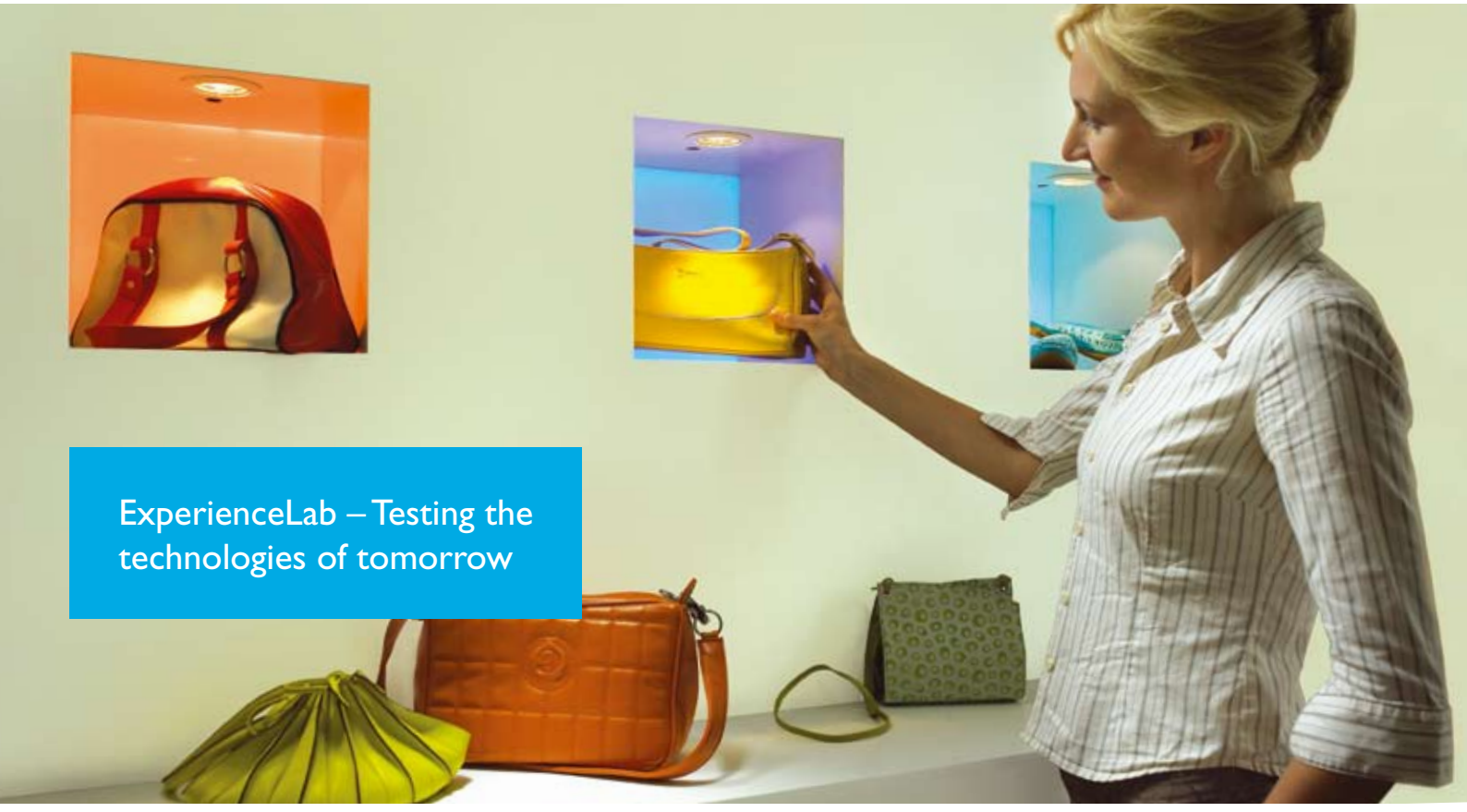
password

Philips Research technology magazine - issue **29** - February 2007



ExperienceLab – Testing the technologies of tomorrow

"Physics does set the rules, but using our extensive knowledge of human hearing – particularly its limitations - we can go one step further and trick the ear."

Beyond physics for superior sound

"Pharmacogenomics - the tailoring of drug therapies to specific genotypes in order to maximize their efficacy and reduce their side effects - is the biggest change in medicine for the last few thousand years."

Molecular medicine - Technology personalizing medical care

"Lighting is no longer about light bulbs mounted in lighting fixtures."

Illuminating experiences - Lighting goes solid state

PHILIPS

Cover story
ExperienceLab - Testing the technologies of tomorrow

What will our world look like in ten years? What technologies are around the corner? These are the questions everyone gets asked when you tell someone that you work at Philips. But Philips is asking different questions. Not what we can have, but what do we need? Do people actually want this technology and what should it do? What benefit does it give them? And we're using our unique ExperienceLab to make sure.

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Password is a quarterly magazine published by Philips Research.

Philips Research, part of Royal Philips Electronics, has laboratories in three regions (Europe, East Asia and North America) where around 1,800 people investigate promising options for innovation.

Editor-in-chief
Peter van den Hurk
E-mail:
peter.j.van.den.hurk@philips.com

Production management
Claudia van Roosmalen
Erica Schrijvers

Distribution management
Cees Jan Mol
Erica Schrijvers

Editorial Board
Prof. Dr. Emile Aarts, the Netherlands
Dr. Steve Battersby, United Kingdom
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Dr. Falko Busse, Germany
Ellen de Vries, the Netherlands
Dr. Michael Pashley, USA

Design and Art Direction
Storm Scott, Eindhoven

Printer & Lithography
Roto Smeets GrafiServices
Eindhoven

Other contributors to this issue
William Third

More information and subscription
Philips Research
Communications Dept
High Tech Campus 5 (MS04)
5656 AE Eindhoven, the Netherlands
Tel. +31-40-27 43403
Fax +31-40-27 44947
E-mail:
prpass@natlab.research.philips.com

See also
www.research.philips.com

A people-centric approach to innovation

In line with Philips' brand promise of Sense and Simplicity, we are continuously pursuing meaningful products and applications to improve people's lives in terms of healthcare and lifestyle. The number of possibilities and opportunities seems virtually infinite, so it is extremely important to make the right choices in the process of turning a potential innovation into a profitable product or application.

This means we need fundamental insights into the things that people need and require in their lives, from basic provisions to support lifestyle - such as listening to one's favorite music in the most comfortable and relaxing manner - to more fundamental needs with respect to one's personal health and environment - such as advanced medical imaging systems for early detection of potentially dangerous diseases, and lighting systems that are easy to set up and even thriftier in their use of power than anything that has gone before. What do people really want, and why do they prefer one solution to another?

In 2001, we started user-centric experience research in HomeLab, studying human-technology interaction and new concepts for ambient intelligence. In cooperation with many partners, all bringing in their respective knowledge and capabilities, a number of successful new business ideas were generated. For example, the sale of the one millionth Ambilight FlatTV set was celebrated at the Consumer Electronics Show in Las Vegas (US) recently. Building on these successes, we opened ExperienceLab in October 2006 – a combination of HomeLab, CareLab and ShopLab – with excellent facilities and people to conduct leading, high-quality user-centered research into lifestyle and healthcare systems and applications (see p.6). With our breakthrough technologies, we are also focusing on healthcare-related developments and aim to address all of the stages in the care cycle from diagnosis to treatment and follow-up processes (see p.12). The advancement of molecular healthcare (see p.22) promises to revolutionize today's healthcare practices by detecting health problems at a much earlier stage, increasing the likelihood of successful treatment and minimizing the severity or duration of an illness.

In our research into audio applications, we also take a highly people-centric approach. It is fascinating to see how groundbreaking innovations can still lead to an even more pleasurable listening experience (see p.26). No matter where you may be - at home, in the car, on your bike – you can listen to your favorite music in a high-quality setting completely designed around you.

Over the last few years, Philips Research has evolved from being a closed scientific institute to an organization that has a strong business drive in a spirit of open innovation. As the new CEO of Philips Research, my focus will be on utilizing our research strengths optimally in our core regions: Europe, the US and Asia. Our global reach, combined with our people-centric approach to research is going to lead to more innovations that excel in their delivery of Sense and Simplicity.

Peter Wierenga
Chief Executive Officer Philips Research

What's new

More information: **www.research.philips.com/password**

CareServant: Patient infotainment that makes the patient feel more like a guest

The Philips CareServant provides interactive communication solutions and services that improve the quality of stay of patients in a hospital, for people in care organizations or in the comfort of their own homes. It is an interactive system, consisting of a plug-in card or a set-top box connected to the TV. It offers users information, communication and relaxation in a care environment, or in the comfort of their own homes. A central network server drives the whole system. The result is a turnkey patient 'infotainment' solution that, apart from controlled access to broadcast programming, also uses modules, for example, for video on demand or games, for access to the Internet or e-mail, for meal ordering or shopping, or for delivering information about hospital facilities or the patient's personal treatment schedule.

