UNIQUE UNIVERSITY: FUNDAMENTALS FOR FITTING

Audiology Online Presentation by
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SPEAKER DISCLOSURE
DEBORAH DOYLE ALLEN, AUD

Relevant Financial Relationships:
• Is an employee of Widex USA and receive financial compensation.

Relevant Nonfinancial Relationships:
• There are no nonfinancial relationships.
LEARNING OBJECTIVES

1. At the end of this presentation the attendee will be able to describe Widex’ Unique True Input Technology fundamentals.

2. At the end of this presentation the attendee will be able to list new features introduced with the new Unique platform.

3. At the end of this presentation the attendee will be able to describe the sound classes available in Unique.

AGENDA

• TRUE Input Technology – Unique Platform

• Widex fitting rationale

• Sound classification concepts

• Adjustable and flexible features

• Products and Technology levels

• Q&A
THE FOUNDATION OF SOUND

- Hearing loss compensation
- Sound quality
- Optimizing listening situations

THE WIDEX SOUND

- **Soft sounds** should be audible
- **Conversational** should be comfortable and intelligible
- **Loud sounds** should never be uncomfortable
UNIQUE’S NUMBERS

<table>
<thead>
<tr>
<th>U-PLATFORM</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>INPUT LIMIT/DYN. RANGE</td>
<td>113 dB / 108dB</td>
</tr>
<tr>
<td>SAMPLING FREQUENCY</td>
<td>33.1 kHz</td>
</tr>
<tr>
<td>BIT DEPTH</td>
<td>18 bit</td>
</tr>
<tr>
<td>PROCESSING POWER</td>
<td>600 million</td>
</tr>
<tr>
<td></td>
<td>Operations/sec</td>
</tr>
<tr>
<td>MEMORY</td>
<td>1Mbit</td>
</tr>
<tr>
<td>INTEREAR</td>
<td>21 Hz</td>
</tr>
<tr>
<td>DELAY</td>
<td>1.3-5 ms</td>
</tr>
<tr>
<td>CURRENT CONSUMPTION</td>
<td>&lt; 1.00mA</td>
</tr>
</tbody>
</table>

WIDEXLINK – WIRELESS TRANSMISSION

- Wireless Transmission
- Invented by Widex
- Proprietary high-speed wireless data transmission
- Designed specifically for hearing aids and acoustical information exchange
- Instant synchronization and coordination
- **21 times a second**
FUNDAMENTALS OF WIDEX UNIQUE

CAPTURE EVERYTHING
PURIFY ALL
PROCESS SEAMLESSLY
SACRIFICE NOTHING

WIDEX UNIQUE

CAPTURE
PURIFY
PROCESS
**WIDEX UNIQUE**

**BETTER AND BROADER INPUT DYNAMIC RANGE**

NEW TRUE-INPUT TECHNOLOGY

- Loud Music, Sports Arena, Cinema, Party, Large Family Gathering
- Traffic, Construction 80-90dB SPL
- Conversation 60-75dB SPL
- Alone at Home 50-60dB SPL
- Whisper 20-30dB SPL
- Falling Leaves 10-20dB SPL

Upper input limit by UNIQUE 113dB SPL

Upper input limit by competitors 106dB SPL

Lower input limit by UNIQUE 5dB SPL

Lower input limit by competitors 35dB SPL

108 dB RANGE
FUNDAMENTALS OF WIDEX UNIQUE

- Capture Everything
- Purify All
- Process Seamlessly
- Sacrifice Nothing

WIDEX UNIQUE

- Wind noise reduction
- Interferometric Feedback Canceller
- Dynamic Cancellation Optimiser
- Soft Level NR

CAPTURE    PURIFY
PURIFY ALL
Bringing sound quality to the next level

WHY SOFT LEVEL NOISE REDUCTION?

- Low kneepoint ensures audibility of soft speech
- Not all soft sounds are desirable
- Reduce soft unmodulated sounds
- Enhances sound quality
HOW DOES SOFT LEVEL NOISE REDUCTION WORK?

Determines which sounds to amplify and which to suppress.

- High degree of modulation
- Low degree of modulation

SOFT LEVEL NOISE REDUCTION HOW DOES IT WORK?

