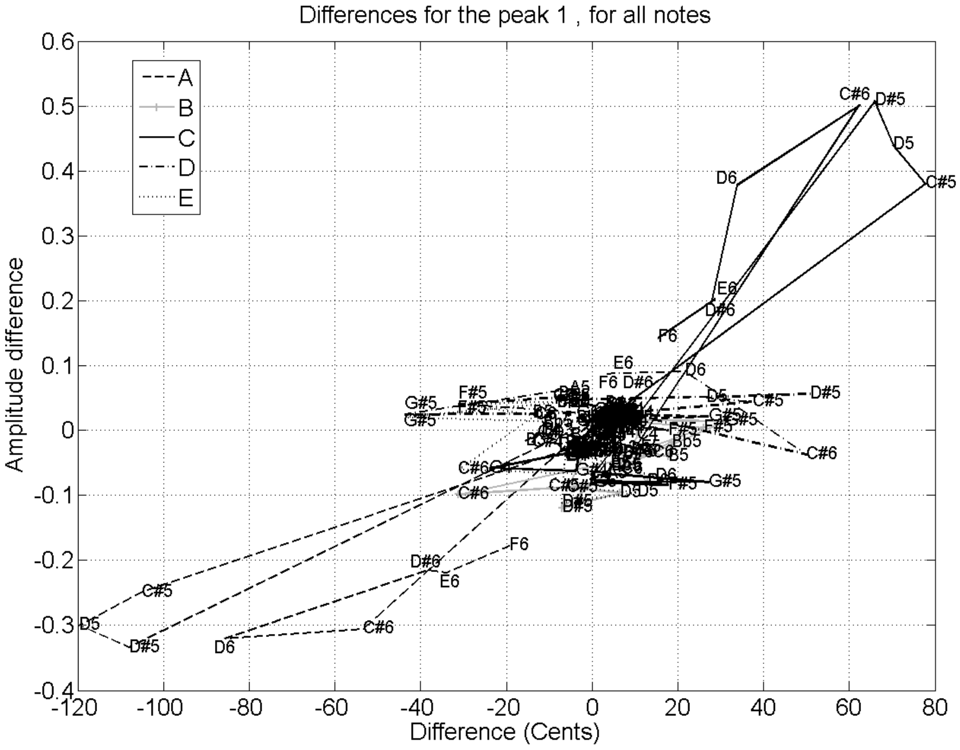
- Impedance magnitudes for the F6 fingering



→ Noticeable differences between the 5 oboes. What are the physical causes of this difference?