As the CareServant is intended as a relief for the medical staff, Philips offers a full range of links to other systems. From RFID readers to ensure each patient gets their correct content, to connections to the patient's demographics and record in the Hospital Information System. As it offers added services, it can also link to the hospital's prepay or invoicing system.

Philips' CareServant is currently running pilots in six institutions in the UK and the Netherlands.

The Philips CareServant provides interactive communication solutions and services that improve the quality of stay of patients in a hospital, for people in care organizations or in the comfort of their own homes.

Novel solutions to improve detection of sleep disturbance and early indicators of heart failure

Philips is currently developing medical technologies that enable people to fight cardiovascular diseases in their own home. The technologies are meant to support physicians in the treatment of patients with a chronic heart disease.
In addition, the technologies should enable and motivate people to adopt a healthier lifestyle for preventative purposes. Philips' efforts span the whole range from a new sensor technology to a service infrastructure that supports people in addressing their specific issues. The true challenge lies in realizing reliable and easy-to-use patient monitoring devices that can be worn unobtrusively on the body, or that can be incorporated in the home environment. The latest results involve an unobtrusive solution to monitor the quality of sleep, and garments that monitor the early indicators of heart failure.

Newly developed biomedical bedclothes provide respiration and heart rate information using a pressure-sensitive bed sheet. Based on this information the quality of sleep can be determined.

The heart failure management solution consists of a garment with textile ECG electrodes, a blood pressure cuff and a weight scale that are wirelessly connected to a handheld device (e.g. a PDA).

The Philips Rehabilitation Exerciser: A neurological motor exerciser to improve outcomes for stroke patients

Effective rehabilitation, e.g. after a stroke, increases patients' quality of life, their ability to resume work and enables them to live independently. It is vital that the training intensity is not diluted, which prevents a return to optimal performance, or that therapies are interrupted prematurely. For many reasons this may often be the case, not the least related to the cost pressure in the healthcare system and a deficit in patient motivation. Philips is developing and testing solutions to increase the efficiency and effectiveness of rehabilitation. The Stroke Rehabilitation Exerciser supports patients and therapists in the implementation and execution of a personalized neurological motor exercise plan at home. It enables an efficient therapy planning for the medical professional and increases the training intensity for the patient.

The physiotherapist plays a fundamental role in the assessment and composition of a training plan, as well as for administering essential therapeutic interventions. The Rehabilitation Exerciser enables a therapist to promote and track home rehabilitation and stay up to date with the progress of the patient. The therapist may review the motion exercises, add or modify the training modules and deliver personal messages to the patients. Face-to-face sessions can be effectively scheduled and organized due to the continuous availability of training data. First clinical trials have started in late 2006.

The Stroke Rehabilitation Exerciser supports patients and therapists in the implementation and execution of a personalized neurological motor exercise plan at home.

The Philips Rehabilitation Exerciser uses inertial sensors to measure acceleration, rotation rate and the earth's magnetic field, and determines the orientation of the sensor unit.

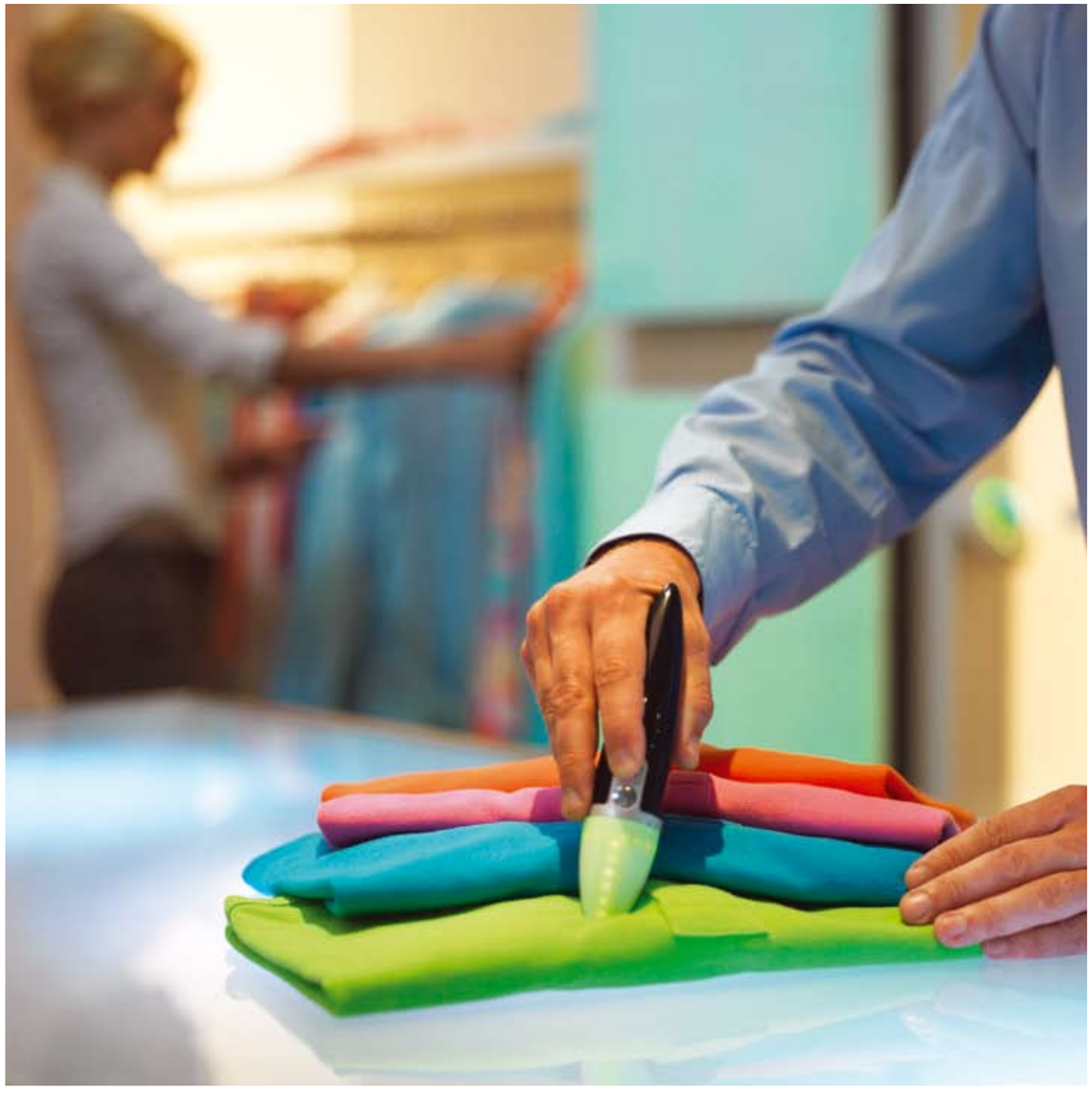
At the end of a Rehabilitation Exerciser session, the patient can play back his/her actual motion or receive a graphic illustration of his/her performance progress.

Advanced liquid-crystal technology shapes the light from LEDs

Scientists at Philips have developed a non-mechanical means of electrically adjusting the size, shape and direction of a beam of light from a light source so that it can be steered onto a single spot or spread out over precisely controlled areas. The technology can also be used to control the color temperature of the light in order to simulate a wide range of different ambient conditions, from the crisp white of bright daylight to the warm glow of candlelight. This new technology promises a whole new era of dynamic lighting in shops, leisure facilities and homes.

The new beam-forming technology utilizes a unique mixture of the refraction, diffraction, light scattering and reflection properties of liquid-crystal materials integrated into a thin transparent panel that can be placed in front of suitable collimated light sources. Although the technology can be used with a range of light sources, it really comes into its own when combined with high-brightness solid-state lighting. When used in conjunction with red, green and blue LEDs (light-emitting diodes), which can generate an almost infinite range of colors and intensities, it increases the functionality of the lamp even further by enabling the user to control the shape and size of the beam. Philips' beam-forming liquid-crystal panels are highly transparent and do not use the polarizers commonly found in LCDs.

The size, shape and direction of the beam of light from one specific light source can be electrically adjusted to create different lighting atmospheres.



To select a color, users simply touch a suitably colored object with the LightWand.

Cover story ExperienceLab

ExperienceLab - Testing the technologies of tomorrow

What will our world look like in ten years? What technologies are round the corner? These are the questions everyone gets asked when you tell someone that you work at Philips. But Philips is asking different questions. Not what can we have, but what do we need? Do people actually want this technology and what should it do? What benefit does it give them? And we're using our unique ExperienceLab to make sure.

By Jack Stafford
Photography: Philips

ExperienceLab is the embodiment of Sense & Simplicity: developing technology not for technology's sake, but to create products that enhance people's lives in a meaningful way. It's about listening to our customers and consumers to understand what motivates them, what they want and what they really need. This is the goal of 'experience research', with the existing HomeLab and its new sisters – CareLab and ShopLab.

