

Dr. John Beerends:



Photo: Wido Worms

# 'You can only deliver quality if you can measure it'

## Personal details

**Works for:** TNO Information and Communication Technology, Delft, as senior researcher working on quality in the fields of speech, audio, video, audiovisual and data

**Born:** 28 May 1954 in Millicent (South Australia)

**Grew up in:** The Hague

**School education:** 1970-1975: Community Technical College, The Hague, electrical engineering

**Higher Education:** 1978-1984: Leiden University; physics, graduated in the field of psychophysics

**PhD:** 1985-1989: 'Pitches of simultaneous complex tones' (research in the field of pitch observation), Eindhoven University of Technology

**Career:** 1975-1978: various jobs as engineer through employment agencies

1989-2003: KPN Research, Leidschendam  
2003-today: TNO Telecom, now TNO Information and Communication Technology, Delft

**Marital status:** married to Ingrid Sikkens

**Children:** daughter Siri (20)

**Hobbies:** listening to music (classical: including Bach, Bruckner, Stravinsky, Varèse; pop: including Canterbury scene, Captain Beefheart, Beach Boys, Peter Hammil, Frank Zappa) and cycling.

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'These days we are more interested in the possibilities offered by audiovisual telecom equipment than in its quality. The quality of mobile connections, in particular, is often so poor that even speech is indecipherable. Only by measuring in the right way, can you improve the speech quality.'

He's the holder – or co-holder – of some twenty patents; Dr. John Beerends, physicist, of TNO Information and Communication Technology in Delft. The first two patents relate to a new loudspeaker system and a pitch meter while most relate to speech and audio quality and their measurement. His ideas in this field have led to the first world standard for the speech quality of telecommunication systems. He has also contributed to other standards in the field of audio and video quality. Beerends has received various prizes for his research. Every now and then during our conversation, he takes from the breast pocket of his shirt two small, thin books: one bordeaux red and one black. He refers quickly to them. The black book is an address book that is almost falling apart and the red one is his diary for 2006. Beerends always has both books with him because as well as their primary function, he uses them for something else. The black book, for instance, is where he writes scientific truths.

### *Ideas for eternity?*

'Eternity, well...I write fundamental things in the black book that I always want to have to hand. Here, for example, it says how loud the standard human voice sounds at a certain distance. I was also interested to learn how many neurones and synapses there are in our brains – an unbelievable number: ten to the power of thirteen and ten to the power of fifteen respectively. And I have noted that exposure to eight hours of constant noise at 90dB will damage your hearing. The line that marks hearing damage is energy-related, so you only need to hear a noise of 96 dB for two hours and you'll suffer damage.'

### *And what do you write in the little red book?*

'Besides my daily worries and meetings, I write down ideas and snippets of

philosophies, mostly related to quality. To create a clear distinction in my diary I use four colours: *red* for work meetings, *blue* is work with a personal component, *black* is for what I can't give a home to, and *green* is for personal meetings and my philosophical thoughts, with which I later hope to do something. Every year I transcribe the green thoughts – update them or let them go. I've been doing this for some fifteen years and it reveals an evolution in your thought patterns. Look, I'm now occupied with measuring quality in the fields of speech, audio, image and video. But what is quality and how do you measure quality? I think it is important to make a distinction between *functional quality* and *beautiful quality*. Functional quality is often very easy to measure: a piece of equipment must be 100% available. So a car, computer or telephone either works or it doesn't, and – if it sometimes doesn't work – you measure the degree of availability. Beautiful quality is much more difficult to measure: the car that I think is beautiful you might find ugly. Is Bach's music any more beautiful than Stravinsky's, Captain Beefheart's or Madonna's? And which loudspeaker sounds best? It's a personal choice and it depends on the context.'

### *So the context is important?*

'Yes, if you want to be able to measure quality, you need an ideal. But what then is the ideal? If you can't define that, you can't actually measure quality. Take a loudspeaker... does an ideal loudspeaker in fact exist? Just suppose, I close my eyes, listen to a voice through the speaker and it sounds to me just like a natural voice. Is the speaker perfect? Yes, certainly for that voice, but that doesn't make it by definition suitable for reproducing a concert hall musical recording. The difference is in the ideal being pursued, *here and now* versus *there and then*. It becomes even more difficult if you can't define an ideal. What, for example, is an ideal wine or an excellent dinner? What you tend to do is give your judgement within the context of good service, the elegant way the meal is served, the congenial atmosphere, nice music or how enjoyable the evening was. In fact, in that case the context determines the quality.'

