

roads  
into  
the  
future

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future



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# Holst Centre's evolution

Industry is increasingly aware that innovation should rely more and more on cross-organisational cooperation. Sharing bright brains, intellectual property, facilities and costs fits this trend of 'Open Innovation'. One of the fields in which this is specifically true is that of Micro- and Nanotechnology.

In 2004, Philips triggered two reputed research organisations, IMEC (Flanders, Belgium) and TNO (Netherlands) to team up and create a joint research centre focusing on promising domains within the Micro- and Nanotechnology field. The initiative based in Eindhoven was coined 'Holst Centre', after Gilles Holst who pioneered industrial research at Philips.

A round of consultation among leading companies in the field led to the decision to set up two programme lines: Wireless Autonomous Transducer Solutions (WATS) focusing on miniaturised, extremely energy-efficient sensor devices and System-in-Foil (SIF) that concentrates on electronic devices on flexible substrates. Most exciting of all is where both combine to enable autonomous flexible devices. Both lines develop generic technologies, addressing the needs and interests that companies share. In addition, a major element is Holst Centre's non-virtual character: it is not a program office distributing research over groups at different locations but a 'physical' centre where researchers of all participating organisations co-work on a daily basis.

In 2005, the Holst Centre plans received a green light from the Dutch Ministry of Economic Affairs, IMEC and TNO as well as the first industrial partners. In the beginning of 2006, the first operational year, a group

of a dozen researchers got established at the High-Tech Campus in Eindhoven and the rapid growth that followed has continued unabated.

More than ten leading companies have joined Holst Centre, a figure that is even more significant if one realises that for most of them, this is their first experience with the shared program approach of Open Innovation. Whether on a full-time or part-time basis, they bring in over 25 of their own researchers ('Industrial Residents') working shoulder-to-shoulder with 110 Holst Centre researchers and resident students from universities in the Netherlands and abroad. The participation of researchers from various parts of the founding organisations, IMEC and TNO, is crucial as Holst Centre strives to bring together the best of these two worlds. Holst Centre now houses 18 nationalities, matching its ambition to be an internationally acknowledged centre partnering with industry and universities from around the world.

Holst Centre has become a major user of MiPLaza, the lab facilities already available on the High Tech Campus, which allowed the centre to make a kick start without having to make any significant investments in facilities up front. As the programs are evolving, Holst Centre is now making first major investments in research equipment that will enhance its unique position. The opening of its new office building at High Tech Campus 31 on 12 November 2007 is a milestone in its evolution. In the years 2008 – 2010, Holst Centre will double in size and industrial participation. We invite you to join us on this road into the future.

# Holst Centre sketching the future

Often the most successful products and services have been those that were never predicted. Holst Centre performs research that is three to ten years ahead of market needs, which are hard to predict. Nevertheless a research centre positioned close to industry needs a good vision of future scenarios and the type of technology that will be required. Such future sketches provide a societal, environmental and industrial frame of reference for the technology programs within Holst Centre.

Imagining the future is fun, but it definitely serves more purposes. A visionary scenario is a strong driver for researchers 'in the lab'. Future sketches trigger creativity but also compel us to reflect on what need is being solved by technology. The boundary conditions for the research activities become better articulated, resulting in ambitious but realistic roadmaps for R&D.

Future visions also enable and intensify discussions with other Holst Centre stakeholders. Industrial partners, in the first place, drive on new services and future products as well as develop their own future scenarios. They especially recognise the importance of the underlying process: going from a product vision to detailed technology roadmaps. The alignment of Holst Centre and industry roadmaps lays the foundation of a long-term, fruitful partnership. Furthermore, future sketches help to communicate the 'rationale' of Holst Centre programs to the broader public, to youngsters with a slumbering engineering ambition, to authorities responsible for long-term innovation policy.

It is always inspiring to bring product designers in dialogue with technology providers. Such dialogue

was behind the exercises in Future Sketches which are contained in this book.

The process started by introducing, in detail, the technological challenges thrown down to Holst Centre researchers. The two program lines, and their synergy, were discussed with industrial design professionals from TNO and this information was shared with Industrial Design students of the Eindhoven University of Technology and the University of Twente. This interaction resulted in more than a hundred sketches for products or services that might become enabled by Holst Centre technologies. From these sketches about 40 were selected for detailed elaboration with art work and visuals. Subsequently, of these 40 the most representative will be elaborated with information about the Holst Centre technology roadmap and used in technical discussions with prospect partners. This book previews some of these future sketches.

In order to see the technology behind the sketches, a word on Holst Centre's programs is required. In the Wireless Autonomous Transducer Solutions (WATS) program line, the research activity is focused on realising highly functional, extremely small and energy-efficient sensor nodes able to interact with the environment by sensing and actuating. They can process data and execute certain programmable tasks, on their own or in a network. They share information with other nodes and smart devices in the environment (e.g. mobile phones) using wireless communication. Very importantly, they have power autonomy; they harvest waste energy from the environment and manage 'on-board' their energy storage and the energy consumption by the various functionalities in

the node. All of this needs to be accomplished within an extremely small form factor, which will be dictated by the final application – a solid cube or a flexible patch. The WATS program line builds on the strength of silicon chip technology. Wireless sensor network technology and applications are recognised key drivers for extending functionality integrated circuits beyond their traditional computer tasks.

But there's more than silicon. The System-in-Foil (SIF) program line demonstrates that functional foils will become the technology platform of choice for large area applications like lighting and signage. Future sensor tags will be 'cut' from a highly functional, multi-layered, low-cost foil. In contrast to the silicon technology platform, production will largely be based on large foils processed as in today's printing business: roll-to-roll. The SIF program line addresses the technologies needed for such functional foils. For instance, major advances are needed in printing and encapsulation of flexible organic electronics, in precise lamination and interconnection of foils and in processes (such as lithography) to structure thin layers on foils. Combining these technologies we will enable a truly flexible future.

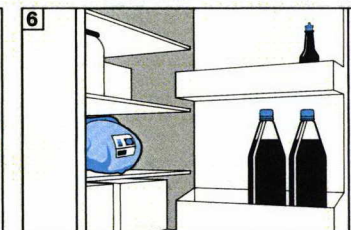
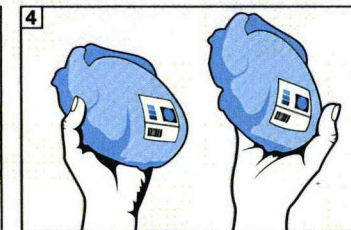
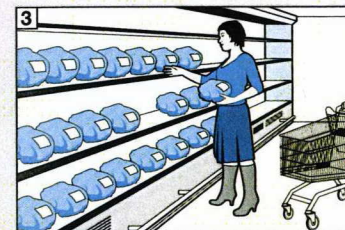
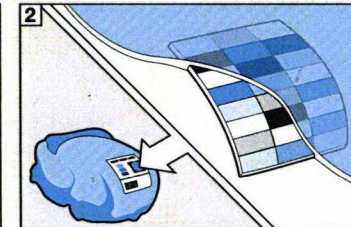
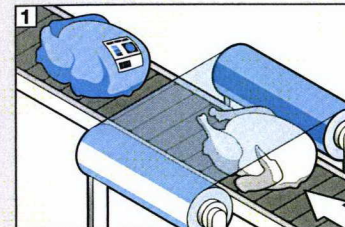
Holst Centre invites you to dream up your own scenarios for future applications enabled by these technology platforms or to become inspired by enjoying the ones our industrial design friends have come up with.



# Smart Food Freshness Labels

A price-freshness ratio and no more consumption of decayed food

Future packages for fresh foods will contain smart labels with a dynamic indicator of the 'use before' date and the number of days the food can still be safely consumed. The smart food freshness label increases food safety and prevents unnecessary waste. Organic electronics printing enables smart sensors to be incorporated in the label.