HomeLab - From research to business innovation

The ExperienceLab began as just one laboratory – HomeLab – in 2001. At first glance when you walk in it looks just like an ordinary apartment. But take a closer look and you'll see that it's a high-tech paradise. "It's a vision of fully integrated, user-friendly smart surroundings that promote well-being, self-expression and productivity and it's called Ambient Intelligence," explains Emile Aarts, Scientific Program Director of Philips Research. "This vision, developed in the late 1990s, provided a major contribution to the development of the current three-pillar strategy of Philips, which builds on the true believe that technology solutions should add to people's well-being, and which is reflected in the brand promise Sense and Simplicity."

Designed around you requires that we have to understand what people need and desire; Advanced means that applications that are seemingly simple, still are capable of realizing complex functionality; Easy to experience demands that applications shall be very easy to understand and to use by our customers.

Future care

Here are some of the technologies being tested in CareLab at the moment:

smartBed

The smartBed monitors an elderly person while sleeping. It monitors vital signs with sensors integrated into the mattress. A bed is an ideal place for monitoring people's cardiovascular and respiratory performance and, of course, their sleep. It can tell you if you've had enough sleep, how much of it was good quality sleep or if you need to get more sleep. By monitoring people in their familiar surroundings like their own home it can actually help save lives. It can encourage a person to stay fit, and it can also help improve the quality of life for people with heart disease.

ILSA (Intelligent Life Style Assistant)

ILSA is an adaptive home environment system that can help people to maintain an adequate quality of life in their home as they get older. It closes doors if there's a draft, it can help them order meals, it notifies emergency services if the person needs help, and much more. It's a great help to the elderly and also to the care-givers, delaying or even limiting the need to live in alternative but expensive healthcare systems.

Later Life Lighting

Good lighting is essential for the elderly and CareLab is helping to create the perfect lighting system for them. Most people have to go to care homes after a fall, and the majority of falls happen at night. CareLab is currently testing foot-level, motion-activated lights that automatically come on at night when a senior person gets up to go to the toilet. There are bright lights to regulate sleep patterns and excellent general lights to make reading or embroidery easier.

Future lifestyle

What's next from HomeLab? Here's a small selection of product concepts currently being put through their paces.

Wireless charging pad

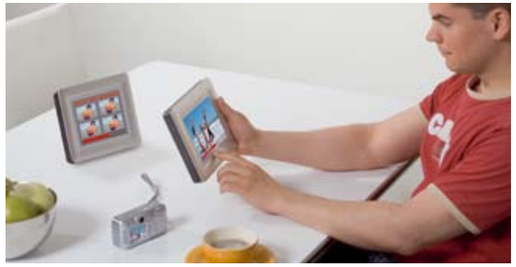
We all have mobile devices and it's such a pain to plug them all in, and often we forget to do so. Well the wireless charging pad is an extremely novel solution. Each mobile device has a receiver coil tuned to its individual power needs, and they sit on the charging pad – about the size of a mouse pad. They're charged automatically and simultaneously.

MediaBubble

Too many picture frames in your house? The MediaBubble displays them all on one single picture frame screen in slide show format. It can even beam the pictures to your TV so everyone can see them

iCat

In HomeLab, a demo uses iCat as a helpful assistant in the kitchen. It combines information about the user's calendar, weight and activity to give tips on what to eat and do, taking into account personal preferences.



It's this user-centered innovation that's the basis for successful new business creation. Ambient Intelligence has been incorporated into some incredible new products and tested in the HomeLab. Here are just some of the examples:

MirrorTV

Mirror TV is an LCD display integrated into a mirror, which means that you can surf TV channels, the internet or even view your blood pressure while brushing your teeth or styling your hair.

Ambilight

Ambilight produces ambient light around the TV screen to complement the colors and light intensity of the on-screen image. It adds a new dimension to the viewing experience, completely immersing you in the content you are watching.

amBX

amBX™ stands for 'ambient experiences'. It's a cutting-edge set of peripherals that take the computer gaming experience to a completely new level. The set includes fans, a 'wrist rumbler', lights and speakers to create synchronized light, surround sound, moving air and rumbling vibrations that will bombard gamers' senses from every angle.

CareLab - Bringing care into the home

CareLab is similar to HomeLab in that it is a home environment, but the difference is that CareLab is targeted on helping one part of the population – the elderly. Caring for people in their home is the way the healthcare industry is moving. It has dramatic advantages for them – better quality of life – and for the caring community, with

Future shop lighting

Here are some of the hottest new technologies currently under the spotlight in ShopLab:

Intelligent ShopWindow

Ever wanted to look around a shop but don't want to go inside? With the Intelligent ShopWindow you can. It's an Intelligent Shop Window that displays more information about products you're interested in. You can trigger it by hand or it can even detect which products in the shop window you're looking at. It would be a major tool for shop window dressers too. They would be able to use the touch screen to change the lighting inside the window from the outside, so they can immediately see whether something looks good or not.

Intuitive Interaction for Lighting Atmospheres

The IILA project has a host of sensors and lighting innovations that react to people as they move around a shop. Dynamic spotlights light individual clothes on the racks as they're moved to give people the feeling of being noticed and appreciated. Reactive spotlights subtly change the light beam on a display to bring it into focus as someone moves in for a closer look. It also includes technologies to make the visual merchandiser's job easier. For example, a LightWand can sample color from a piece of clothing and beam it magically to display around the item.

Relax area

Ever been shopping with your partner and had to leave early because he was bored? Well the relax area can gauge whether persons are actively shopping or not by analyzing their movements. It then changes the lighting to make them more relaxed, or if they start reading a magazine in one of the seats, then a spotlight will come on to help them read.

massive cost savings. "Hospitals and care homes are overcrowded and people prefer to stay in their homes," explains Boris de Ruyter, Philips Research. "Technology is the key to making this possible cost-effectively. But the current elderly are a difficult segment to impose new technologies on. They have not grown up in a high-tech environment, and their health and mental problems make it very difficult to know what technologies they will be able to work with."

The CareLab process works by picking a problem, seeing if the technology exists to solve that problem, and then testing it in the CareLab. Or if not, then developing a new technology and testing that.

ShopLab - A new future for shop lighting

ShopLab is the odd one out in the ExperienceLab. It's a shopping environment and it tests lighting technology. Most shop designers radically undervalue lighting and ShopLab aims to rectify that. It's also different in that it doesn't test on users only. It brings in lighting professionals, retailers and designers as well; the experts who can give feedback on what will or won't work.

> "Lighting can play a big part in our buying decision and it should be recognized as a marketing instrument."
> Richard van de Sluis, Philips Research.

From these brainstorms the technologies are refined and improved to better meet the buyers' needs.

"Shopping is one of the main leisure activities in the Western world. We spend a vast proportion of our income and our spare time in shops," explains Richard van de Sluis. "It's also important to realize that we don't only go shopping because we need certain things. A lot of the time we're just wandering around and buying things on impulse. Lighting can play a big part in our buying decision and it should be recognized as a marketing instrument." ShopLab is developing innovations in two areas: flexible atmospheres and attentive environments.

Flexible atmospheres

Shops are constantly changing their interior. New collections come in every season. New displays need to be made to attract shopper's attention. All this costs time and money. With flexible lighting, you can instantly change the atmosphere to match a new collection, or even a single item, without the need for refurbishment. It works by incorporating lighting into a shop design at a much earlier stage. The shop interiors are neutral backgrounds, and the lighting provides the color, mood and decoration.

Attentive environments

Shop lighting is usually, like most lighting today, a static thing. It's either on or off. It doesn't change throughout the day. It doesn't react to customers. It can't be changed easily or by a non-professional. ShopLab is aiming to change all of that. Its technologies aren't just the latest lighting technologies, but also the latest sensor technology. It focuses on the user and adapts the lighting to them, as opposed to the other way round. PW

Extra info **www.research.philips.com/password**
ExperienceLab

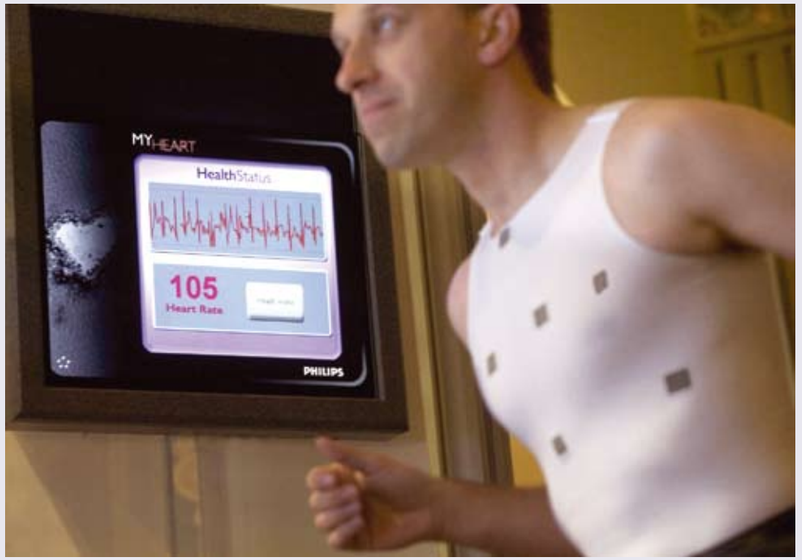
Joint cooperation

MyHeart - Fighting cardiovascular diseases through prevention and early diagnosis

When it comes to people's health, the first and foremost rule is that prevention is better than cure.

