Agenda

- Factors to consider when choosing your coupling
- Back to Basics with ‘Plumbing”
- Vents/Dampers/Sound Bores
- The limitations of slim tubes/open fittings
- Phonak coupling options
- How to select the most appropriate coupling option
- Mythbusters!

All while playing......
Other Live Courses

Monthly FM eLearning Classroom

'Monthly FM eLearning Classroom featuring Peter Stelmacovich, FM Product Manager'

Here is a schedule of what we will cover in the upcoming months:

July: Three case studies of successful adult FM users
August: Selecting the appropriate FM transmitter for your client?
September: Back to School with FM – what's new with Phonak products?
October: Teens and FM, Career Selection for those with hearing loss
November: Improving Music Perception via FM and Hearing Instruments

Continuing Education Information
Offered: AHIP/1.0; CAA/1.0; CASLPA/1.0

Dates and Registration

Go to http://www.phonakpro.com/ca to register today!
Recorded Sessions – CEU approved!
5 sessions on our website = 6 CEU approved hours
Over the years, coupling options have changed....

**Trumpet Headband**

This Trumpet headband by F. C. Rein, England, was made about 1850. The metal headband could be worn either on top of the head or around the base of the neck.

**Acoustic Fan with Ear Trumpet**

Some acoustic fans had tiny ear trumpets attached and could be used either open or closed. The Hawksley Catalogue states, “Its power varies according to the size of the instrument which is attached to the fan...used with the fan open it gives rather better results...”
The ‘Plumbing’ in Hearing Instruments over the years....
Factors to consider

- Degree of hearing loss
- Previous hearing instrument experience
- Ear pathologies
- Occlusion
- Dexterity
We have many choices!

xShells

cShells

Slimtips

Domes!!!!
Let’s Play.....
Put the following three words in the order in which they influence the frequencies (from lows to highs, respectively):

Sound bore, Venting, Dampers

Venting/Dampers/Sound bore
Three aspects of acoustic coupling

![Diagram showing frequency regions affected by each of the components of the hearing aid coupling system. The diagram includes labels for 'Vents', 'Dampers', and 'Sound bore'. The frequency range is from 125 Hz to 8000 Hz.](image)


Venting and *acoustic mass*

*Figure 5.8* A vent made up of two tubes of different lengths and diameters.

Figure 5.10 Effect of different sized vents on the frequency response of amplified sound, relative to the response with a tightly fitting earmold or earshell (Dillon, 1985).

Source: Dillon (2001): Hearing Aids
Which way to vent?

- Venting via ‘plumbing’
- Venting via electronic low cuts while programming

Remember: no hearing instrument electronics can compete with the low distortion and the very flat frequency response that a vent can provide!
Parallel, Diagonal or trench venting?

**FIGURE 2.** The effects of vent style on gain and frequency response. The hearing aid, earmold style, and vent diameter were held constant and the vent type was changed. The green curves show aided gain for a parallel vent and the purple curves show the aided gain for the same product and earmold style using a diagonal vent. The orange curve is the REUR.

Vent Size and Fitting Ranges

When should you choose a particular vent size?

- 0-30 dB for (125-2000 Hz)
  - IROS or Large cavity vent

- 35-60 dB for (125-2000 Hz)
  - Medium or Large Parallel vent

- 65-80 dB flat
  - Small parallel vent

- 85 dB flat
  - No vent or pressure vent

Acoustically Optimized Venting

- Takes the guesswork out of vent selection
- Unique vent tuned to each customer’s ear canal or size of the ear and hearing loss
- Smoother frequency response
- Small
- Open
- Best vent - Not necessarily Biggest Vent Virtually eliminates the occlusion effect and own voice annoyance
Vent Inserts

For these inserts to be useful, remember:

1. For the narrow inserts to be useful, leakage must be minimized by making a tight fitting earmold; otherwise, if too much leakage the size of the vent is inconsequential.

2. For the widest inserts to be useful, the vent itself must be short and wide (not always possible if ear canal is narrow and real estate is already an issue or if you also need to accommodate a horn).

