Justifications for Hearing Aid Technology

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The “Best” Technology

- In 1902, the Ear Horn
- In 1930, the Body Aid
- In 1955, the Behind-the-ear
- In 1975, the In-the-ear
- In 1980, Compression technology
- In 1988, Programmable technology
- In 1996, Digital technology
- In 2000, 2nd Generation Digital technology
- 2011: the 9th iteration of Digital technology?
What Can Technology Do?

• Miniaturization

• Improved Sound Quality

• Control of Loud Sounds

• Specialized Listing Situations
  • Improve speech intelligibility in noise
  • Music, television, telephone
  • Hearing in the car, hunting, etc.

• Complete Communication Strategies

• Plan for the Future
What Technology *Can’t* Do

- Restore 100% of lost hearing
- Give perfect intelligibility for soft-speakers (*Seinfeld’s puffy shirt*)
- *Eliminate* background noise
- Eliminate the need for batteries (*Rechargables?*)
- Eliminate damaging moisture or earwax (*Self-Cleaning*)
- Eliminate the need for repairs
- Keep Fido from eating the hearing aid
- Balance the Federal budget
We have a 99% Digital Market

• I used to say “Just because a hearing aid is Digital does not mean that it is better than an analog or programmable hearing aid.”

• Just because a hearing aid is Digital does not mean it needs to be expensive

• The judgment for or against advanced hearing aid technology should not be solely based on cost or degree of loss
Digital is often better than a cost-equivalent Analog instrument

- Despite inflation, the cost of hearing aids has actually decreased
  - In 1988, the average price for a top-end programmable hearing aid was $1,750 (2-channel, processing time 20-30 per Second; Digital not yet available)
  - In 1996, 2-channel digital, processing time of 400,000 – 4,000,000 times per second, for price of $2,500 each
  - Now, an entry level digital with the same processing speed as those introduced in 1996, but with 4 channels, retails for about $995.
  - Other, more expensive digital instruments (as high as $3,995 each) do exist, but with vastly more advanced features than anything previously introduced.
  - A basic analog linear instrument that retailed for $495 in 1990 still retails for $495.
We now have a 100% digital market

- Easier assembly process (less labor)
- Recuperated research and development
- Lower chip cost
- Simpler & easier to address patient issues
- But… *Not All Digitals are created equal!*
One pair of digitals is $1,600, another pair is $6,000…

Why the difference?

• Higher degrees of analysis (channels, “handles”)
• Different levels of noise-reduction technology
• Different style choices (not so much anymore)
• Integration with other technology (i.e. FM & Bluetooth)
• Automation of features
Primary Considerations to Justify Technology

- Degree of hearing loss
- Configuration of hearing loss
- Progressive nature
- Tolerance issues
- Issues regarding background noise
- Specific needs of the individual
Degree of hearing loss

- Regardless of the degree of hearing loss (mild, moderate, severe, profound), advanced technology hearing aids can benefit their users; it is an issue of “power”
- For persons with severe to profound losses, Digital feedback Managers (DFMs) can be very beneficial
- Size is a more important issue than technology when considering the degree of hearing loss
Configuration of hearing loss

- Oddly-shaped and steeply-sloping hearing loss configurations are more difficult to fit
- Multi-channel programmable and digital instruments are better suited to handle odd configurations
- “Flat” hearing losses have less need for advanced technology, but other reasons may compel the need for it.
Configuration of hearing loss: Samples of odd audiograms

- Steeply-sloping losses
Configuration of hearing loss: Samples of odd audiograms

- Reverse-sloping losses
Configuration of hearing loss: Samples of odd audiograms

- “Cookie-bite” or “Reverse Cookie-bite”
Configuration of hearing loss: Samples of odd audiograms

- Non-Patterned Losses
Configuration of hearing loss:
Solutions for Cochlear Dead Zones

Some hearing losses can reach a level where traditional amplification simply does not help