Where illness cannot be cured, the second rule is that disease management is better than hospitalization.

By Peter Harold
Photography: Philips



On-body sensors and electronics for monitoring vital body signs

In addition to improving the quality of people's lives, exercising these rules frequently has the added benefit of reducing healthcare costs, freeing up hospital resources to care for critical patients. This is particularly true in the case of chronic cardiovascular disease, which currently affects more than 20% of Europe's population and is one of the world's biggest killers.

The MyHeart consortium, comprising 33 industrial, research, academic and medical organizations from 10 different European countries, is working on both the preventative and management aspects of chronic cardiovascular disease. It is doing so through the application of technology that monitors vital body signs, analyzes the measured data in relation to heart function and provides direct feedback to users or clinicians. The MyHeart project, to which Philips Research is a major contributor, is one of the largest biomedical and healthcare research projects within the European Union and runs until the end of 2008. It will spend a budget of around 35 million Euro, of which 16 million Euro is funded by the European Union as part of the EU 6th Framework Program.

Over the past two years, the MyHeart project has identified four key product concepts that are likely to bring the most benefit to the prevention and management of chronic cardiovascular disease:

1) Activity Coach
Maximizing the enjoyment and health benefits of regular exercise and targeted primarily at healthy individuals.

2) Take Care
Assessment and reduction of the risk factors for cardiovascular disease through vital body sign monitoring, lifestyle coaching and motivation, targeted at people who are at risk of developing cardiovascular disease.

3) Neuro Rehab
Improving and shortening the rehabilitation period through physical and mental exercises, targeted primarily at heart attack and stroke victims.

4) Heart Failure Management
Improving quality of life and life expectancy for heart failure patients by early detection of deterioration in their condition (decompensation) and improved patient management.

The principal technology development common to all of these applications has been the development of on-body sensors and electronics for monitoring vital body signs and physical movement. These sensors and electronics have now been integrated into functional clothing and combined with wireless-based telemetry and user interaction systems to produce prototype product concepts that will enter clinical trials in 2007.

Philips Research's main involvement in the MyHeart project so far has been the development of wearable electronics and body sensors that can unobtrusively detect and measure vital body signs such as heart rate and breathing rate, communicate and analyze the acquired data and provide feedback to users or health providers. The prototype systems that it has developed for use in user/clinical trials comprise a disease management system for heart failure patients and a sleep monitoring system that can be used by patients suffering from sleep disorders or anyone who wishes to improve the quality of their sleep.

Heart failure management

Heart failure patients frequently suffer complications that currently require them to be hospitalized so that their condition can be stabilized. These complications are typically the result of a process known as decompensation, in which progressive deterioration of heart function leads to potentially lethal conditions such as fluid imbalance in vital organs. In many cases, this decompensation remains undetected until the patient suffers noticeable symptoms and visits their doctor.

As part of the MyHeart initiative, Philips Research has developed a heart failure management system that can provide several days advance warning of life-threatening decompensations, giving doctors time to stabilize the condition by modifying the patient's drug regime rather than having to admit them to hospital.

The system comprises an electronic weight scale and blood pressure monitor, a zip-up body vest with integrated electrodes and control electronics to measure the patient's ECG

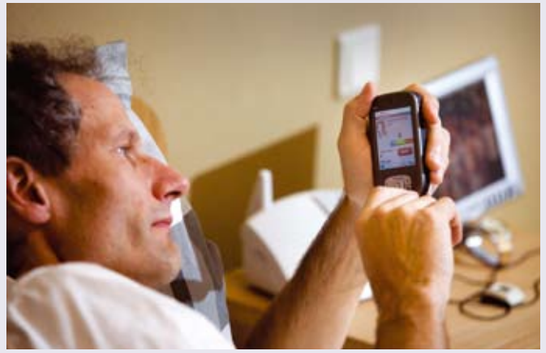
(electro-cardiogram), and sensors that are placed in the patient's normal bed to measure heart rate, breathing rate and body movement while sleeping. All of these devices communicate measurement data via wireless links to a PDA on which the heart failure management software runs. This software guides the user through a daily ritual of taking their weight, blood pressure and ECG measurements, and then combines this data with information from the bed sensors to assess changes in overall heart function. It also identifies specific conditions such as atrial fibrillation and cardiac arrhythmias (irregular muscular contractions of the heart) that require medical attention. Measurement data can then be delivered to healthcare providers either via the phone network or a system such as Philips' Motiva Interactive Healthcare Platform.

One of the key technologies developed by Philips Research relates to the signal-processing algorithms needed to extract ECG data from the electrodes built into the zip-up vest and bed sensors, which because they must be unobtrusive are somewhat less effective than conventional taped-on ECG electrodes. The next development, which will take place during clinical trials, is refinement of the algorithms that predict decompensation to make them highly reliable as well as patient-specific.

Sleep monitoring

The same bed sensors and electronics that are used in Philips Research's heart failure management system can also be used to analyze sleep quality and give users valuable feedback on how to improve it. It therefore has significant application in both the consumer and medical domains.

Monitoring biomedical bedclothes provide respiration and heart rate information.



The data collected by the biomedical bedclothes can be presented to the user on the display of a handheld device, e.g. a PDA.

Measuring heart rate and breathing rate – two of the key parameters needed to assess sleep quality – is not easy. Taped-on ECG electrodes are not only highly obtrusive and likely to keep the user awake, they are also prone to becoming dislodged or disconnected as users roll over in their sleep. The solution developed by Philips Research and Italian textile manufacturer Smartex consists of an electrically conducting pillowcase that makes contact with the user's head and a similar sheet of material at the foot of the bed that contacts the user's feet. These two electrodes pick up the minute electrical potential developed between the head and the feet as a result of electrical impulses to the heart. An additional sensor, made from a sheet of pressure sensitive electret material, is positioned halfway up the bed under the mattress cover to detect user movement. This sensor is also sensitive enough to pick up the chest movements associated with breathing and can even detect the ballistic recoil generated by each contraction of the heart muscles.

Once again, the key to making the system work is extracting meaningful information from the noisy signals that are picked up by the sensors. The signal-processing algorithms built into the electronics must initially distinguish viable measurement periods from non-viable periods – for example, when the user moves his/her feet such that they no longer make contact with the foot electrode. Even during viable measurement periods, the signals that correspond to rhythmical contractions of the heart or chest muscles must be distinguished from noise sources such as movement artifacts or static electricity. Philips Research's signal-processing algorithms are able to extract these rhythmical patterns from the sensor signals to reliably measure heart and breathing rates.

Combined with information from the movement sensor, these measurements are then used to identify periods of light, deep and REM (Rapid Eye Movement) sleep, micro-arousals and waking periods. Each morning, after downloading information to a Bluetooth-connected PDA, the user can access a detailed breakdown of their sleep patterns in the form of parameters such as time of going to bed, time awake in bed, time asleep and sleep efficiency. The system even gives users clues as to why their sleep was interrupted – for example, by periods of snoring.

They can also receive general recommendations on sleep improvement, such as avoiding caffeine drinks before bedtime and creating an appropriate environment in the bedroom. In addition, the computed sleep parameters can be used to develop a personalized coaching strategy for sleep quality improvement that encourages users to adopt a healthier lifestyle – for example, by adopting regular bedtimes that also fit in with their schedule or by selecting favorite techniques such as relaxation therapy. The success of these measures is then monitored by the system and fed back to users, providing an inherent motivation for them to stick to their new lifestyles.

Open innovation

One of the most important things about these developments, and indeed about the MyHeart project as a whole, is that putting together such systems requires a multi-disciplinary approach that brings together hardware engineers, software engineers, textile manufacturers, industrial designers, clinical experts and healthcare providers. Only by adopting the open innovation approach that Philips Research is well known for is it possible to create system solutions that will truly benefit people's health and well-being. DW

The centerpiece of the early diagnosis solution to prevent heart failure is a garment with textile ECG electrodes sewn seamlessly into the fabric.

Extra info **www.research.philips.com/password**
MyHeart

Illuminating experiences - Lighting goes solid state

Light-emitting diodes (LEDs), those small solid-state lamps that were once only good for showing that your video recorder was on, are today fuelling a major revolution in the lighting industry. The reason is that LEDs just got brighter. Their luminous efficiency – the amount of light you get out compared to the electrical energy you put in – already surpasses that of tungsten and halogen lamps. Soon it will even exceed that of fluorescent lamps. So if you thought that compact fluorescent lamps were the end of the lighting story, think again.