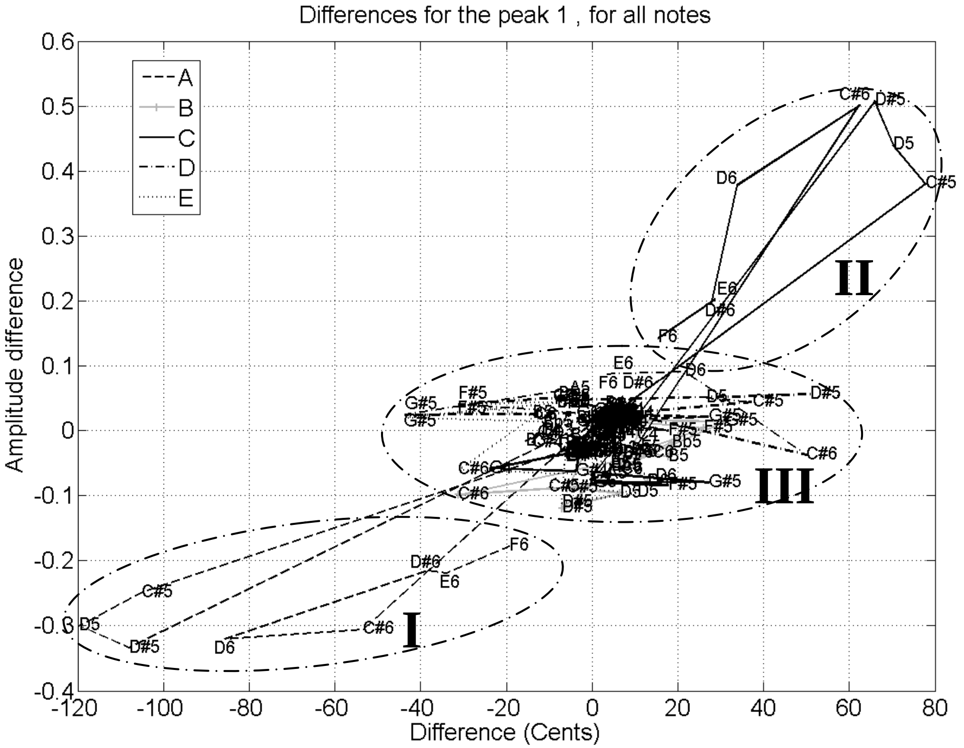
Analysing multiple impedance curves

- New representation of impedance peak data



Analysing multiple impedance curves

- New representation of impedance peak data



I Oboe A: notes ([C#5, D5, D#5] ; [C#6, D6, D#6, E6, F6])

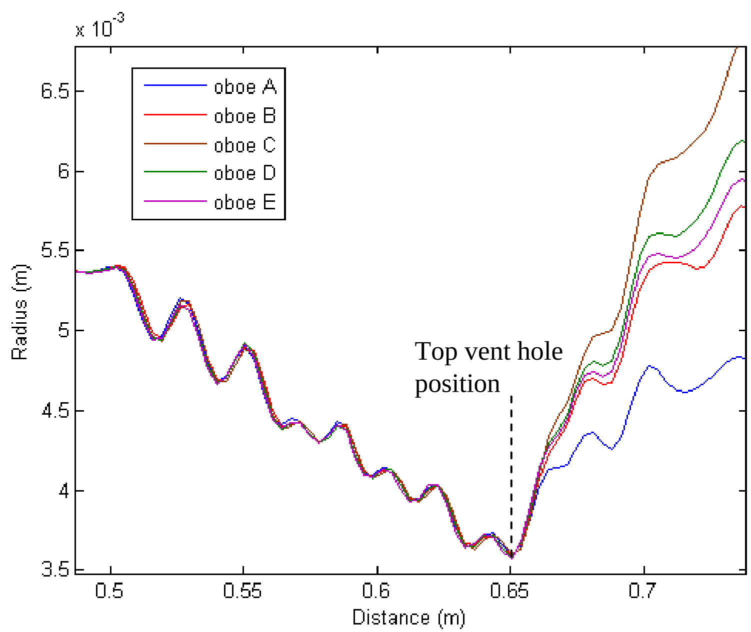
II Oboe C: same notes ([C#5, D5, D#5] ; [C#6, D6, D#6, E6, F6])

III Oboes A and C remaining notes, and all notes for oboes B, D and E

Geometrical differences affecting certain notes

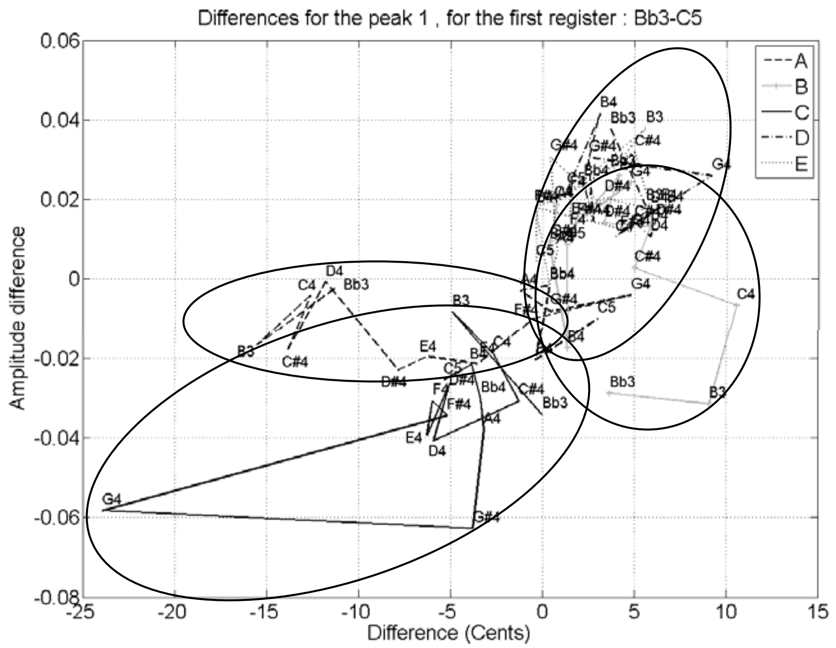
- Fingerings used for notes [(C#5, D5, D#5) , (C#6, D6, D#6, E6, F6)] have an open vent hole in the top joint.