1. A manufacturing process seals chickens and applies smart labels.

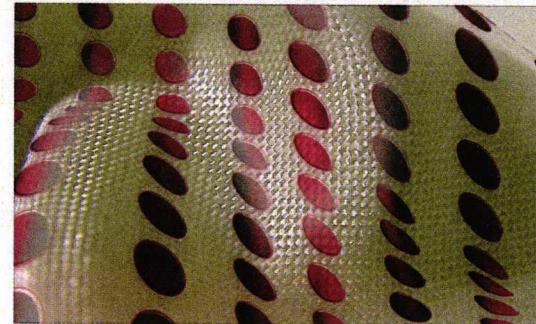
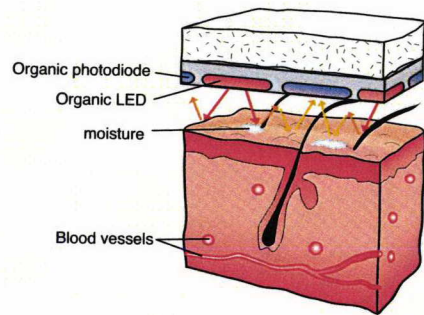
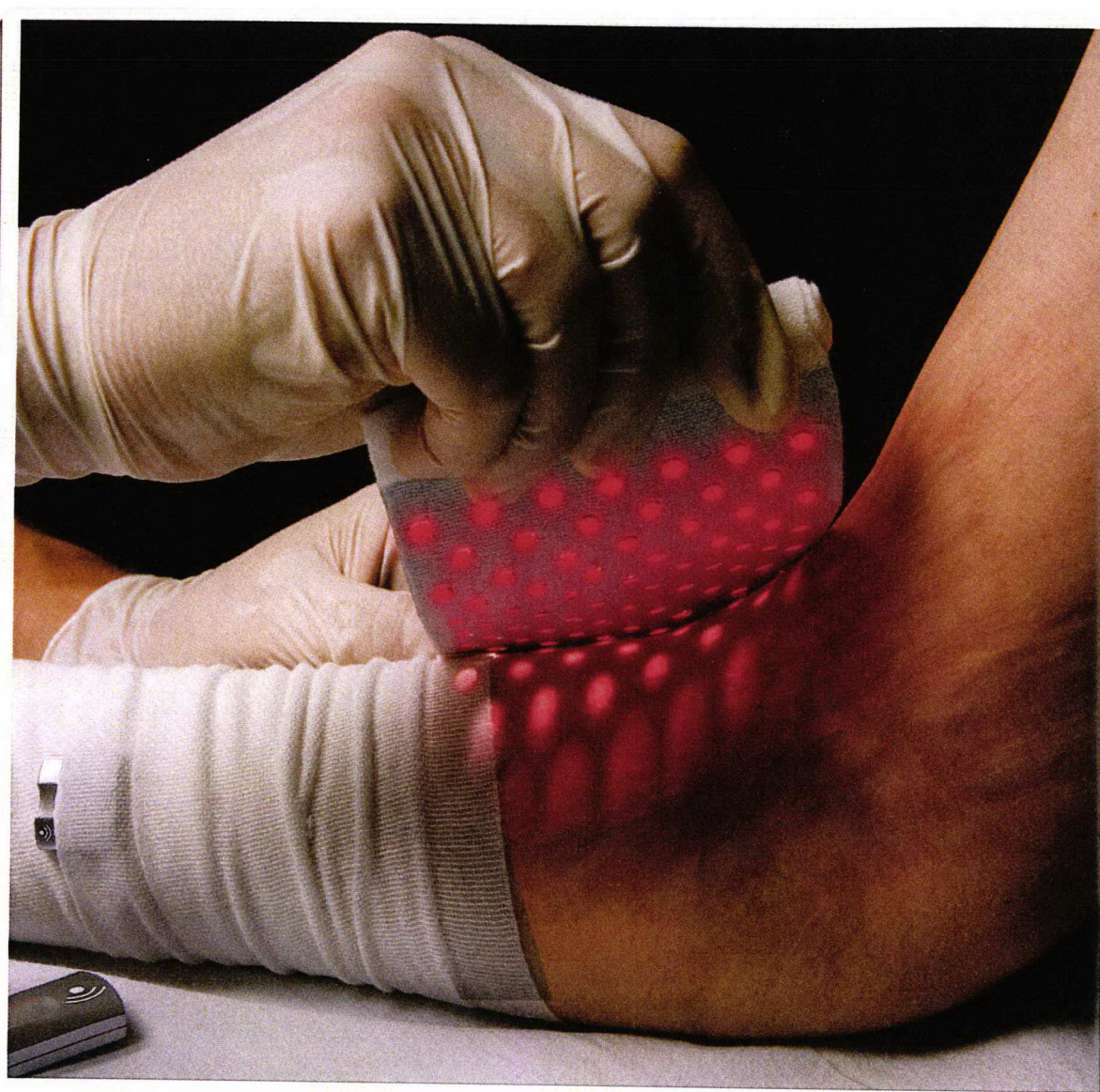
2. In this smart label sensors are integrated which can determine the freshness of the chicken. This freshness is displayed in terms of days fit for consumption. The chicken is transported to the supermarket where it is put on the shelves.

3. Lena is doing her weekly shopping in the local supermarket and is looking for 2 chickens. She checks the freshness indicator to decide which one to buy.

4. She looks at the different chickens and compares the dates that are shown on the label. The prices are directly related to freshness of the food. She decides to buy one fresh chicken for consumption later that week and a less fresh (and cheaper) one for dinner that evening.

5. At home she puts the chicken with the longest use before date (consume within 2 days of that particular date) in the refrigerator. The other one is prepared for dinner.

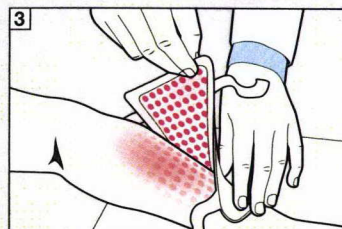
6. Three days later Lena opens the refrigerator to check whether the chicken is still good enough to eat. The label indicates that the chicken can be stored for one more day, so it is still fresh enough to eat because it has been stored in a chilled place.



# Smart Bandage

Remote wound monitoring and accelerated wound healing

Future bandages will incorporate ultra-thin flexible sensor sheets for remote monitoring of the healing process. Infections will be sensed and signalled at their earliest stage. Flexible, light-emitting layers will stimulate wound recovery through light therapy.



1. Mary is preparing dinner when a pan slips of her hands and hot water splashes on to her arm. Severely burned, she is taken to the hospital.

2. The wound is treated by a nurse in the hospital.

3. The wound is covered with a Smart Bandage and the bandage is activated. The bandage is provided with information about Mary and the type of wound.

4. As Mary returns from the hospital, the bandage has already started its light therapy by exposing the wound frequently to a dose of light. At the same time the bandage monitors the condition of the wound and the healing process. The amount of light adjusts automatically to the healing process.

5. Data on the healing process is sent via a wireless link to the hospital database where a doctor is able to monitor the process. After a few days the bandage indicates that it has to be replaced for a new clean one.

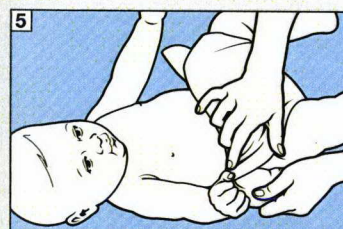
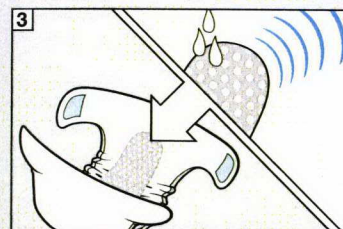
6. A few weeks later the wound has healed successfully and after a final inspection by a doctor, Mary's arm is fully recovered and the bandage disposed of.



# Smart Diapers

The diapers that give a warning signal when they need to be replaced

Smart diapers will consist of low-cost, disposable and flexible miniature moisture sensors added to standard diapers. These will alert the carer when the diapers need to be replaced. The smart diapers can be used in home situations as well as in day-care centres as well as in hospitals and nursing homes for monitoring incontinent patients.



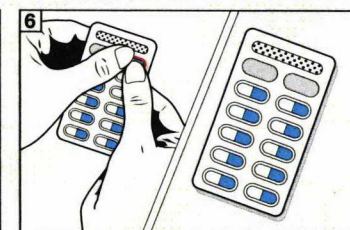
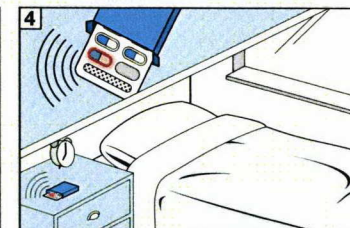
1. Simone is working in a day-care center where she is responsible for a number of toddlers.
2. The babies wear so called 'smart diapers'.
3. The diaper is provided with a moisture sensitive flexible sensor system that can detect water and faeces and send the information to a receiver.
4. At certain moment in the day the diaper of one of the small children detects water, sends a signal wireless to a control station which directs a message to the mobile phone of Simone.
5. She cleans the baby and changes the dirty diaper.
6. The old diaper is thrown away and deactivates automatically. The new diaper is recognized by the surveillance system.