By Peter Harold
Photography: Philips

The Inner Ring Road Bridge in Bangkok, Thailand, lit up with Philips LED lighting systems.

LEDs have always had some advantages over other types of lamp. They are small and rugged, have no glass to shatter, and they exhibit typical lifetimes in excess of 50,000 hours – far longer than almost any other light source with the exception of the sun. They can be made in an enormous range of spectrally pure colors, or they can be laced with suitable phosphors so that they emit broad-spectrum white light. And unlike incandescent and fluorescent lamps, their forward radiation contains no heat, unless of course you deliberately set out to make an infrared LED.

The big difference about today's LEDs is that they are much brighter. In fact so much brighter that Philips LumiLEDs – a company now wholly-owned by Philips that started life in the 1990's as a cooperation between Philips and Hewlett Packard – claim that their latest Luxeon Flash LED can deliver more light than a miniature Xenon flash tube. That makes camera-phone flashes one of the first mass-market consumer product applications for high-brightness LEDs. However, the real impact of high-brightness LEDs on our lives will be as lighting sources for general lighting, architectural and automotive applications, providing us not with a momentary flash of inspiration but a continuously illuminating experience.

High-brightness LEDs are already found in the rear lamp clusters of production cars. The next move will be into their headlights. In the consumer lighting market, products such as Philips LivingColors, DecoLEDs and AccentLEDs are already providing people with long-life energy-efficient solutions for low-power decorative and accent lighting. In the longer run, the next step will be LED-based replacements for multi-watt incandescent and fluorescent lamps. As proof of concept, Philips Research has already developed a prototype LED lamp that produces around 200 lumens, which is more light than you get from a low-voltage 20-watt halogen lamp. It means that LED replacements for halogen downlighters are not far away. And because the LEDs in this lamp produce far less heat than a halogen lamp, the Philips Research lamp is far more energy efficient.

Low heat, not no heat

It is wrong, however, to assume that LED lamps produce no heat. While it is true that the light they emit contains little or no infrared radiation, LEDs do not operate at 100% efficiency (nothing does) and they therefore generate some heat within the semiconductor material from which they are made.

The difference is that it's conducted heat rather than radiated heat, and it must be carefully managed if the semiconductor die is not to over-heat. This is one of the challenges that Philips Research scientists had to solve in their prototype lamp. An equally important challenge was integrating AC/DC converter electronics into the base of the lamp so that it can be plugged directly into existing AC line voltage lighting sockets. It means converting several hundred volts AC into the low-voltage high-current DC drive required by the LEDs, doing so at a very high conversion efficiency so that little additional heat is generated, and then

Scientists at Philips have developed new LED retrofit lamp prototypes that are bright, compact, robust and energy-efficient. The prototypes have been equipped with a standard fitting and can therefore be used in existing sockets.

With LivingColors, a consumer product that was introduced in the Netherlands recently, you can display an almost infinite variety of colors: just turn the wheel to choose.

Controlling the beams

Philips Research's innovative beam forming technology utilizes a unique combination of the refraction, diffraction, light scattering and reflection properties of liquid crystal materials.

Used in conjunction with RGB LED lighting, it can be used to generate an almost infinite range of colors, intensities and beam patterns. Philips Research's liquid crystal panels are highly transparent and don't use the polarizers commonly found in LC panels. They therefore sacrifice very little of the light.

The ability to remotely control the shape, direction, color and color temperature of a light source via a user-friendly interface will be of immense benefit to retail stores, especially in areas such as fashion and furniture retailing. These stores currently have to manually change or reposition luminaires every time they rebuild a display area. It will also be of benefit in restaurants, conference centers and meeting rooms where a range of lighting ambiences need to be created. Ultimately it's a technology that will be built into interior lighting for homes.

packing everything into the confined space of a lamp base. Achieving it relied heavily on Philips Research's system-level knowledge of high-efficiency AC/DC converter design, thermal management techniques and system-in-package (SiP) technology.

These system-level competencies also play a critical role in realizing one of the other major advantages of LED lighting – that of controllability. The intensity of an LED is easily controlled by adjusting the current through it, but the important thing is that it results in little or no color shift in the light that is emitted. This contrasts markedly with 'black-body radiators' such as incandescent lamps, which suffer from a considerable change in color temperature as they are dimmed.

Color, color and more color

This unique property of LEDs opens up exciting new possibilities for color control, because it allows lamps that incorporate closely-spaced red, green and blue LEDs to generate virtually any color imaginable, simply by adjusting the relative intensity of the different color LEDs. It's the same color-mixing principle that's used to produce color TV pictures. In the case of LED lamps, the result is a variable color, variable brightness, lamp that produces vivid saturated colors.

Such lamps are already on the market, but most of them suffer from one significant drawback – they simply provide users with three intensity controls, one for each color of LED. As a result, users need to know how much red, green and blue light to mix in order to get the color they want, and that is no easy task. Since one of the three pillars of Philips is sense and simplicity in everything it produces, Philips Research scientists are coming up with innovative new ideas for intuitive control of these variable-color LED lamps (see sidebar 'Color made simple').

The absence of heat in the forward radiation of LED lamps also offers much more flexibility in the type of optical system that

Color made simple

Most people don't know how much red, green and blue light to mix together to get the color they want, but they do know the color they want when they see it. That's why Philips Research has come up with the LightWand – a simple point-and-click device to copy colors from everyday things around you and paste those colors onto LED-based lighting.

To copy a color, you simply point the LightWand at it and click the copy button. The LightWand then glows with the color you've selected. Then you point the wand at the lighting fixture that you want to generate the colored light and click the paste button. It's as simple as that.

The LightWand system is initially being targeted at shop display lighting applications and is currently undergoing user trials in Philips Research's ShopLab experience laboratory.

you can place in front of them. For example, scientists at Philips Research are investigating the use of liquid-crystal panels to alter the beam angle and color temperature of an LED lamp (see sidebar 'Controlling the beams'). This control is totally electronic, with no moving lenses or reflectors, which makes it extremely well suited to automated lighting applications.

Lighting system solutions

By offering this high level of flexibility, LED lighting is opening exciting new possibilities for designers and architects, and the lighting division of Philips has been quick to take up the challenge and give them what they want – something that Philips refers to as its 'designer delight strategy'.

Buckingham Palace in the United Kingdom now has its historic architecture enhanced with LED lighting manufactured by Philips, and Finland's world-famous 'Kemi Snowcastle' hotel uses the saturated color capability of Philips LED lighting to splash vivid color through crystal clear ice. Philips LED lighting, chosen not only for its decorative effect but also for its long-life and low cost-of-ownership, also illuminates the Inner Ring Road Bridge in Bangkok, Thailand.

In addition to providing architects and designers with vibrant lighting atmospheres that they could previously only have dreamed of, these projects are also indicative of something else that has changed as a result of LEDs. Lighting is no longer about light bulbs mounted in lighting fixtures. It's about complete system solutions with sophisticated electronic controls that turn lighting into what it should be – a feast for the eyes. DW

Extra info **www.research.philips.com/password**
LEDs • solid-state lighting

Technology news

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Best Paper Award for Hongqiang Zhai

Hongqiang Zhai of Philips Research North America was awarded the Best Paper Award for a paper he presented at the 14th IEEE International Conference on Network Protocols (ICNP) Conference, November 12-15, 2006 in Santa Barbara, California, USA. Co-author of the paper with the title 'Impact of Routing Metrics on Path Capacity in Multirate and Multihop Wireless Ad Hoc Networks' was Yuguang Fang of the Electrical and Computer Engineering Department, University of Florida, USA.

Since 1993, ICNP has established itself as one of the premier conferences in the computer networking field. ICNP deals with all aspects of communication protocols, from design and specification, to verification, testing, performance analysis, and implementation.

Hongqiang Zhai, Philips Research North America

Ronald Aarts IEEE Fellow

Recently, Prof. Dr. Ronald Aarts of Philips Research was named IEEE Fellow, effective 1 January 2007, by the Board of Directors for research and application in signal processing for acoustics and sound reproduction. The IEEE Grade of Fellow is conferred upon a person with an extraordinary record of accomplishments in any of the IEEE fields of interest. The total number of people selected in any one year does not exceed one-tenth percent of the total voting Institute membership.

Prof.Dr. Ronald M. Aarts, IEEE Fellow

Ronald has been with Philips Research since 1977. Since 1994, he has worked on the improvement of sound reproduction by exploiting digital signal processing and psycho-acoustical phenomena, e.g. with major contributions to 'Incredible Sound' and 'Ultra Bass'. He has invented and explored various non-conventional sound transducers such as the 'singing display' and the thermo-acoustic loudspeaker. Ronald already is Philips Research Fellow and Fellow of the Audio Engineering Society (AES), and he also works as part-time professor at the Eindhoven University of Technology (TU/e), the Netherlands.