- *Sound is distorted or absent*
- *Amplification contributes to feedback*
Configuration of hearing loss:
*Solutions for Cochlear Dead Zones*

As a solution, some manufacturers have come up with solutions that transfer the high frequency sounds into a range where the patient has better hearing:
Configuration of hearing loss:

Solutions for Cochlear Dead Zones

Another manufacturer’s solution is to transpose the missing frequencies into the range where the patient has better hearing:

![Diagram of frequency regions and filters](image)
Progressive Hearing Losses

• More loss is expected over time, but will vary due to many factors—heredity, noise exposure, nature of hearing loss overall physical health, etc. *It can only be really predicted by repeated evaluations over time.*
• “Damaged ear theory”; hearing loss is bound to be progressive in a damaged system
• Conventional instruments are like eyeglasses, and their prescriptions are limited
• Programmable and digital instruments can have their prescriptions *updated*, extending the life of the product by 50-100% in comparison with analog instruments
• Some digital instruments have *upgradable circuits*, meaning that the *technology* in the instrument can be improved with software updates, extending the product life by 75%-150% in comparison with analog instruments.
Tolerance Issues

- Linear: same amplification for soft sounds as for loud sounds. *Sometimes preferred by long-term users.*
- Compression: more amplification for soft sounds, less amplification for loud sounds. *Preferred by new users.*
- Programmable compression: analyzes input 20-30 times per second before releasing. *Now obsolete.*
- Digital compression: analyzes input 400,000 – 40,000,000 times per second before releasing
- Multi-channel: will analyze input in different frequencies, giving different amplification and compression as necessary.
Background Noise: Can Hearing Aids Handle It?

- **Digital Noise Cancellers (DNCs)**
  - Work against ambient noise for comfort purposes
  - Very limited benefits for improving speech intelligibility in noise (improvement $<2\text{dB SNR}$ for a moderate loss).
  - Performance is enhanced based on the number of *channels* in the hearing aids.
Background Noise: Can Hearing Aids Handle It?

• Directional Microphones
  • Clinically proven as the most effective for improving speech intelligibility in noise (3.5dB – 12dB SNR for a moderate loss)
  • Can be more effective when coupled with digital technology (adaptive, automatic, exaggerative)
  • Limited to larger instruments (BTE, ITE, ITC)
Background Noise: Can Hearing Aids Handle It?

- Directional Microphones—Levels of Performance
  - Fixed directional
  - Adaptive directional
  - Automatic directional
  - Frequency-specific Adaptive
  - Beam-forming technology
Assessments for Noise Reduction Needs

• Audiologists can use special filtered speech-in-noise tests to assess the degree of impairment in background noise.

• While there are many variations, the most practical and current clinical test is the QuickSIN.
  – Patients are listen to a series of sentences and are asked to repeat them.
  – Each sentence is progressively harder to understand the speech as the noise level is increased.
  – Three sets of six sentences are used per ear, and a performance score is rendered.
Assessments for Noise Reduction Needs

• QuickSIN Evaluation of Results
  – Score of 0-2:
    • Normal “Speech-to-Noise” hearing
    • Noise reduction would be beneficial, but the person actually performs quite well in noise. Seriousness of the situation will dictate the need.
  – Score of 3-7:
    • Mild “Speech-to-Noise” Loss
    • Noise reduction would be very beneficial, and is recommended. Expectations for performance in noise should be excellent.
Assessments for Noise Reduction Needs

• QuickSIN Evaluation of Results
  – Score of 8-15:
    • Moderate “Speech-to-Noise” hearing loss
    • Noise reduction would be very beneficial, and is recommended. Expectations for performance in noise should be good.
  – Score of 15-25:
    • Severe “Speech-to-Noise” Loss
    • Noise reduction would be beneficial, and is recommended. Expectations for performance in noise should be average.
  – Score of 25+:
    • Profound “Speech-to-Noise” Loss
    • Noise reduction would be of limited benefit; further testing in noise with the hearing aids to verify true benefit is recommended. Expectations for performance in noise should be marginal.
    • The use of personal FM technology may be recommended.
Specific needs of the individual