## Venting and Insertion Gain

<table>
<thead>
<tr>
<th>Vent size</th>
<th>500</th>
<th>750</th>
<th>1000</th>
<th>1500</th>
<th>2000</th>
<th>3000</th>
<th>4000</th>
<th>6000</th>
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<tbody>
<tr>
<td>Occluded</td>
<td>65</td>
<td>66</td>
<td>64</td>
<td>60</td>
<td>56</td>
<td>41</td>
<td>45</td>
<td>50</td>
</tr>
<tr>
<td>1 mm</td>
<td>65</td>
<td>64</td>
<td>61</td>
<td>58</td>
<td>52</td>
<td>39</td>
<td>45</td>
<td>47</td>
</tr>
<tr>
<td>2 mm</td>
<td>60</td>
<td>60</td>
<td>57</td>
<td>54</td>
<td>49</td>
<td>36</td>
<td>41</td>
<td>48</td>
</tr>
<tr>
<td>3.5 mm</td>
<td>51</td>
<td>53</td>
<td>52</td>
<td>48</td>
<td>43</td>
<td>31</td>
<td>35</td>
<td>41</td>
</tr>
<tr>
<td>Tube</td>
<td>41</td>
<td>43</td>
<td>42</td>
<td>40</td>
<td>34</td>
<td>23</td>
<td>26</td>
<td>37</td>
</tr>
</tbody>
</table>

The effects of venting

FIGURE 3. Vent parameters for different parallel vent diameters and for an open “tube” fitting with no canal occlusion. Based on Lybarger.4
Effects of venting on directivity

- Dillon (2001) reported:

  ‘Conventional directional microphones produce their greatest directivity at low frequencies; to maximize the benefits of a directional microphone means the vent should be as small as possible.’

Myth: Directional mics are not compatible with open-fit hearing aids

- Microphone port separation effects high frequency directionality.
- In 2006, the industry standard was 12 mm.
- In 2006, Phonak introduced microSavia with port spacing of 5 mm which is now industry standard.
- Directivity indices as a function of frequency were measured in a field study and revealed DI's in excess of 6 dB across the entire bandwidth.
- More venting reduces the DI's below 1500 Hz, but there is still benefit to provide directionality for mid to high frequencies for patients with high frequency sensorineural hearing loss.

Vent size and Occlusion

- In many cases, increasing the vent size can reduce occlusion
- Amplclusion?
Things to check / try in Phonak Target (Occlusion)

1st - Check acoustic parameters

Occlusion Manager

Note: This allows you to apply different levels of occlusion compensation to each ear for binaural fittings.
Let’s Play.....
To reduce the low frequency amplification as much as possible on a custom product, you could consider:

A diagonal Vent
Dampers

Frequency regions affected by each of the components of the hearing aid coupling system

Source: Dillon (2001): *Hearing Aids*
Dampers (in a nutshell....)

- To maximize damping at 1000 Hz, place the damper as close to the earmold as possible (tip of the earhook)
- To maximize damping at 2000 Hz, place the damper as close to the receiver as possible
Let’s Play.....
Dampers in BTE instruments are used to smooth the peaks in the:

Mid Frequencies (750-3000 Hz)
Sound bore

Tubing Diameter, Length, Acoustic Horns and Libby Horns
Tubing thickness

- Internal diameter affects the passage of sound along a tube

- Outer diameter (thickness) affects the amount of leakage, important to consider for high gain instruments
  - Example: #13 thick wall tubing provides 2 dB more attenuation than standard #13
Tubing Diameters

<table>
<thead>
<tr>
<th>Tubing Size</th>
<th>Inside/Outside Diam</th>
</tr>
</thead>
<tbody>
<tr>
<td>#12</td>
<td>2.16/3.18 mm</td>
</tr>
<tr>
<td>#13 standard</td>
<td>1.93/2.95 mm</td>
</tr>
<tr>
<td>#13 medium</td>
<td>1.93/3.10 mm</td>
</tr>
<tr>
<td>#13 thick</td>
<td>1.93/3.30 mm</td>
</tr>
<tr>
<td>#14</td>
<td>1.68/2.95 mm</td>
</tr>
<tr>
<td>#15</td>
<td>1.50/2.95 mm</td>
</tr>
<tr>
<td>Thin tube</td>
<td>0.90/1.40 mm</td>
</tr>
</tbody>
</table>

The effects of tubing diameter

**FIGURE 3.** The effect on hearing aid response for various tubing diameters measured on an ear simulator. The internal diameters for size 13 and 14 tubing are listed above. The .031-inch diameter is similar to today’s thin tube internal diameter.\(^5\)

In Summary…..