Unique Vision Training System supports top swimmers

At the National Swim Center De Tongelreep in Eindhoven, the Netherlands, world's first Vision Training System (VTS) was recently installed. With this system - developed by MiPlaza, part of Philips Research, and Dartfish, a video software company - a swimming trainer can continuously view the swimmer from underwater in real time without having to use moving cameras. Along the pool side, eleven fixed underwater video cameras are installed that feed their output to the system's control computer.

This computer automatically and seamlessly fuses together the camera views and displays the video, coupled with timing data, on poolside displays for instant analysis by the trainer. For the top swimmers and trainers at the National Swim Center de Tongelreep, VTS technology brings a key innovation in the tools and support they need to set ever higher standards of performance.

One of the underwater cameras of the Vision Training System in National Swim Center De Tongelreep, Eindhoven, the Netherlands.

New book 'Ambient Lifestyle – From Concept to Experience'

On the occasion of Philips HomeLab's fifth anniversary and the opening of Philips ExperienceLab, the book 'Ambient lifestyle – From concept to experience' was published. It reports on the research efforts that were undertaken at HomeLab over a period of almost five years. During this timeframe, new ways of working were developed based on the concept of Experience and Application Research, and over forty experience prototypes were developed and evaluated using this novel approach. The overview is richly illustrated and placed in a broader context by a number of introductory chapters.
It is a book for anyone interested in the use of novel technologies for the development of innovative user-centric products and services.

Editors: Emile Aarts, Elmo Diederiks
Publisher: BIS Publishers
(www.bispublishers.nl)
ISBN: 978-90-6369-161-5

New CEO for Philips Research

On January 18, 2007, Dr. Peter Wierenga was appointed as new Chief Executive Officer of Philips Research. In this function he will succeed Dr. Rick Harwig, who has managed Philips Research since 2004. Dr. Harwig will concentrate on his existing role as Chief Technology Officer of Royal Philips Electronics, Chief Executive Officer of Corporate Technologies and Member of the Group Management Committee. Since joining Philips in 1980, Dr. Wierenga has held several positions in Research and Development. As CEO of Philips Research he will be responsible for the worldwide research activities in Philips.

First AES Student Paper Award for Arijit Biswas

At the 121st Audio Engineering Society (AES) Convention in San Francisco (October 5-8, 2006), the paper 'Perceptually Biased Linear Prediction' by Arijit Biswas (student and presenting author) and Bert den Brinker (advisor, Philips Research Europe - Eindhoven, the Netherlands) was selected as winner of the special Student Technical Papers Award Competition, organized for the first time. The paper, which will be published in the Journal of the Audio Engineering Society, describes a low-complexity technique for linear prediction analysis and synthesis using a perceptually-derived prediction filter.

121st AES Convention Papers Co-Chair Rob Maher (Montana State University) (on the left) and Arijit Biswas.

The input signal spectrum is shaped so that the coder's quantization error is effectively masked by the signal itself. Arijit Biswas is pursuing PhD within the Signal Processing Systems Group of the Technische Universiteit Eindhoven (TU/e), the Netherlands. His project is carried out in collaboration with the Digital Signal Processing Group at Philips Research Europe - Eindhoven.

Molecular medicine – Technology personalizing medical care

Molecular medicine is bringing a revolution that will transform healthcare. New insights into genetics, molecular biology and biochemistry, together with innovative technologies, are generating new, groundbreaking applications.

By Peter Harold
Photography: Michel Klop, Philips

Feature healthcare

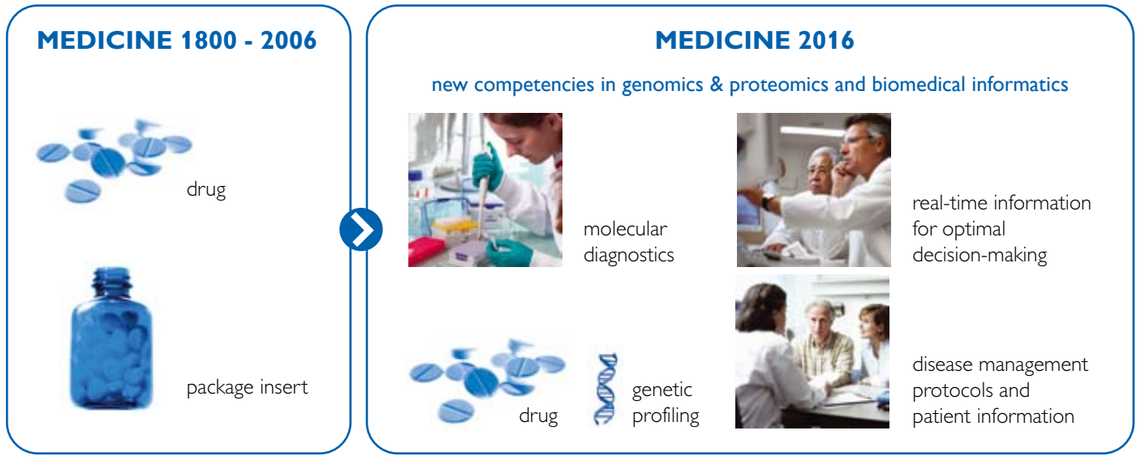
"As our company wants to stay leading in the field of medical diagnostics, it is essential for us to create a footprint in molecular medicine, which is expected to revolutionize in-vitro diagnostics as well as medical imaging. In addition, molecular medicine will bring diagnostics much closer to influencing decision taking on pharmacologic therapies, and to tools and methods for therapy delivery. Philips has many relevant technologies in house, but we have realized early on that becoming active in molecular medicine requires building a broad competency in the life sciences. In particular, we need to build a deep understanding of disciplines such as molecular biology, bioinformatics, and microfluidics, and the ability to work with advanced life science tools. This is why we have invested in hiring new talent, and in building an entirely new, very well equiped laboratory, the Life Sciences Facilities of Philips Research at the High Tech Campus in Eindhoven. This facility will be used by Philips Research and by its partners. Establishing the right research and business partnerships, such as our alliance with Schering on optical molecular imaging, will be a crucial success factor for Philips in this field. We fully realize that we cannot do this alone," said Henk van Houten, Healthcare & Wellness research program manager in his opening speech at the Symposium on Molecular Medicine, which was organized to mark the opening of the new Life Sciences Facilities.

The key notion underlying molecular medicine is that diseases have their origin in processes occurring at the molecular and cellular level. Each of us has a unique genetic profile, and it's reflected through the expression of our genes to the extent that every one of us is visibly and biochemically different. It's how, when and why the genes in our chromosomes are switched on and off – the process known as gene expression – that makes us what we are. And diseases are often associated with changes in the gene expression levels.

Our gene expression, and the myriad different molecular reactions that it triggers in our bodies, now lies at the heart of a paradigm shift that's taking place in the way we diagnose and treat disease, because differences in our genes can dramatically change the way our bodies react to certain drugs. In the extreme, similar dosages of a drug that's highly effective in one patient can be lethal to another. In other words, it's so personal that it can be a matter of life or death, and it's leading to a whole new field of medicine known as pharmacogenomics – the tailoring of drug therapies to specific genotypes in order to maximize their efficacy and reduce their side effects. It's the biggest change in medicine for the last few thousand years and it's being made possible by developments in molecular healthcare.

Molecular medicine

Pharmacogenomics relies on three different capabilities. Firstly, that you can accurately diagnose disease, preferably in its very early stages so that very small doses of highly targeted drugs can be used to cure it before the patient begins to suffer symptoms. Secondly, that you can identify those characteristics of the patient's genotype that affect the patient's drug response. And thirdly, that you can monitor their response to therapy in real time, so that you can



Pharmacogenomics and molecular healthcare will re-write the rulebooks for treating disease, replacing generic 'one-fits-all' approaches with patient-specific therapies that take a patient's unique genetic profile and real-time drug responses into account.

deliver maximum efficacy with minimum side effects. All three of these capabilities lie within the realm of molecular healthcare.

Today, progress in molecular healthcare is taking place in two distinct, but related fields. The first of these, normally referred to as molecular diagnostics, involves the development and commercialization of in-vitro assays based upon the patient's DNA, expressed proteins or similar bio-markers in order to determine the precursors of disease or the patient's genotype. Today, such assays are typically carried out on blood, urine or saliva samples and involve complex time-consuming processes to amplify the quantity of a bio-marker before it can be detected. However, Philips Research is already working on a biosensor that could perform such assays within minutes in a doctor's surgery or at a patient's bedside (see sidebar 'Magnetic biosensors'), facilitating mass screening to identify people at risk.

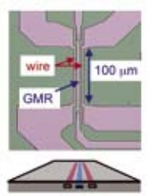
The second field is molecular imaging, which involves the development and commercialization of in-vivo bio-marker assays carried out in hospitals using various types of scanning equipment such as Positron Emission Tomography (PET), Single Photon Emission Computed Tomography (SPECT), Magnetic Resonance (MR), Ultrasound and Optical scanners. The primary objective of this development work is to combine functional imaging with structural imaging so that specific in-vivo molecular processes can be identified and spatially pinpointed, typically through the use of imaging contrast agents that bind to specific biological proteins. Molecular imaging will therefore fulfill both a diagnostic role and treatment role, by allowing doctors to pinpoint disease sites and track the progress of drug therapies. The same contrast agents that are used to highlight disease sites may even be able to carry drug payloads that can be selectively unleashed precisely where they are needed.