Input classified as “Quiet” or “Speech in Quiet”
Classifier detects soft, unmodulated signal
Level of unmodulated signal is 62 dB SPL or less
Dampering occurs
PURIFY ALL

Bringing **sound quality** to the next level

SOFT LEVEL NOISE REDUCTION

WIND NOISE MANAGER

Wind Noise DETECTION

WIND NOISE MANAGER

HOW DOES IT WORK - DETECTION STAGE
WIND NOISE MANAGER
HOW DOES IT WORK - SEPARATION STAGE

Speech = Correlated signal
Wind = Uncorrelated signals

Microphone 1
Microphone 2

WIND NOISE MANAGER
SEPARATION STAGE

Wind noise
DETECTION

correlated from
un-correlated
SEPARATION
WIND NOISE MANAGER
REDUCTION STAGE

Wind noise DETECTION

correlated from un-correlated SEPARATION

Wind Noise SUBTRACTION

WIND NOISE MANAGER
BENEFITS FOR HEARING AID USERS

- Improvement speech intelligibility (backed by internal trial results)
- No need to remove HAs when in windy environments
- Benefits monaural hearing aid users
OUR GOAL

ONE UNIQUE UNIVERSAL PROGRAM GEARED FOR ALL SITUATIONS - WHETHER AVERAGE OR EXTREME

GOAL: ONE program to rule them all
To achieve this we have designed a system that:

1. Has a more detailed analysis of the surrounding environment
2. Has an assessment of actual sound environment
3. Is able to determine what is needed and provide the optimal feature and gain balance
The most sophisticated system available

Various sound environments | Optimal sound in specific situations

REALITY BASED SOUND CLASS LIBRARY
THE SOUND CLASSES

1. Quiet
2. Quiet with speech
3. Transport
4. Transport with speech
5. Urban
6. Urban with speech
7. Party
8. Party with speech
9. Music

All in one universal program

UNIQUE INTRODUCES:
WIDEX SOUND CLASS TECHNOLOGY

CLASSIFIER
INTERNAL CONTROLLER
PREFERENCE CONTROL
HOW ARE WE ABLE TO CLASSIFY A GIVEN SIGNAL?

- Frequency weighting
- Modulation
- Frequency weighting
- Amplitude modulation
- Degree of fluctuation in amplitude
- Tonality
- Loudness
- Windnoise
- Voiced/Unvoiced speech detection
- InterEar coordination

HOW IS SPEECH IDENTIFIED?

UNIQUE SPEECH DETECTOR

DETECTION OF VOICED SPEECH

DETECTION OF UNVOICED SPEECH
HD LOCATOR
PRECISE SOUND INTEGRATION

Features
- Multi-channel fully adaptive directional microphone system with low-frequency compensation and Speech Tracer
- Standard for all technology levels

Benefit
- Intelligibility with comfort in various listening environments
**TRUSOUND SOFTENER UPDATED**

**TRANSIENT SOUND IMPULSE**

- Default Softener setting allows -8 decibel reduction
- Plus setting allows for -16 decibel reduction
TRUSOUND SOFTENER BENEFITS

- Takes off the “edges” of transients
- Naturalness without harshness
- No direct effect on speech intelligibility
- Avoid unnecessary lowering of IG_{loud} and MPO
- May improve speech understanding
- Benefits every hearing aid wearer

NEW AND IMPROVED UNIQUE FEATURES

- Real Time Speech Enhancer
- Variable Speed Compressor
- Unique Audibility Extender
- High Frequency Boost
REAL TIME SPEECH ENHANCER

- Online calculation of correct SII including hearing loss, venting, noise and speech
- New speech detector
  - Voiced speech detector & unvoiced speech detector
  - Statistic combination

UNIQUE VARIABLE SPEED COMPRESSOR

EDRC  JUMP  FAST COMPRESSOR
COMPRESSION IS **DYNAMIC** BECAUSE SOUNDS ARE DYNAMIC …

ADVANTAGES OF USING **FAST ACTING** COMPRESSION

- Hearing impaired people have reduced dynamic range
- Speech sounds vary in intensity
  - Ensuring audibility of soft sounds
  - Follows syllabic variation
- Loudness “normalization”
DISADVANTAGES OF USING FAST ACTING COMPRESSION ONLY

- Reduces temporal cues – affecting those with cognitive issues
- Lower speech intelligibility when used with a high CR (> 3) (Plomp, 1988).
- Spectral smearing in a multichannel compression hearing aid, resulting in poorer speech intelligibility despite enhanced audibility (Bor et al, 2008; Souza et al, 2005)
- Ambient noise becomes more perceptible during pauses between speech
- Reduces signal-to-noise ratio in moderate levels of background noise
- Reduces inter-aural level difference between two hearing aids of a bilateral pair. This could make spatial awareness and localization more difficult
- More prevalent in compressors with more channels and a higher CR