<table>
<thead>
<tr>
<th>Tubing Diameter Change</th>
<th>&lt;750</th>
<th>750-1500</th>
<th>1500-3000</th>
<th>&gt;3000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wider</td>
<td>Minimal</td>
<td>Moves peak to higher Hz</td>
<td>Moves peak to higher Hz</td>
<td>Minimal</td>
</tr>
<tr>
<td>Narrower</td>
<td>May Decrease</td>
<td>Moves peak to lower Hz</td>
<td>Reduces height of peak and moves to lower Hz</td>
<td>Decrease</td>
</tr>
</tbody>
</table>

More ‘Plumbing’…. The Effect of Tubing Length

## In Summary….

<table>
<thead>
<tr>
<th>Tubing Length Change</th>
<th>&lt;750</th>
<th>750-1500</th>
<th>1500-3000</th>
<th>&gt;3000</th>
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<tbody>
<tr>
<td>Short</td>
<td>Slight decrease</td>
<td>Moves peak to higher Hz</td>
<td>Moves peak to higher Hz</td>
<td>Minimal</td>
</tr>
<tr>
<td>Long</td>
<td>Slight increase</td>
<td>Moves peak to lower Hz</td>
<td>Moves peak to lower Hz</td>
<td>Decrease</td>
</tr>
</tbody>
</table>

What does this mean?

- In a recent Junior Newsletter, we asked Marlene Bagatto about the limitations of slim tube fittings. Here is a snapshot of her response:

“Open fit hearing aids, specifically slim tube fittings, are a good option for patients with no worse than a moderate high frequency hearing loss. This is because the slimness of the tube reduces the amount of high frequency gain that can be provided. If the patient is an audiologic candidate for this type of device, then the hearing aid must be verified on the real-ear in order to measure the effect of the open fit. Attaching the device to a coupler will only measure what is going on in the high frequencies and not the impact of the openness of the dome in the canal.”
Let’s Play.....
Which of the following would result in peaks in the 1500-3000 Hz range shifting upward in frequency?

Shortening the tubing length
How can I increase high frequency gain through the plumbing?

- **Acoustic horns**: when the diameter of a tube increases, modifying the amount of high frequencies that will easily pass through
- **The shorter the horn, the higher the range of frequencies affected**
- **Horns with BTE earmolds can be much longer than in ITEs**, so you have the capability to increase high frequencies across a broader range (3 kHz and above)
- **Libby Horns**
Creating an acoustic horn

A simple way to create an acoustic horn is to just insert the tubing slightly into the earmold (creating a natural horn effect)

The disadvantages of this are:
1. The length of the horn will always be less than the sound bore length of the mold, so the boost may not extend sufficiently far down in frequency
2. The Tubing is poorly retained in the earmold.
Figure 5.20 A Libby 4 mm horn (a) fully inserted into the earmold, and (b) partially inserted, with the mold forming the final section of the horn. Diameters are in mm.

Real Ear results showing the positive effect of a Libby Horn

**FIGURE 5.** The difference in high frequency gain between an earmold with standard tubing and sound bore (purple curve) compared to 4 mm Libby horn (blue curve). The REUR is the orange curve.

Let’s Play.....
Dampers in BTE instruments are used to smooth the peaks in the:

**Mid Frequencies (750-3000 Hz)**
Procedure for selecting earmold and earshell acoustics

1. Find the maximum vent size possible (using the table)
2. Estimate the minimum vent size needed
3. Decide on the vent size
4. Select a sound bore profile
5. Select a damper

Phonak SlimTube HE

Data from a chart showing averaged ear simulator response with different lengths (L=50, 55, 60 mm). The graph compares the standard SlimTube (dark blue) and SlimTube HE (green). The frequency range is from $10^2$ to $10^4$ Hz, and the response is measured in dB.