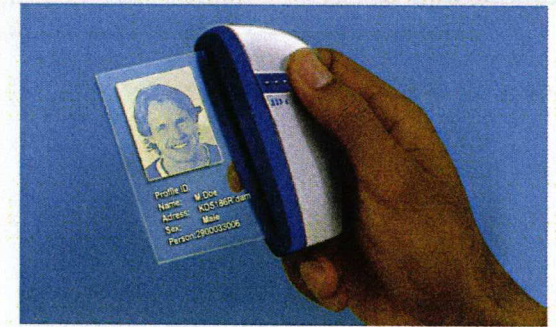
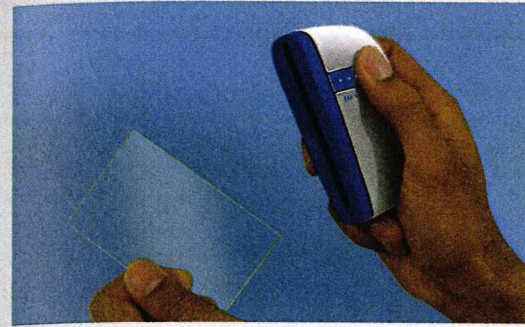
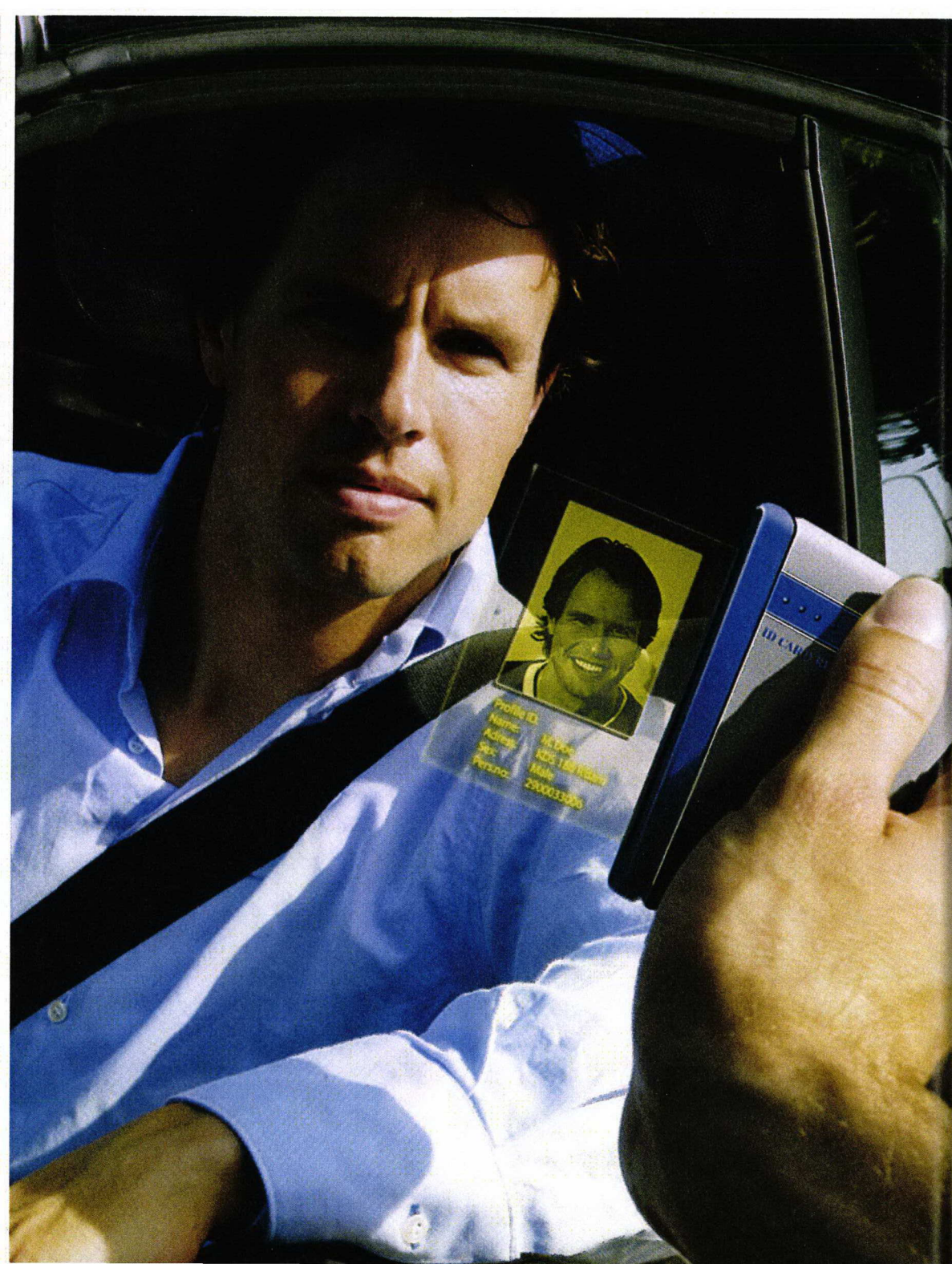
# Smart Blister

Self-reminding pill packaging

Research has shown that about 50% of patients take their medication incorrectly - at the wrong moment or in the wrong dose or even forget to take it - which leads to less effective treatment. The smart blister medication packaging reminds you to take the right pills at the right time. It indicates which pill has to be taken, warns the user and records which pill is taken and whether it's taken at the right moment or not. The package can be programmed to the specific prescription of that person.



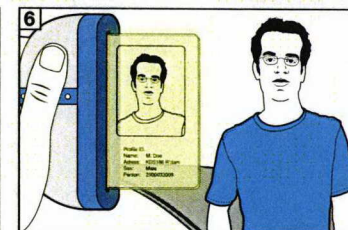
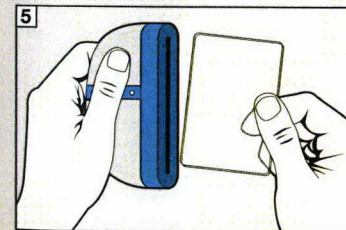
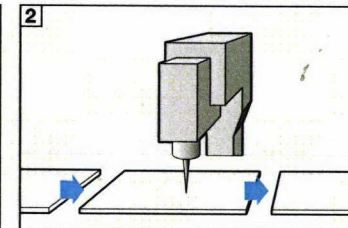
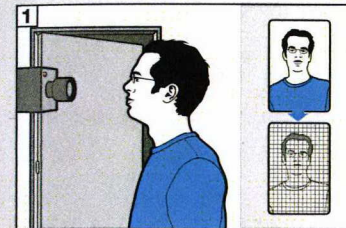
1. Laura's doctor prescribes medication for her health problems
2. Laura collects her medication from the pharmacy. The package is electronically linked to Laura's medical file.
3. At home she takes her first pill and leaves the package in her bedroom
4. The next day the package starts emitting a sound in order to remind Laura to take her daily dosage. Every 10 minutes the signal is repeated till the pill is taken out.
5. Laura hears the signal and picks up the package, which is coloured red under the pill she needs to take.
6. When she takes out the pill from the blister, the package registers the fact and the warning signal disappears.



## OLED ID Card

Identity card with security measures based on polymer light-emitting technology on foil

Forgers are constantly looking for ways of sidestepping identity card protection. A coded, light-emitting photograph could prevent the reproduction or forgery of ID cards. The solution lies in the unique process of printing organic, light-emitting electronics on flexible foil.



1. John's ID card is about to expire so he heads for the city hall to apply for a new one. A picture is taken and this image is sent to the card issuing authority where it is turned into a unique digital grid pattern representing his face.