- Reflectometry shows differences in the height of the pad.



Acoustical and geometrical differences for other notes

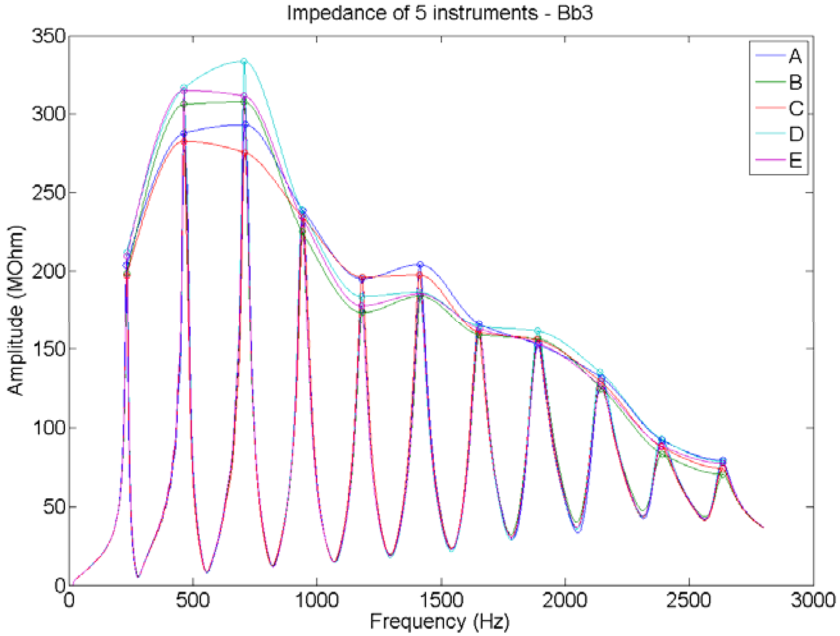
- Differences for first impedance peak, first register fingerings



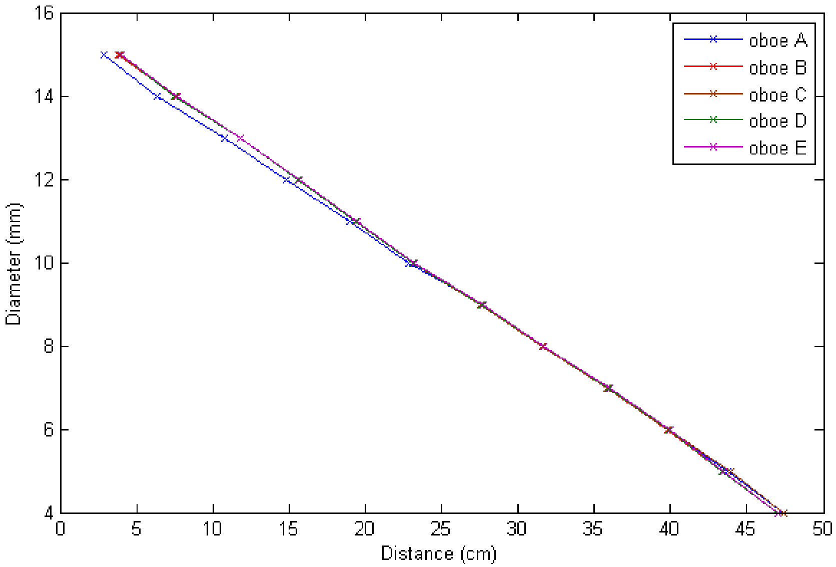
→ Smaller differences but 4 groups (oboe A, oboe B, oboe C and oboes D & E)

Acoustical and geometrical differences for other notes

- Differences for Bb3 fingering



Bore profile measurement



Differences in the impedance partially explained by discrepancies in the bore profiles.

Conclusion

- These five instruments are perceived and measured as being very similar.

- Noticeable differences for several notes, due to the adjustment of the height of the top vent hole. Most clearly perceptible for F6.

- Small differences in the low register, partly related to differences in the bore profiles.