### *Where does your fascination for sound come from?*

'My hobby is listening to music. When I was at technical college and later, too, I developed

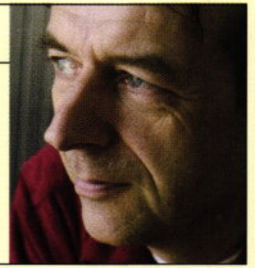
new ideas about the sound reproduction of loudspeakers. One of those ideas won me 45,000 guilders and I got a patent out of it. After technical college I went to study physics in Leiden and eventually I graduated in psychophysics, the discipline that deals with the relationship between what you measure and what you observe. The next step was my PhD research in Eindhoven. That covered the topic of pitch perception.'

**And then you joined KPN Research in 1989. What did you do there?**

'At first I was working on the coding of audio, for both speech and music. Coding a signal in a way that is both economical and smart, so you can store it and then transport it. The basic idea was developed back in the 1980s. Good speech coding for GSM was a highly lucrative business but KPN Research had too little clout to secure a place among the top institutes. So we concentrated on measuring quality. As it happens, you can measure quality with the same ideas that underpin economic coding. When I'm working on this, I often follow my intuition and I use my ears and other people's. This subjective measurement must ultimately correlate with the objective measurement. We used the results in the modelling and that's how we eventually developed our PSQM measurement method: *Perceptual Speech Quality Measure*. With that proposal we participated in 1992-1993 in the first

**Dr. John Beerends:**

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round of world standardisation run by the International Telecommunication Union, the ITU. It was a competition between six proposals by various concerns and conglomerates. Our proposal won hands down. Still, it involved some wrangling. If you miss a beat, you're out, especially if it turns out that your measurement method is heavily protected by patents. Our proposal was eventually accepted in 1996 as the first world standard for measuring speech quality and given the number P861. After that a battle in the market ensued in which new methods claimed to achieve a higher correlation between the subjective, observed quality and the objective, measured quality. In 1999 a new comparison was carried out by the ITU. Our PSQM-99 proposal came first that time too, just ahead of the proposal by British Telecom. The ITU then proposed that the best parts of the two proposals be combined. That happened and that's how the new world standard PESQ with the ITU-number P.862 came into being. And now the next round of world standardisation is on its way.'

**Do we need a new standard?**

'Absolutely! The technical developments don't stop. It's a pity but you notice that today we are more interested in the possibilities offered by audiovisual equipment than in the quality. Quality is simply an afterthought in the design. Think of the background noise with mobile phones, a robot-like voice, delay, echo, gaps in words or the loss of words in a conversation. In Voice-over-IP, calling via computer and inter/intranet, the quality could be greatly improved. Another problem with telecommunication equipment is that you can buy a piece of equipment that functions perfectly well at your end but at the other end of the line it's delivering appalling quality. Whose responsibility is it in fact to, say, suppress an echo? In practice, it turns out that such a problem can best be solved by the person who is *not* troubled by the echo. And that makes it difficult to address the problem. I call someone and, through a concurrence of circumstances, he is troubled by an echo while

at my side of the connection it sounds perfect. If that happens more often – and I keep hearing that the other person is getting poor quality – I might perhaps buy a better phone and hope that it gets better. But first everyone thinks, oh well, as long as it doesn't affect me.'

**Why is TNO the place that you do this work?**

'There is simply nowhere else that this kind of research would be possible. The public value seems obvious to me: making it possible to deliver quality by being able to measure quality. Measuring quality does have financial rewards – and our patents certainly generate income – but it is not a runaway commercial success. It doesn't appeal to companies. Universities often come up with ideas that aren't practicable in a standard. That leaves just TNO!'

**What do you still want to achieve?**

'With my ideas about speech degradation-decomposition, I want to create a new ITU world standard (see 'Favourite Project'). I also want to continue working in a broad field on audiovisual and data quality. And we have close contacts with our TNO colleagues in Soesterberg. In the 1980s they became world famous for their work in the field of speech intelligibility. We are now trying to integrate our speech quality and their speech intelligibility into one measurement system. That system could be applied in broadcasting systems or evacuation systems and in hearing aids. Right now, for example, we are developing a model to measure the quality of hearing aids. As well as a great many people who are hard of hearing across the audio spectrum, you also have people with a particular type of hearing loss. For example, people who can no longer hear a certain part of the frequency spectrum. They need a good quality hearing aid that is fit to their own personal hearing loss.'

**If you hadn't had this profession, what would you have done?**

'As a technical college student I'd probably have done something using my hands.'

**Favourite project**

'Speech degradation-decomposition' – that's what Dr. John Beerends calls his latest project, which he's been working on since January 2006. It is a project that KPN and TNO are co-financing and it will run until the end of 2009. 'It is my favourite project because I am free to choose the direction the research takes. Speech quality involves all sorts of distortion. Things like background noise, time clipping, amplitude clipping timbre changes, etc. For each type of distortion we want to express the impact on the perceived speech quality in a figure. If different distortions occur simultaneously, you can determine the dominant distortion and then the measurement system can be used to optimise the speech connection.'