- Dark blue: standard SlimTube
- Green: SlimTube HE
Custom Tip choices….

<table>
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<tr>
<th>Product Overview for Earpiece Compatibility with BTE and CRT Hearing Aids</th>
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<tr>
<td><strong>Please see product overview for Earpiece compatibility with BTE and CRT Hearing Aids</strong></td>
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<tr>
<td><strong>Indicate Tube length 0-3</strong></td>
</tr>
<tr>
<td><strong>Left</strong></td>
</tr>
<tr>
<td>-----------------------------------</td>
</tr>
<tr>
<td>[ ] L [ ] R SlimTip Hollow Hard std.</td>
</tr>
<tr>
<td>[ ] L [ ] R SlimTip Hollow Digital Soft</td>
</tr>
<tr>
<td>[ ] L [ ] R SlimTip Solid Hard</td>
</tr>
<tr>
<td>[ ] L [ ] R cShell Hard (std.)</td>
</tr>
<tr>
<td>[ ] L [ ] R cShell Soft</td>
</tr>
<tr>
<td>[ ] L [ ] R xShell</td>
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</tbody>
</table>
We have many choices!

xShells

cShells

Slimtips

Domes!!!!
Phonak Target can help with your coupling selection

- Simulate a fitting in Phonak Target
- Select various instruments and observe the fitting ranges
Selecting the appropriate coupling

Appropriate selection

In-Appropriate selection
Carefully observe the results of the feedback manager.
Myth: Feedback phase-inversion completely eliminates feedback issues with open-fit hearing aids

- Various feedback cancellation algorithms are used in modern instruments
- Vent considerations are still important
- Further research is required, but it is safe to conclude that a practical limitation resides in the maximum stable high frequency gain for occluded earmolds used with open fit devices

Myth: Real-ear measurements (REM) are not possible with open-fit devices.

- Best to use REAR on the SPL-o-graph
- REAR can be measured for different presentation levels
- Hearing instruments can be adjusted to account for leakage of sound

Let’s Play.....
Running the Phonak Feedback Manager will help you by:

A & C
Let’s talk about receivers.....

Naída S

CRT

Super Power

Ultra Power

<table>
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<th>dB HL</th>
<th>Ear Sim</th>
<th>2cc</th>
</tr>
</thead>
<tbody>
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<td>72</td>
<td>65</td>
</tr>
<tr>
<td>250</td>
<td>80</td>
<td>75</td>
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<tr>
<td>500</td>
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<td>1k</td>
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<td>100</td>
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<td>133</td>
<td>133</td>
</tr>
<tr>
<td>8k</td>
<td>144</td>
<td>144</td>
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</table>
Naída S CRT
External Receiver devices

SuperPower Plus xReceiver

<table>
<thead>
<tr>
<th></th>
<th>Ear Sim</th>
<th>2cc</th>
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<tbody>
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<td>Gain</td>
<td>72</td>
<td>65</td>
</tr>
<tr>
<td>MPO</td>
<td>137</td>
<td>133</td>
</tr>
</tbody>
</table>
Choosing your receiver – size matters!
### Coupling for CROS – which is best?

<table>
<thead>
<tr>
<th></th>
<th>Phonak CROS Retention</th>
<th>CROS SlimTube</th>
<th>Phonak CROS Tip</th>
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</tr>
<tr>
<td><strong>Phonak CROS H20</strong></td>
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<td><img src="image5.png" alt="Image" /></td>
<td><img src="image6.png" alt="Image" /></td>
</tr>
<tr>
<td><strong>For demonstration</strong></td>
<td></td>
<td><strong>Suggested fitting solutions</strong></td>
<td></td>
</tr>
</tbody>
</table>
Let’s Play.....
What are the available receiver options for our custom products?

M, P, SP, and UP receivers
Thank you for Playing with us Today!