ADVANTAGES OF USING SLOW ACTING COMPRESSION

- Longer release time, less effective compression ratio, more linear – preserve temporal structure
- Preserves short term changes within the envelope (and temporal fine structures)
- Preservation of signal-to-noise ratio in moderately noisy places (Neuman et al, 1998)
- Preservation of natural interaural level difference cue for spatial hearing
- Higher naturalness and better sound quality (e.g., Neuman et al, 1995, 1998; Hansen 2002).
- Better speech intelligibility for people with more than a moderate loss (Souza et al, 2005; Davies-Venn et al, 2009)
SUMMARY BETWEEN COMPRESSION SPEED AND COGNITIVE ABILITY

<table>
<thead>
<tr>
<th>WM Type</th>
<th>Fast Acting</th>
<th>Slow Acting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Good WM</td>
<td>Distortion – present, not bothered</td>
<td>Distortion – absent</td>
</tr>
<tr>
<td></td>
<td>Audible cues - useful</td>
<td>Audible cues - loss</td>
</tr>
<tr>
<td>Poor WM</td>
<td>Distortion – present, bothered</td>
<td>Distortion – absent</td>
</tr>
<tr>
<td></td>
<td>Audible cues - useful</td>
<td>Audible cues – loss</td>
</tr>
</tbody>
</table>

All people (good and poor WM) can use audibility cues; but only good WM can tolerate a loss of temporal cues (or poor WM rely more on temporal cues)

IMPLICATIONS FOR HEARING AID DESIGN AND AUDIOLOGY

- Immediate reaction
  - Fast acting compression for people with good WM
  - Slow acting compression for people with poor WM
- Considerations
  - Research done with only one form of compression
    - Combination of compression speeds?
  - Sacrifices
    - Good WM with poorer sound quality from FAC
    - Poor WM with compromised audible cues from SAC
  - Difficulty classifying people into good and poor WM
    - Sensitivity of test measure? Scope of practice? Time?
- Need a compressor that can preserve the temporal cues AND audibility cues to benefit people with good and poor working memory
DESIRABLE ENHANCEMENTS IN SINGLE SPEED COMPRESSORS

• Fast acting compression
  • Need to preserve waveforms at all levels, and especially loud inputs (because of potential saturation)
• Slow acting compression
  • Need to achieve audibility for soft sounds (especially after loud sounds)
  • Transition from low gain to high gain (and vice versa) must be rapid enough but seamless
• Ideal solution is a slow acting compressor (primary) working in parallel with a fast acting compressor (secondary) – preserves temporal structures and audibility cues

VARIABLE SPEED COMPRESSOR – DESIGNED FOR EFFORTLESS HEARING

• Effortless Hearing design – people with good and poor working memory can all realize their potentials
• The variable speed compressor has a slow-acting and a fast acting component
• Slow acting component preserves temporal characteristics of input (needed by people with poorer WM) and fast acting component picks up the audibility cues from sudden changes in input levels (benefits both good and poor WM)
VARIABLE SPEED COMPRESSION - JUMP

- Faster reaction from loud to soft environments – more audibility in changing environments
- Possible true slow compression for all environments

FAST COMPRESSOR

- Make slight syllabic compression possible
- More of the soft speech sounds placed above hearing threshold
- Different compression ratios for different environment, without compromising slow compression strategy
ADVANTAGES OF A VARIABLE SPEED OVER A SINGLE SPEED COMPRESSOR

• More consistent audibility for soft sounds, especially after a loud sound
• More comfort for transient sounds, and when transitioning from soft to loud sounds
• Better SNR at high input level, preserving the temporal structures (and better speech understanding in noise)
• Better preservation of temporal waveform at ALL input levels
• Optimal for people with good and not-so-good working memory and those with a severe hearing loss

OTHER NEW AND IMPROVED FEATURES IN UNIQUE

AUDIBILITY EXTENDER

HIGH FREQUENCY BOOST
AUDIBILITY EXTENDER

Many relevant updates:

• Improved sound quality
• More options for individual settings
• Automatic setting of basic/expanded:
  • depending on start frequency
  • below or above 2.5kHz