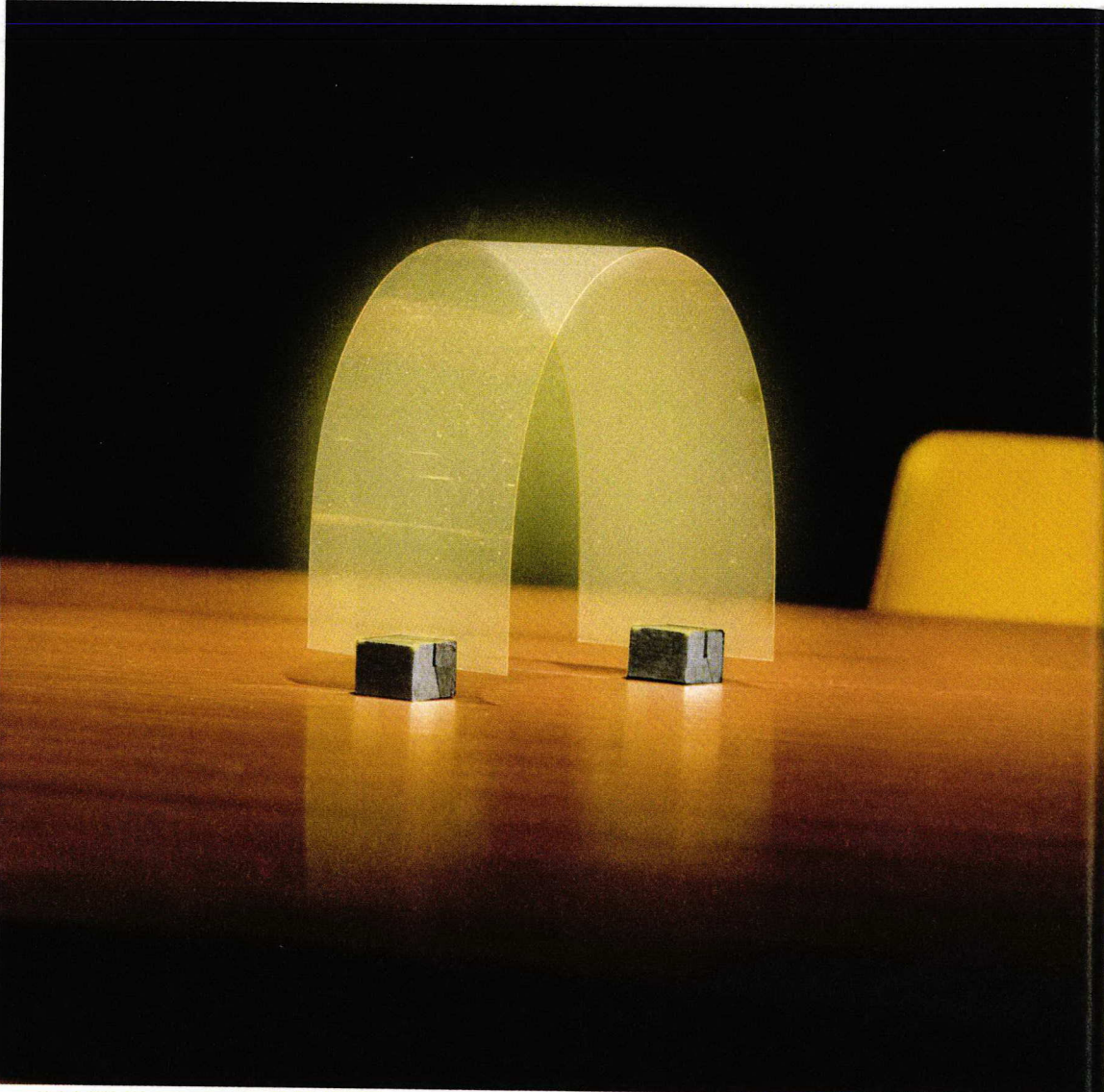
2. An ID card is produced with a light-emitting image and ID code by merging layers of polymer electronics on foil. The unique code and image of the face are created by permanently deactivating certain areas on the light emitting foil.

3. John collects his ID card from the city hall and returns home. His picture is not visible on the card.

4. John drives quickly to an appointment and is stopped by the police for speeding. He has to identify himself.

5. His ID card is inserted into a small reading device for the exclusive use of the designated authorities. The image of John's face is illuminated when the card is inserted.

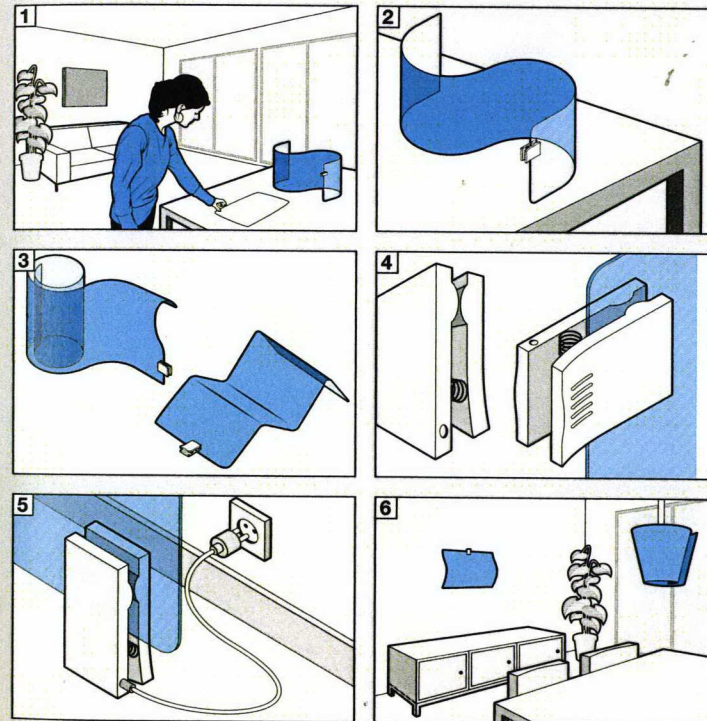
6. The image of the face is compared with John's actual appearance. Additional information on the card is transferred to the reader. The speeding fine is debited from his bank account and John continues on his way.



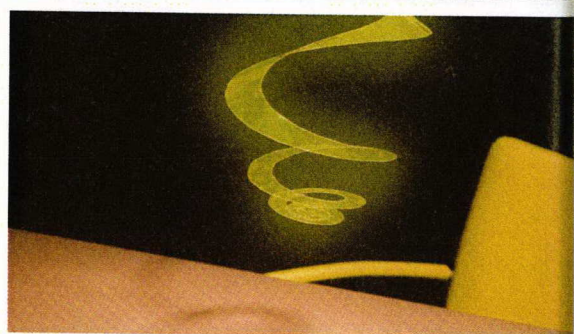
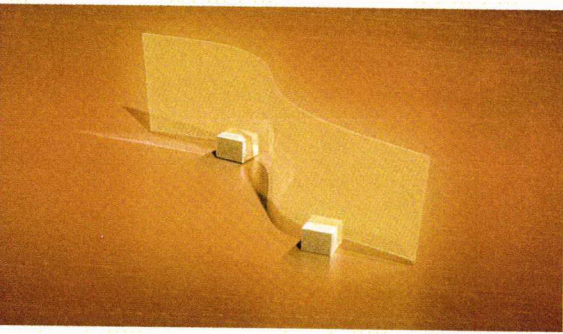
# Origami Lights

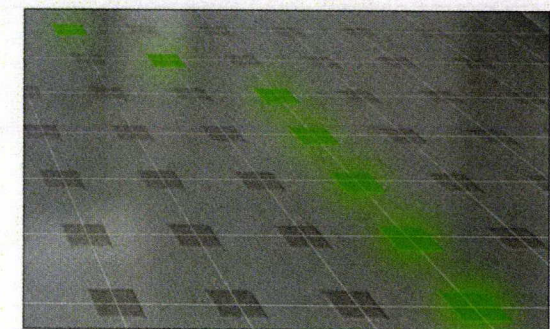
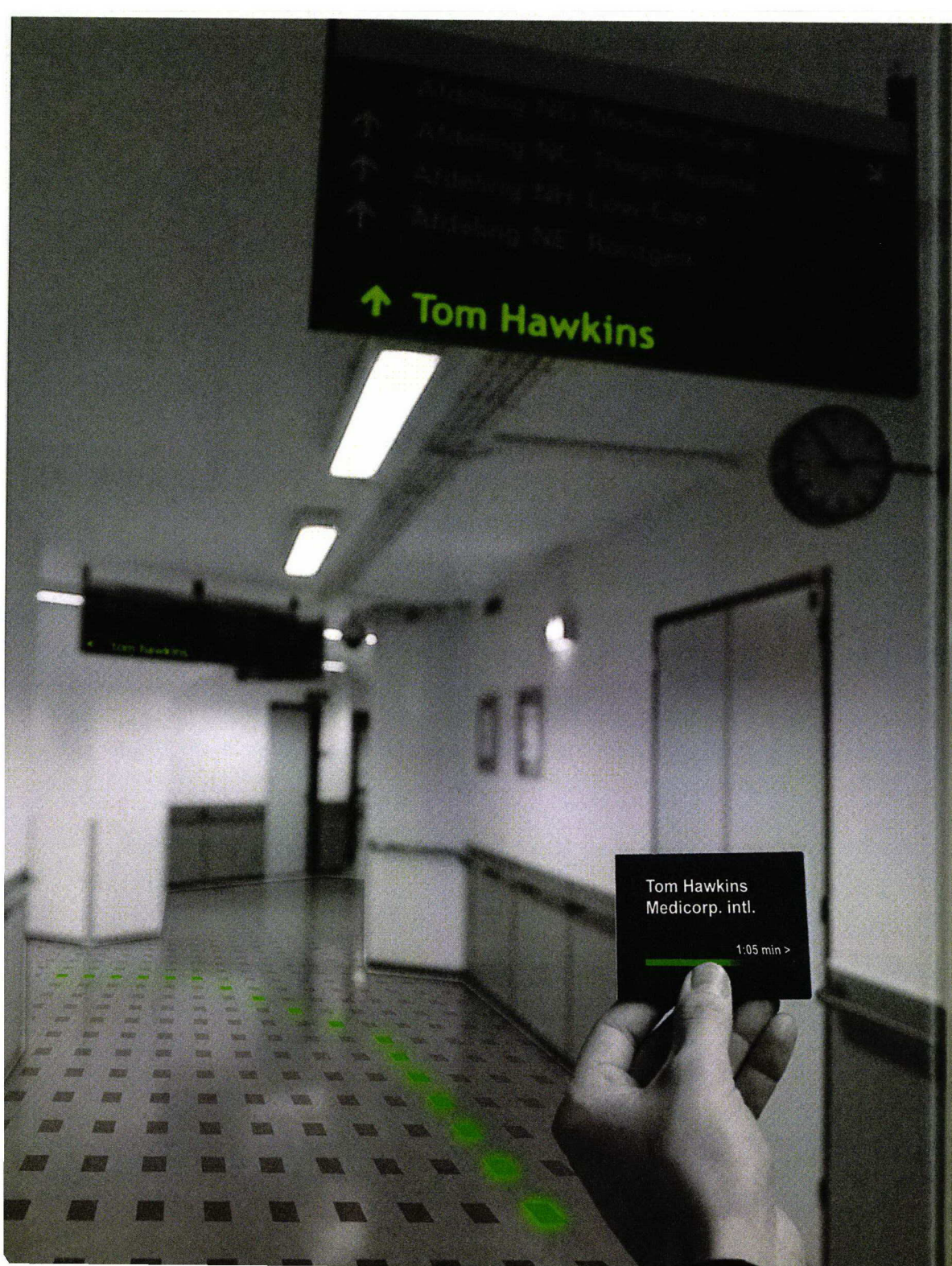
Foldable light sheets