Magnetic biosensors

By binding target molecules to the surface of a silicon chip and labelling these with magnetic nanoparticles, Philips Research's GMR (Giant Magneto-Resistive) based biosensor allows the detection of low biomarker concentrations in fluid samples such as blood, urine or saliva with no or minimal sample pre-treatment, and does so within minutes rather than hours. By applying an external magnetic field, the technology can be extended to measure the bonding forces between biological molecules.

Chip in Cartridge

Chip with 4 sensors



> "Imaging techniques can potentially offer information at in-vivo cellular and molecular levels with both spatial and temporal resolution. Combining these technologies to study systems biology in an interactive manner should allow us to gain unprecedented insights, and hopefully lead to new diagnostic and therapeutic tools."
>
> Dr. King Li, Chair of Radiology at the Methodist Hospital in Houston, Texas, USA - keynote speaker at the symposium

With the benefit of both structural and functional information about a specific patient's condition, it will also be possible to create accurate computer models of their disease – so called 'in-silico' representations. Philips is already employing computer modeling to create patient-specific in-silico representations of cardiac function (see sidebar 'Form and function – aiding therapy').

By providing healthcare organizations with an efficient means of identifying and treating disease in its early stages, before patients even begin to suffer symptoms, molecular healthcare has the potential to massively reduce the costs associated with late-stage intervention and after-care. Diseases likely to be targeted are therefore those where the cost of treatment and/or care is currently high – for example, cardiac disease, cancer, arthritis and Alzheimer's.

"In virtually every part of the world, better living standards are resulting in a larger proportion of the population living into old-age and as a result the cost of managing age-related chronic disease is far outstripping growth in GDP (gross domestic product)," commented symposium keynote speaker Dr. King Li (Chair of Radiology at the Methodist Hospital in Houston, Texas, USA).

Form and function – aiding therapy

By combining structural and functional information obtained from medical imaging, scientists at Philips are able to create patient-specific 'in-silico' computer models of cardiac function that allow doctors to plan optimum therapies.

Philips researchers working with Philips' new cardiac modeling software that automatically matches its heart model to the patient's multi-slice CT scan and then creates a highly detailed patient-specific 3-D model from which a wide range of morphological and physiological measurements can be extracted.

"In the western world we are also seeing a worrying increase in obesity, putting many more people at the risk of developing debilitating diseases such as type-2 diabetes in later life."

However, the challenges to bringing in-vivo molecular diagnostics and imaging to maturity remain significant. Despite having successfully mapped the human genome, scientific knowledge about gene expression and the myriad biochemical reactions that it sets in motion are far less well understood, particularly in relation to the progression of disease. Identifying the right biomarkers for specific diseases therefore remains a major challenge. Only then can appropriate contrast agents be developed to target these biomarkers and appropriate drug delivery systems be developed to nip disease in the bud. And because most of these processes must be performed in-vivo, all the materials and processes involved must be fully tested for bio-compatibility, subjected to clinical trials and formally approved. In addition, development of total-system solutions for combined imaging, diagnostics and treatment will mean new business models in the medical industry in which pharmaceutical companies, medical equipment companies and academia pool their knowledge and resources.

Philips Research's new Life Sciences Facilities on the High Tech Campus in Eindhoven, the Netherlands, which was officially opened during the Scientific Symposium on Molecular Medicine, aims to rise to these challenges. It's a 2,200-m^2 bio-approved research area that includes laboratories for chemical synthesis, molecular biology, bacteriology and radiochemistry, plus a molecular imaging lab equipped with the latest MRI, PET, SPECT, CT and optical scanners.

The High Tech Campus in Eindhoven also houses the headquarters of the new Center for Translational Molecular Medicine (CTMM), which was introduced by Hans Hofstraat, CTMM Executive Board Member and Vice-President of Philips Research at the symposium. "The CTMM is a public-private partnership with the ambition to become a leading Netherlands-based innovator in future molecular diagnostics and molecular imaging research, paving the way for the introduction of molecular healthcare in clinical practice," said Hofstraat.

The Dutch Ministry of Economic Affairs recently indicated that it would support the initiative with matching funds of up to 200 million euros over a period of 5 years, provided that milestones are met. The Dutch Minister of Foreign Trade, Mrs. Karien van Gennip, confirmed the Dutch Government's commitment and support to the CTMM at the symposium through a live video link from Shenzhen City (China), where she was attending the China High Tech Fair.

The joint R&D programs that Philips Research will carry out in its new Life Sciences Facilities with CTMM partners and other collaborators in the area of molecular healthcare will bring about healthcare solutions that epitomize Philips' brand promise of Sense and Simplicity. PW

Extra info **www.research.philips.com/password**
molecular medicine • Life Sciences Facilities • Center for Translational Molecular Medicine

Aural perception experiment in an echo-free laboratory

Beyond physics for superior sound

Philips Research is mixing innovative loudspeaker technology with physics, digital signal processing and just a little audio 'mind magic' to bring high-fidelity sound reproduction to tomorrow's products.

By Steven Keeping & Andrew Woolls-King
Photography: Gerhard van Roon, Michel Klop

The human ear is one of Mother Nature's most amazing creations. It can detect sounds from the faintest whisper to the loudest thunderclap, and the slightest of tuning errors in a musical note, rhythm or score. All this is achieved by receiving and converting sound waves into electrical impulses with such precision that the brain can interpret and distinguish an almost infinite variety of sounds.

For scientists and engineers tasked with improving sound reproduction using modern electronics, the human ear provides a salutary lesson in perfection; and one that never lies. Products that reproduce perfect frequencies and wide dynamic ranges according to the artificial ear of a lab microphone in a room engineered to give perfect acoustic response, can sound awful to the human version in a cluttered living room with dubious acoustics. This is one of the reasons why Philips Research's Digital Signal Processing (DSP) Group has a specialized team of six researchers – known as the Acoustics & Sound Reproduction Group – who utilize knowledge of the highly refined sensor that is the human ear: how it works, its capabilities and its limitations. The reference point for all their research is not a frequency response spectrum on a measurement instrument, but feedback from a human listener.

"We have found, for example, that you don't need exceptionally high resolution for spatial reproduction because the human ear is not very sensitive when it comes to distinguishing between sources that are less than a few degrees apart," explains Prof. Ronald Aarts, Research Fellow and a veteran Philips Researcher who specializes in sound reproduction improvements and leads the dedicated group. "By understanding the capabilities of the ear,we can set boundary conditions within a technical design specification that allow us to create an audio system that sounds incredible to consumers."

> " Physics does set the rules, but using our extensive knowledge of human hearing – particularly its limitations - we can go one step further and trick the ear."
> Prof. Dr. Ronald M. Aarts, Philips Research

Over the last decade, the group has made remarkable progress and spawned hundreds of patents (over a hundred filings in the last five years alone), authored dozens of papers, and created several inventions that have been successfully commercialized by Philips' Consumer Electronics product division. But as impressive as inventions such as Incredible Sound, UltraBass and Two-to-Five may be, they are merely the early fruits of a project with a much bolder mission "to provide the listener with the best sound at any time or position in space". It's an ambitious undertaking, demanding the development of 21st century sound reproduction technologies that don't just depart from conventional audio, but also attempt to push beyond the boundaries set by the laws of physics.

Conjuring perfect sound

"Our group brings together people with expertise in loudspeaker technology, physics (particularly room acoustics), digital signal processing and psychoacoustics," says Prof. Aarts. Psychoacoustics is the psychological and semantic study of how the human mind interprets sound; if you think that's moving beyond the realms of the rigorous scientific methods associated with Philips Research, you could be forgiven. But sound reproduction is not always exactly predictable and psychoacoustics is the 'magic ingredient' that transforms the perceived quality and realism produced by next-generation audio electronics. "Psychoacoustics enables us to go beyond ordinary physics," says Prof. Aarts. "Physics does set the rules, but using our extensive knowledge of human hearing – particularly its limitations - we can go one step further and trick the ear."

It's a bit like the sleight of hand a magician uses to defeat the eye, or how red/green/blue dots and lines combine to produce color television pictures. The latest innovation from the group is a perfect example. "BaryBass is a transducer that dramatically enhances the perceived bass response of compact speakers," says Okke Ouweltjes, Research Scientist within the Acoustics & Sound Reproduction group (see sidebar 'Deep notes from shallow speakers'). Ouweltjes continues: "There are particular disadvantages with small loudspeakers commonly used for portable audio products and in flat-screen TVs where space is at premium. This rules out the use of the large conventional magnetic speaker drivers and cones needed to produce low-frequency bass sounds in the 20 to 120 Hz range. The problem is that the majority of consumers can't understand and aren't interested in hearing why small speakers don't produce deep bass - they just want a solution."