HIGH FREQUENCY BOOST

• For people with mild to moderate HL
• Adds amplification to high frequency sounds
• Default setting in the music program
• Can be activated in “Feature settings” within compass
THE MOST SOPHISTICATED SYSTEM AVAILABLE

Various sound environments

Optimal sound in specific situations

WIDEX SOUND CLASS TECHNOLOGY

REGULATION OF THE SOUND CLASS SYSTEM

Starts in the Quiet sound class

Decides upon sound class every second

If different sound classes on L and R it will go to the last sound class agreed upon

Needs to identify same sound class 3 seconds in a row to change

Stable sound picture & smooth transitions
AUTOMATIC CHOICE OF SOUND CLASS

Currently detecting: Quiet without speech

Select sound class:
- Quiet
- Transport
- Urban
- Party
- Music

User preference:
- Quiet with speech: More comfort, Balanced, More audibility
- Quiet without speech: Balanced

Adjust all sound classes

COMFORT → AUDIBILITY
HOW DOES THE HEARING AID KNOW MY INTENTION?

CAN A VOLUME CONTROL SUPPORT MY INTENTION?
WHAT IS THE PREFERENCE CONTROL?

Audibility

Comfort

Multiple parameters

PREFERENCE CONTROL AND VOLUME

<table>
<thead>
<tr>
<th>9 steps</th>
<th>Volume</th>
<th>HA features</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 steps up</td>
<td>+8</td>
<td>+6</td>
</tr>
<tr>
<td>3 steps up</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 steps up</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 step up</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neutral</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1 step down</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 steps down</td>
<td></td>
<td></td>
</tr>
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<td></td>
<td></td>
</tr>
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<td>4 steps down</td>
<td>-8</td>
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<td>1 step down</td>
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</tr>
</tbody>
</table>
SACRIFICE NOTHING

CAPTURE EVERYTHING
PURIFY ALL
PROCESS SEAMLESSLY
SACRIFICE NOTHING

FULL FLEXIBILITY
NO SACRIFICES

Passion Micro CIC
Fusion CIC
Fashion Mini ITE/ITC
Fashion
**UNIQUE LEVELS AND STYLES**

- **UNIQUE 440**
  - 15 Channels
  - Wind Noise Attenuation
  - HF Boost
  - RT/Speech Enhancer
  - SLNR
  - ZEN
  - AE
  - DEX Devices

- **UNIQUE 330**
  - 10 Channels
  - Speech Enhancer
  - SLNR
  - ZEN
  - AE
  - DEX Devices

- **UNIQUE 220**
  - 6 Channels
  - SLNR
  - Noise Reduction
  - ZEN
  - AE
  - DEX Devices

- **UNIQUE 110**
  - 4 Channels
  - SLNR
  - Noise Reduction
  - ZEN
  - AE
  - DEX Devices

**WIDEX UNIQUE**

**BREAKING THE SOUND BARRIER**
SUMMARY

- Widex True Input Technology forms the basis of the Fundamentals of the Unique platform.
- The new features introduced with Unique provide best in class hearing loss compensation.
- Incredibly fast classification and processing of sound into sound classes provides the wearer with optimized amplification only available in Unique.
- Please view the handouts accompanying this course and the articles listed next.

ARTICLES AND REFERENCNES AVAILABLE ON UNIQUE

- **Speech Intelligibility Benefits of Hearing Aids at Various Input Levels**
  Authors: Kuk, Francis; Lau, Chi-chuen; Korhonen, Petri; Crose, Bryan
  Source: Journal of the American Academy of Audiology, Volume 26, Number 3, March 2015, pp. 275-288(14)

- **New Technology for Effortless Hearing: A “Unique” Perspective**
  By Francis Kuk, PhD; Erik Schmidt, PhD; Anders Holm Jessen, BSEE, and Marianne Sonne, MA
  November 2015 Hearing Review

- **Designing Hearing Aid Technology to Support Benefits in Demanding Situations, Part 2**
  By Lars Baekgaard, MSc, Steen Rose, and Hanne Pernille Andersen, PhD
  Hearing Review

- **Widex Fitting Rationale: A Need for a Change**
  By Karolina Smeds, PhD, Martin Dahlquist, MSc, Josefina Larsson, Sofia Hertzman, and Florian Wolters
  January 2016 Hearing Review
THANK YOU

Questions:
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More Information:
• www.widexpro.com
• https://learn.widex.pro/learn