Imagine light from flexible transparent sheets which can be applied in any form, enabling you to bend a light source like a piece of paper and create your personal decorative light object. Both professional designers and consumers will find applications that we haven't thought of yet.



1. A light object located in a living room generates a nice atmosphere.
2. It's a thin sheet-like object.
3. The object that can be formed into every desired shape is called 'origami light'.
4. The switch is a clip that can be clicked anywhere on the edge of the sheet.
5. The clip is also the power connection, which can be connected directly to the mains or store energy.
6. Origami Light can be placed anywhere: on a table, against the wall or on the ceiling.

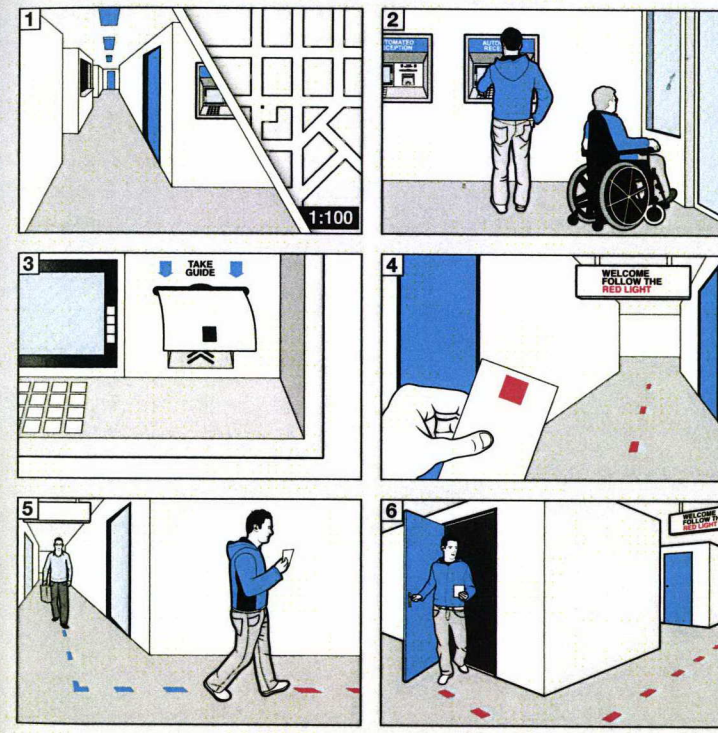




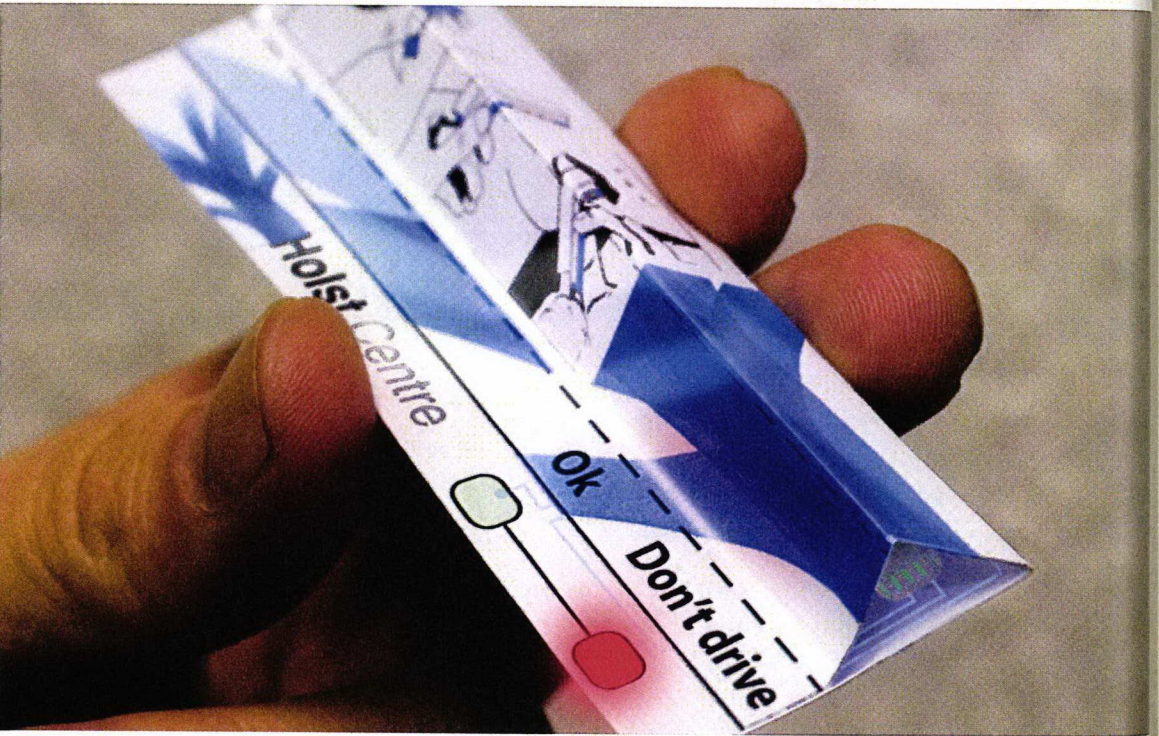
# Light Guide

A dynamic visitor guidance system

There's nothing as difficult as finding your way through a maze of corridors when you visit a complex, unfamiliar building for the first time. The Light Guide is an active guidance system in public buildings and large offices. Visitors are guided to their destination by an active light pattern that runs in front of them. The system identifies the visitor's location using wireless communication between the floor and a low-cost, disposable RFID tag printed on a receipt given to the visitor at the building's reception desk.



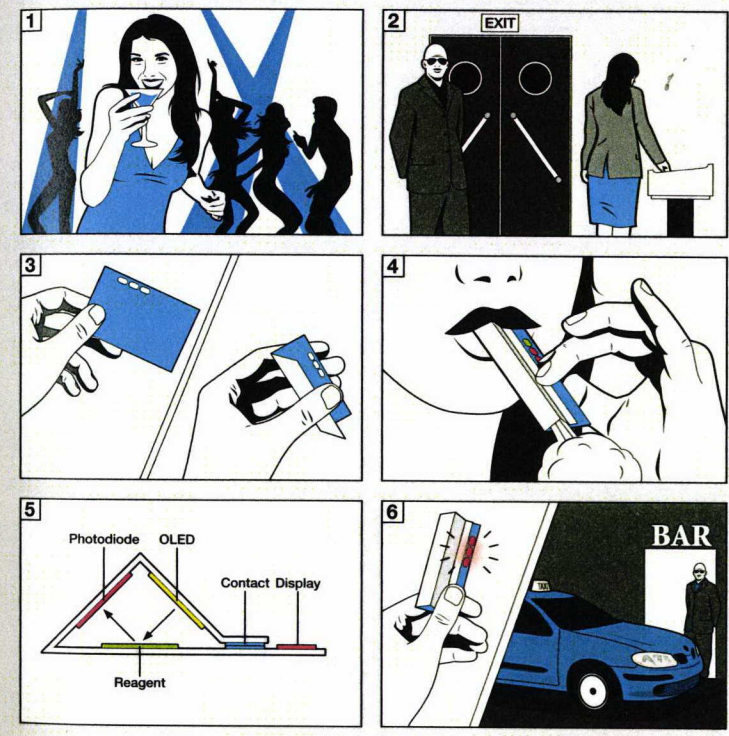
1. A large hospital with a complex labyrinth of passages.
2. A visitor arrives at the automated reception desk near the entrance of the building where he or she is registered.
3. The visitor receives a printed receipt equipped with an RFID tag that will guide him or her to her location in the building.
4. The badge is provided with a colour dot. A dot on the floor in the same colour lights up in front of her on the floor. Also a transparent display on the ceiling welcomes the visitor and shows the way.
5. The visitor follows the light guide on the floor, which keeps pace with the speed of the visitor and leads him or her towards the destination.
6. When the visitor wants to return, he or she walks out of the room and the light guide appears again on the floor to guide the visitor to the exit.