- How active of a lifestyle?
- Frequently in background noise?
- Style preferences?
- Work-related issues? *(911 operator)*
- Telephone use
- Ultimately a judgement call
Needs Assessment Schedule

- Rating scale with 5 areas of consideration, with a “Need Score” of 0-5 per area

- Configuration of hearing loss
  - Flat (<3dB/octave): 0  
    *Solution: 1-4 channels*
  - Mild slope (4-10dB/octave): 1  
    *Solution: 4-8 channels*
  - Steep slope (10dB+/octave): 3  
    *Solution: 6-20 channels*
  - Odd configurations: 5  
    *Solution: 12-20 channels*

- Progressive Hearing Loss (style also considered)
  - Not Progressive: 0  
    (any style)
  - Mildly Progressing (10dB/5 years): 1  
    (any style)
  - Moderately Progressing (10dB/3 years): 3  
    (ITE or BTE)
  - Quickly Progressing (10dB/year): 5  
    (BTE)
Needs Assessment Schedule

• Rating scale with 5 areas of consideration, with a “Need Score” of 0-5 per area

• Tolerance issues (average dynamic range, or ADR)
  • None (ADR >35dB): 0 Linear, single channel
  • Mild Tolerance (ADR 25dB-35dB): 1 Compression, low channel
  • Moderate Tolerance (ADR 15dB-25dB): 3 Compression, medium channel
  • Severe Tolerance (ADR 5dB-15dB): 5 Compression, high channel

• Noise Issues (also affects style choice)
  • Never in noise or QuickSIN 0-2: 0 None necessary
  • Up to 2 hours per day or QuickSin 3-7: 1 Basic Directional
  • 2-4 hours per day or QuickSin 8-15: 3 Adaptive Directional
  • 4+ hours per day or QuickSin 16+: 5 Adaptive, frequency-specific consider FM
Needs Assessment Schedule

• **Unique Needs of the patient**
  • Judgment call, score 0-5
  • Style issues
  • Work-related situations
  • Home-related situations
  • Lifespan of instrument for replacement
Needs Assessment Schedule

• Overall score of 0-25
  • 0: Basic, analog, linear, no features  ($500-$1,000 each)
  • 1-5: Economy digital, 1-4 channels, minor noise reduction  ($800 - $1,250 each)
  • 6-10: Basic digital, 4-8 channels, automatic & moderate noise reduction  ($1,250 - $2,000 each)
  • 11-15: Advanced, 8-16 channels, automatic & adaptive noise reduction  ($1,800 - $2,500 each)
  • 16-20: Elite, 16+ channels, automatic, adaptive, frequency-specific  ($2,500 - $4,000 each)
  • 20+: Elite, consider ALDs & FM
Overall needs review

*The Bell Curve*

- Below average: $1,200, $1,800
- Above average: $2,400, $3,200
Pricing Considerations

• Price is negotiable
  – Can reduce the package (i.e. warranty, batteries) in order to get a lower cost
  – The majority of practitioners charge about the same price
  – Consider value-added features (i.e. on-site repairs, educational programs, etc.)
Current Examples of Technology

Leading Manufacturers, April 2011

(Alphabetical)

**Bernafon**
- **Economy:** Inizia 3 / 1
- **Entry-level:** Verite 5, Veras 5
- **Mid-Range:** Verite 7, Veras 7
- **Elite:** Verite 9, Veras 9
- **Power:** XTreme

**Phonak**
- **Economy:** OK!, Milo Plus
- **Entry Level:** Certena, Cassia, Audeo-3, Nios-3, Naida-3
- **Mid-Range:** Versata, Solana, Audeo-5, Nios-5, Naida-5
- **Elite:** Exelia, Ambra, Audeo-9, Naida-9
- **SPECIAL:** Target CROS technology