"This is where psychoacoustics comes in," notes Prof. Aarts. "It tells us that the human ear finds it difficult to discriminate between low bass notes when they are reproduced against a background of other music. This means that when we map the bass range of the music into a single tone, and reproduce that with a highly sensitive transducer for that particular tone, the bass produced from small speakers during a piece of music will sound to the human ear like the deep bass that could only normally be delivered from large loudspeakers."

Home theater for dummies

Recent research in the UK revealed that a nearly half (47 per cent) of all consumers fail to set up their home theater systems correctly – often omitting a speaker – and consequently experience inferior sound. There are two main problems: incorrectly connecting the wiring and positioning the speakers in the wrong locations such that the sound reproduction 'sweet spot' doesn't coincide with the listener's position defined in the recommended set-up (see sidebar 'Targeting the sweet spot'.) "We want to solve this problem by making sure that home theater systems are dramatically easier to set up and self-correcting in the event of a wiring or speaker positioning problem," says Dr. Arno van Leest, Senior Scientist within the Acoustics & Sound Reproduction group. "For example, if the user accidentally swaps the connections to a speaker they'll lose the low frequencies. We are working on a system to detect and correct this error – reinforcing Philips Sense and Simplicity brand promise at the same time."

> " The majority of consumers can't understand and aren't interested in hearing why small speakers don't produce deep bass - they just want a solution."
>
> Okke Ouweltjes, Philips Research

"And if people fail to put their home theater speakers in the recommended positions or can't due to the physical constraints of their listening room," adds Dr. Werner de Bruijn, another Senior Scientist within the Acoustics & Sound Reproduction group, "we are looking at several ways to help them. This includes widening the sweet spot to make sure it coincides with the user's position, and tracking the user in order to move the sweet spot as they move."

Automatic loudspeaker configuration is a technology capable of shifting the sweet spot from poorly positioned speakers to where the user sits. This capability is an advanced development and is about to be taken up by Philips Consumer Electronics division with a view to commercialization. This technology is far in advance of the sound level compensation systems from other companies currently on the market. "Automatic loudspeaker configuration allows the system to optimize the sound reproduction after the user has positioned the speakers to compensate for positioning errors by doing much more than just adjusting sound levels," explains Dr. de Bruijn.

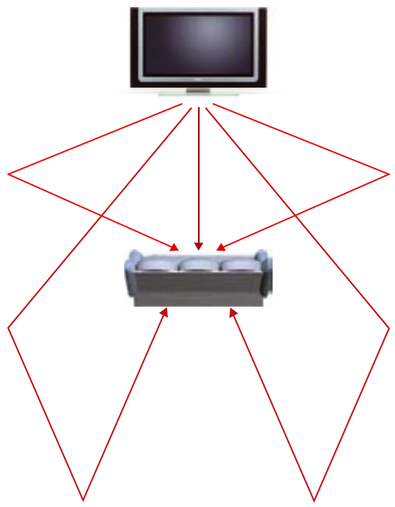
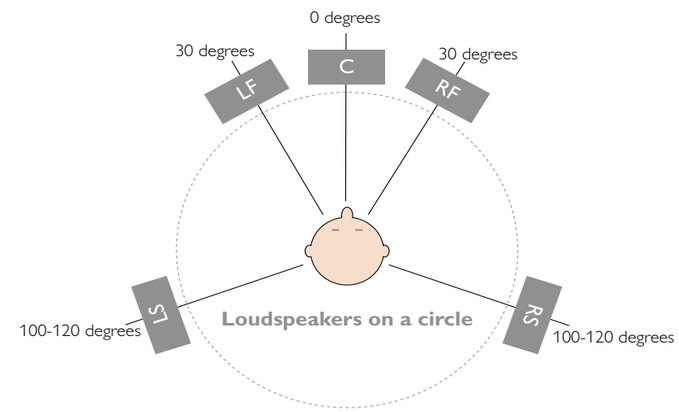


Fig 1. Loudspeaker arrays
Yet another technology for simplifying home theater set-ups being investigated by Philips are speaker arrays that 'shape' the sound in order to funnel it via the walls to the listener.

"The system determines the optimal processing required for the best sound reproduction based on the respective speaker locations rather than just feeding the signal dumbly to poorly-positioned speakers." (see sidebar 'Targeting the sweet spot'.) Yet another technology for simplifying home theater set-ups being investigated by Philips are speaker arrays that 'shape' the sound in order to funnel it via the walls to the listener (see figure 1).

Targeting the sweet spot

Surround sound systems based on the 5.1 configuration are excellent at recreating the ambience of a movie theater in the home. But they have an Achilles Heel; if the speakers aren't set-up as recommended by standards such as ITU-R BS.775-1 (*'Multichannel stereophonic sound system with and without accompanying picture'*) the impact is significantly diminished. Unfortunately, proper set-up is often too involved or too difficult for the average home user, so Philips has addressed the problem with automatic speaker configuration. Once the speakers have been placed in the most practical positions determined by the user, the system self-calibrates by measuring the distance between TV and speakers to determine the optimal processing for the best sound based on the respective speaker locations.



Recommended set-up for five loudspeakers

Using the TV as a reference point, the system electronics performs a test comprising sending an impulse from a speaker and calculating the distance from this speaker to all other speakers by timing the delay in the response between microphones mounted on the speakers, and a microphone on the reference point. Once this information has been determined for each speaker, the system computes the minimum sized-sphere that would contain all the speakers. In operation, the sound from speakers that are inside the boundary of this sphere are delayed so that sounds from all five speakers are synchronized at the user's position. Secondly, an amplitude-panning algorithm generates phantom sound sources at the recommended angles creating the illusion that the speakers are properly positioned. The result is a large audio sweet spot, perfectly located from the listener's perspective.

In a second development for applications such as listening to audio from mobile telephones, Philips researchers have come up with a head tracking system that monitors the listener's head movements using a video processing unit, and that processes the sound to the stereo speakers so that the audio sweet spot is ideally positioned relative to the listener's ears. The system is designed to maximize the sound experience from portable stereo equipment that traditionally has a very narrow sweet spot because of limited speaker separation.

Measuring the audio characteristics of a BaryBass loudspeaker unit.

Deep notes from shallow speakers

The laws of physics dictate that compact speakers with small cones are inefficient and struggle to reproduce bass notes at a high sound pressure level. The problem is that a small cone just can't vibrate with sufficient amplitude to generate adequate sound pressure. The result is a limited frequency range and shallow sound.

Philips' approach is to combine a highly efficient transducer and its knowledge of psychoacoustics specifically to reproduce bass notes. The transducer is called BaryBass and couples a unique magnetic driver with a long sound port. Its high efficiency means BaryBass is small enough to fit the compact speakers typical of portable audio equipment or flat screen TVs.

The transducer's high efficiency comes at the price of a restricted frequency range. However, Philips researchers have turned this into a virtue by using the fact that the human ear is poor at discerning the difference between frequencies in the 20 Hz and 120 Hz bass frequency range, especially when combined with all the other frequencies making up a music or movie sound track. Audio electronics converts all frequencies in this range to a single frequency of 55 Hz to reproduce sound by BaryBass. The listener's experience isn't diminished by the conversion into a single frequency; on the contrary, it's enhanced by the compact speaker's ability to reproduce deep, resonant bass.

BaryBass: deep, resonant bass tones from a compact speaker

New York… in Amsterdam

The group's scope extends far beyond sound reproduction in audio equipment, to projects combining high-quality vision with realistic sound. DreamScreen, for instance, combines high-definition large display panels with high-fidelity sound, so that, for example, a person in an office at Philips' headquarters in Amsterdam could – if they so desired - look out of their virtual window at a Manhattan streetscape complete with blaring firetruck sirens, the squawk of a newsvendor, and the screech of a yellow taxi's tires.

In a second futuristic application, speaker arrays are being used to direct localized sound to accompany shop window video displays of goods that can be purchased in the store. "A person could ask for information about a product via an audio stream in a way such that people only a meter away, receiving information about another product, aren't disturbed," explains Dr. de Bruijn.

After a decade of research by the group, the potential applications of acoustics still appear limitless. From headphones that reproduce the ambience of a concert hall, to laser loudspeakers and acoustic cooling, Philips Research is actively responsible for some of the most radical advances occurring in 21st century audio reproduction. "Many of the things we are doing with acoustics are unique," says Prof. Aarts. "Even after two decades specializing in this discipline I'm amazed at how many exciting developments we are involved with." PW

Extra info **www.research.philips.com/password**
digital signal processing • BaryBass

The use of a loudspeaker array at an interactive shopping window

today

The incandescent bulbs in our homes, based on less energy-efficient technology developed before the 1970s, waste 95 percent of their energy by generating heat instead of light.

tomorrow

The Edore, a revolutionary new halogen light bulb for the home that will become available in 2007, provides a crisp high-quality light, lasts 3 times longer and saves 50 percent of the energy consumed by an ordinary household bulb.