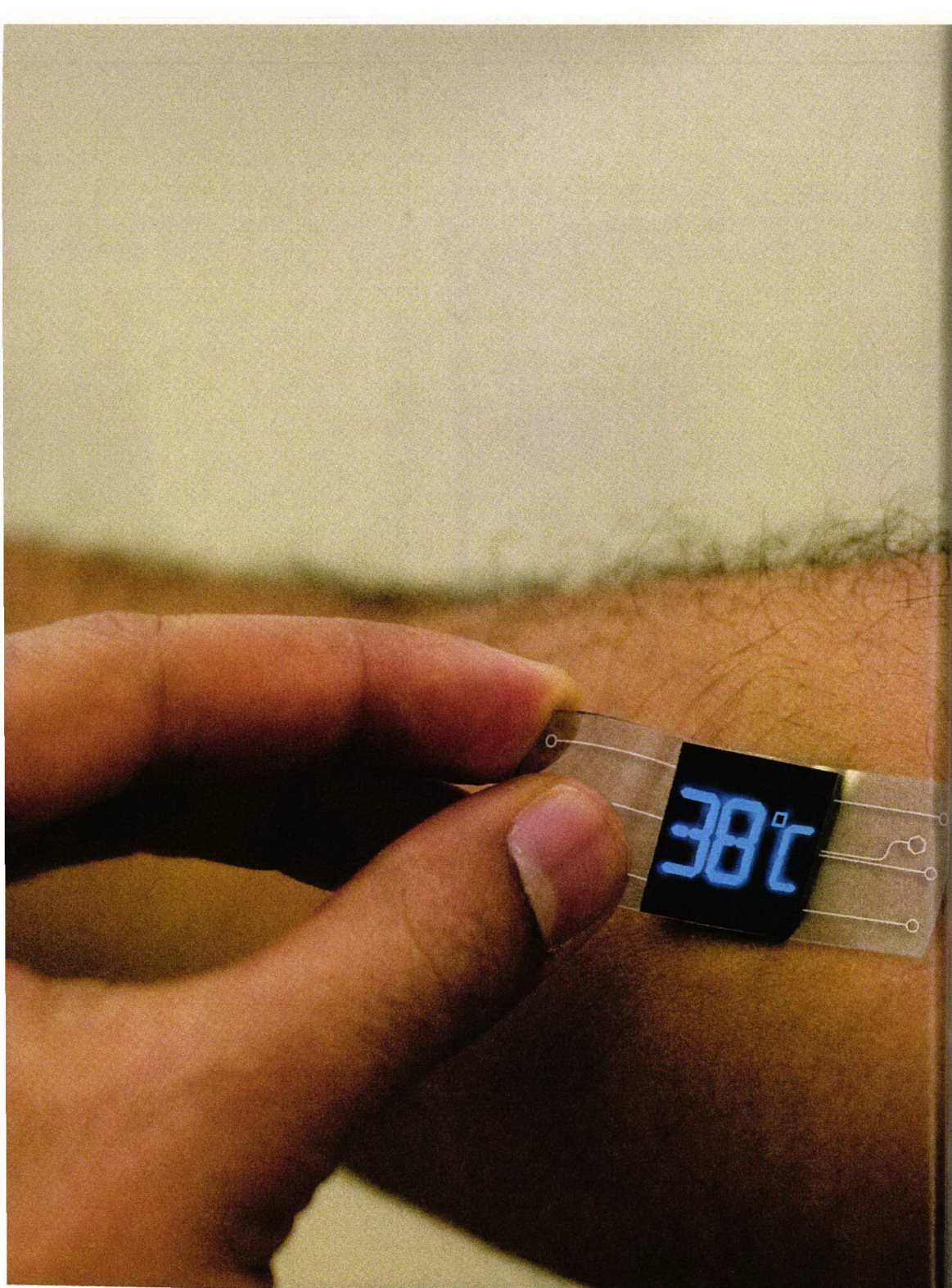
# Alcohol Test Card

Disposable breathalyser

The disposable 'breathalyser' is the perfect tool for people who want to check their sobriety before deciding to drive. A simple card (credit-card size) turns into a sophisticated alcohol analyser in seconds. The card consists of a smart electronic sensor and a light-emitting indicator printed on its surface.



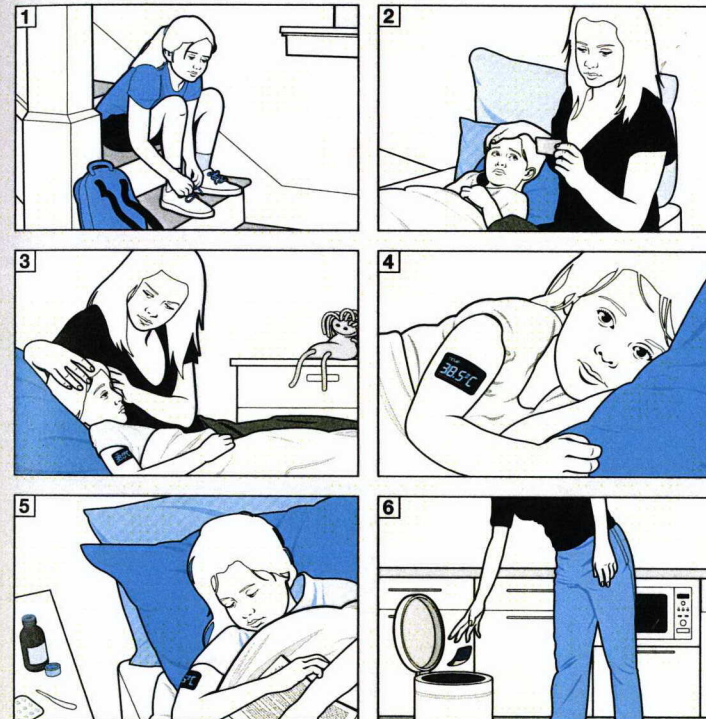
1. Janet goes out by car for a drink with some friends. As the atmosphere is very relaxed, she stays longer than planned and drinks a little more than she had anticipated.
2. Near the exit is a rack with breathalyser cards located and the doorman points her in the direction of this rack.
3. Janet takes out a card with sponsor information and folds it according to the instructions that are listed on the back.
4. She blows through the card.
5. And she pushes the card together. In the card a flat polymer sensor is integrated which analyses Janet's breath.
6. The tester indicates that the permillage of alcohol in Janet's blood is excessive, so she decides to leave her own car behind and to take a taxi.



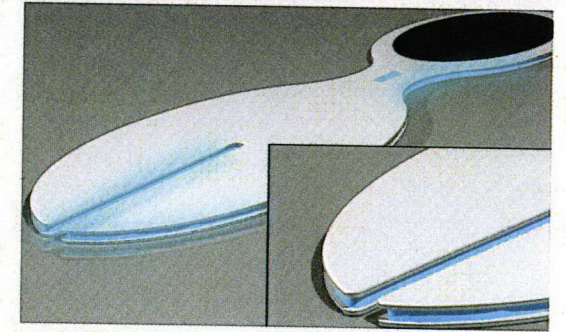
# Thermoflex

Thin and flexible surface temperature measurement

Thermoflex is a low-cost flexible foil thermometer that can accurately and reliably measure surface temperature. It can be integrated into all kinds of applications, from medical and home temperature measurements to industrial process control applications.



1. Daisy, an 8 year-old girl returns home from school feeling ill.
2. Her mother tells her to go to bed and takes out a patch.
3. She sticks it on her child's body.
4. The sticker shows the temperature on the body; at 38 degrees she has a fever.
5. The patch shows the body temperature the rest of that day and the following day when it shows that the temperature has dropped.
6. The fully disposable all plastic patch is then removed and thrown away.