**Oticon**
- **Economy:** Hit, Hit Pro
- **Entry-level:** Vigo, Vigo Pro, Delta 4000
- **Mid-Range:** Delta 6000, Dual 5, 7, V, or W, EPOQ V or W
- **Elite:** Agil, Agil Pro, Dual XW, Delta 8000, Dual 9
- **Power:** Sumo, Chili

**ReSound**
- **Economy:** Essence
- **Entry Level:** Ziga, Dot-10, Live-5, Alera-5
- **Mid-Range:** X-Plore, be7, Dot-20, Live-7, Alera-7
- **Elite:** be9, Dot-30, Live-9, Alera-9
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<th>Mid-Range</th>
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# Current Examples of Technology

*Leading Manufacturers, April 2011 (Alphabetical)*

## Widex
- **Economy:** Flash, Real
- **Entry Level:** Mind 220, Clear 220
- **Mid-Range:** Aikia, Mind 330, Clear 330
- **Elite:** Inteo, Pasion 110, 115 and 440, Mind 440, Clear 440

## Unitron
- **Economy:** Breeze, Next Essential, Shine Plus
- **Entry Level:** Next-4 and 8, Latitude-4 and 8, Quantum-6
- **Mid-Range:** Next-16, Latitude-16, Quantum-12
- **Elite:** Yuu, Passport, Quantum-20
- **Power:** 360e, 360 Plus
- **SPECIAL:** Tandem-4 and 16 CROS systems

## Other Manufacturers
- Interton (ReSound)
- Miracle Ear (Siemens)
- Beltone (ReSound)
- Sona Medical (Phonak)
- Nu Ear (Starkey)
- AudioSync (Starkey)
- MicroTech (Starkey)
- Lyric
Lyric

Extended-wear disposable instruments

• Worn 24/7 for 2-4 months
• Can be worn when sleeping, showering
• Replaced by the audiologist when needed
• Retail price $425 each
• Can be fit same day as hearing test
• Invisible and discrete
Lyric

Contraindicators and Considerations

- Basic technology (analog, limited adjustability)
- Retail price $425 each, extended over 2 years for two ears: $6,800
- Mild to moderate losses only
- Limited ear sizes
- Certain medical conditions prohibit candidacy (diabetics, immune issues, bleeders, wax producers)
- Actual candidacy: 30% of appropriate those with mild to moderate losses.
Personal FM Technology

*When Hearing Aids Aren’t Enough*

FM technology refers to a type of wireless system that helps people better understand speech in noisy situations. FM systems commonly work together with a user’s hearing aids, although systems are also available for those with otherwise normal hearing (such as people who suffer from APD, ADHD etc.).
Personal FM Technology

When Hearing Aids Aren’t Enough

The person speaking wears or holds a transmitter microphone, or the transmitter is placed in the middle of the group (picking up speech from all around).

Using harmless radio waves, the FM system sends speech signal(s) to the listener, who wears a tiny FM receiver behind the ear.
Personal FM Technology

When Hearing Aids Aren’t Enough

FM Candidates:
• Clients working in extreme noise
• Clients with severe to profound hearing loss
• Clients requiring better hearing over a distance or through barriers
• Clients frequently in meetings, training sessions, and classroom situations
BlueTooth Technology

*Hands-Free Cell phone access*

- Available from most major manufacturers.
- Delivers cellular signal to *both* aids if two are worn.
- Limited to larger instruments (BTE, mBTE, ITE, HS, ITC)
- Cost: $250 - $400 depending on manufacturer and provider
- Can be linked to other devices (Plantronics telephone interface; television, mp3 players, etc.)
Questions to be Asked

- Configuration of hearing loss
- Issues regarding background noise
- Issues regarding tolerance
- Progressive nature of the hearing loss
- Special needs of the patient
- Detailed report
Questions to be Asked

• What is included with purchase?
  – Warranty
  – Batteries
  – Other Accessories
  – Can these be reduced in order to lower the price?
• What other options are available for this patient?
The End?