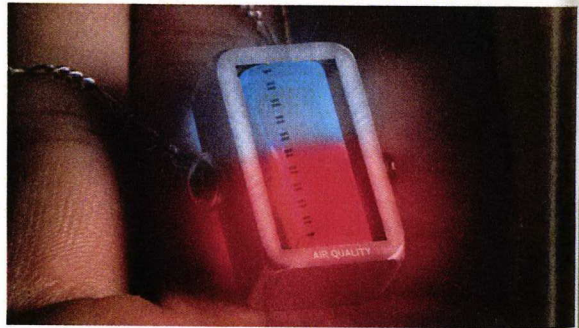
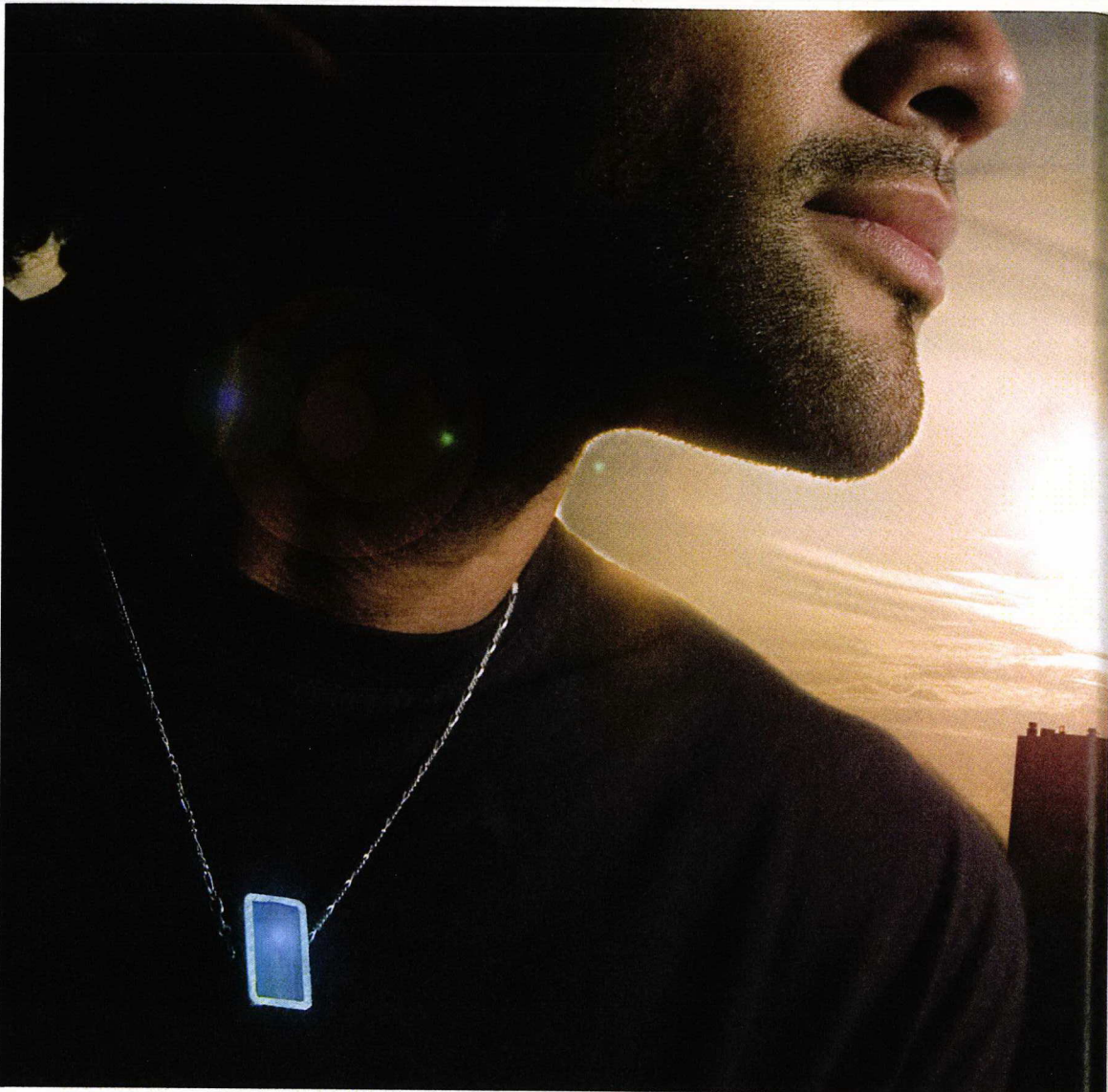
# Instant Drug Detector

Detection of drugs and doping on the spot

Current doping tests involve lab analysis of samples that takes days for the results to be known. In the future an instant drug detector will make it possible to screen a sportsman just before an event and provide the anti-doping authority with the result immediately.



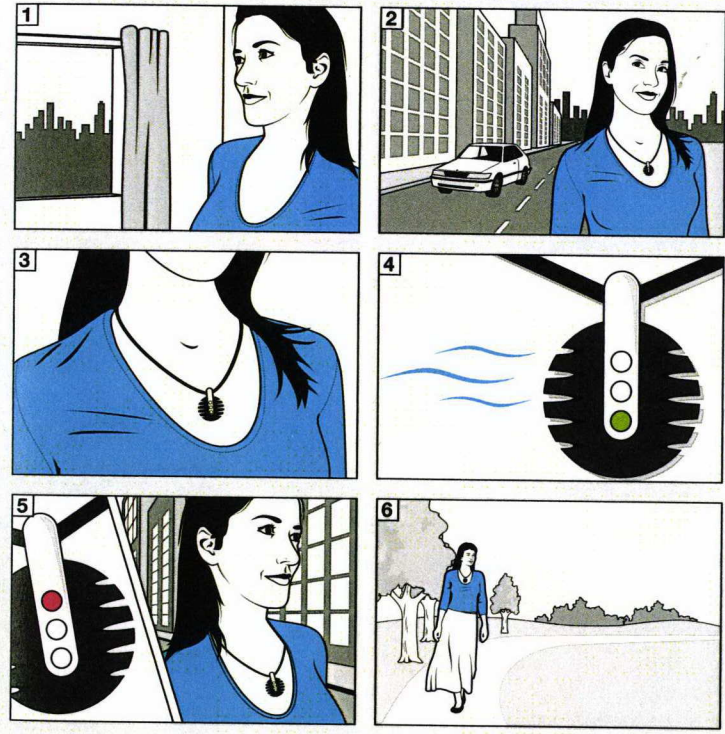
1. Summer 2014, the Tour de France has started. Just before the start of one of the stages an official approaches the cyclists.
2. A cyclist has to put a drug tester in his mouth in order to collect a saliva sample.
3. The official checks the identity of the cyclist in order to verify that he is taking the sample of the right person.
4. The small device that is put in the mouth collects some saliva and conducts a drug test for the most popular stimulants. In a minute the result is shown.
5. The device turns red, which means that the cyclist has used forbidden stimulants.
6. The cyclist is disqualified from the stage. The saliva sample is sent to the lab for an extra test in order to obtain 100% certainty about the result of the test.



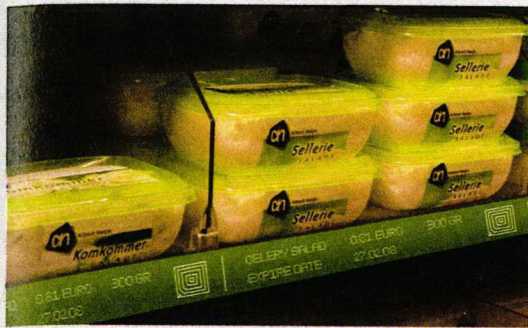
# Personal Air Freshness Indicator

Wearable pollutant warning

Air pollution is increasingly affecting many of us, especially in large cities and industrial areas. The wearable fresh air indicator is a very small device that is able to warn individuals when precautions have to be taken. Inside, a polymer based sensor analyses the quality of the air. Warning signals are given by the changing colour of the organic light emitting surface. The energy required by the device is generated inside by a tiny energy scavenger which takes the energy from the environment.



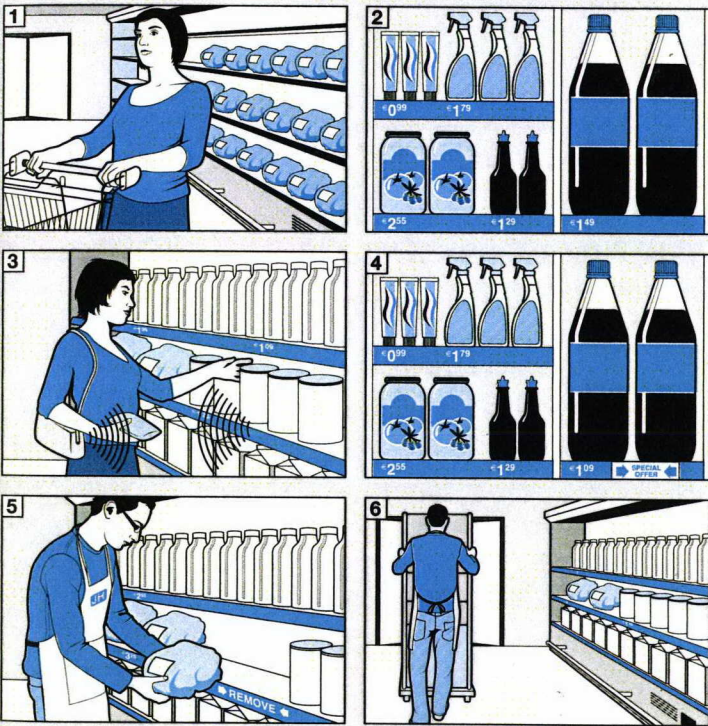
1. Eileen has asthma, lives in a big city and always has to be health-conscious.
2. When she goes outside she always wears a special necklace.
3. The necklace looks like a piece of jewellery in the shape of a flower but has an integrated air quality sensor for measuring pollution in the outside air.
4. The quality of the air is measured every minute. The sensitivity level is set to her personal health condition. When predetermined limits are exceeded a signal is given.
5. When she walks through one of the main streets, the heart of the flower starts emitting a red light.
6. Now that Eileen knows where the air is potentially hazardous for her, she quickly walks in another direction until the light turns off.



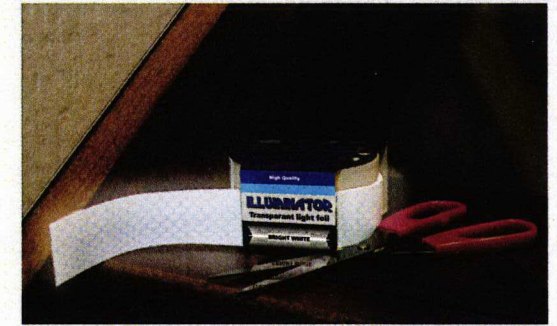
# Intelligent Shop Shelves

Retail identification and information display

Increasingly, retail stores have to comply with strict food laws and supply detailed data regarding type, origin, composition and freshness of products. Shelves are also an ideal location for showing commercial information, which can enhance sales. An intelligent, wirelessly addressable shelf display system can be a dynamic means of providing the individual consumer with additional information and facilitate inventory control.



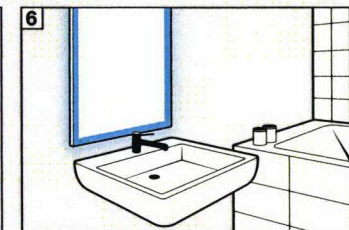
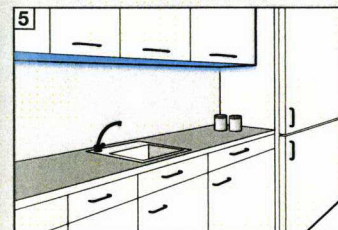
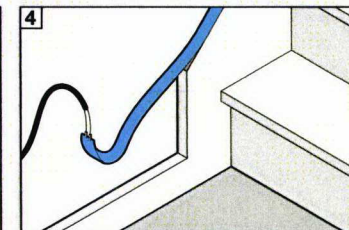
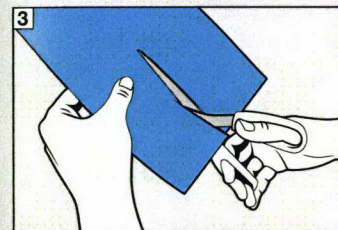
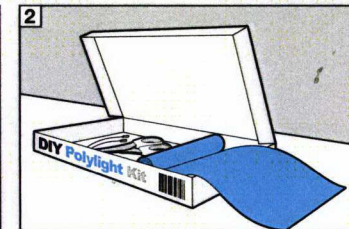
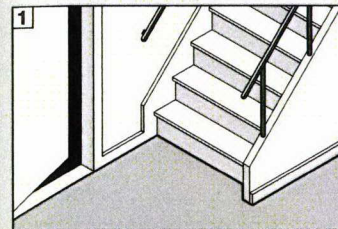
1. Lena is in the supermarket to buy her weekly purchases.
2. Before she passes the shelves, it displays normal price and product information.
3. The shelves recognise Lena by her shopping card in her purse. Lena's attention is drawn to a changing display text.
4. The display shows her customised offers. She picks out a product and continues shopping.
5. When one of the shop employees passes a certain shelf a message is displayed that refill is required because of the need to remove some products because they have passed their perishable date.
6. When the shelf is filled and the employee walks away the message automatically changes into pricing and product information.



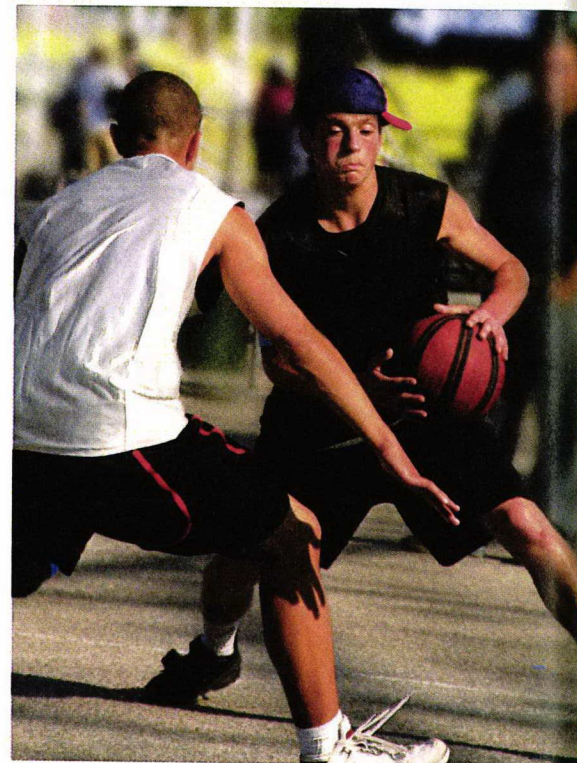
# DIY Poly Light Foil

Do-it-yourself light-emitting flexible foils

The DIY Poly Light Foil Kit will provide consumers with the possibility to create their own lighting application with flexible light-emitting foils. These low-power efficient light foils can be cut and formed into any shape and can be used creatively both in the home or outdoors.



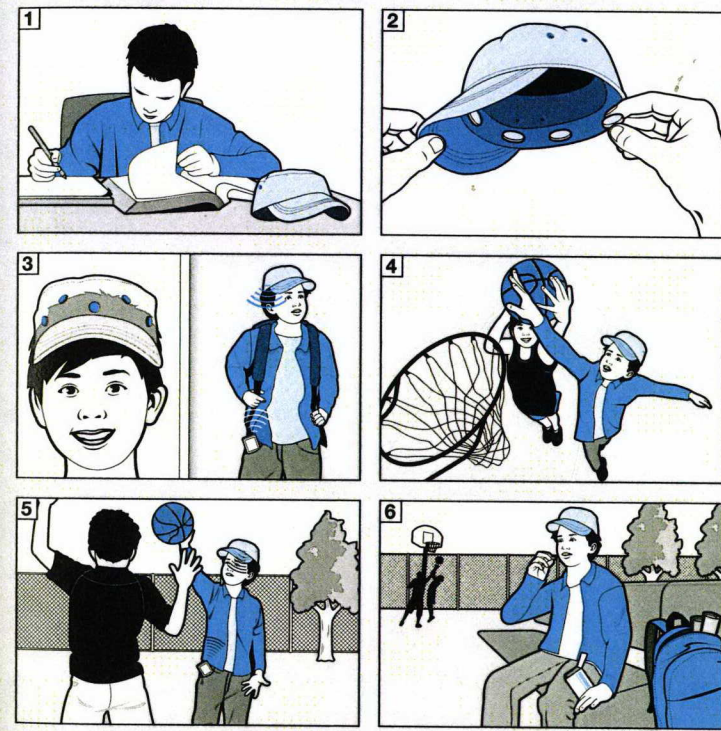
1. Bob is doing some home improvement and wants to create staircase lighting in his house.
2. He buys a DIY PolyLight kit at the D-I-Y store. The kit contains a roll of polymer light-emitting foil, wiring, small proximity sensors and a power converter.
3. At home he uses a special pair of scissors that cuts and seals the material at the same time.
4. When the flexible material is the right shape, he sticks it on the surface and adds connectors to power the light.
5. Besides the stairs, he uses the foil under the kitchen cupboard to provide lighting for the sink.
6. And he uses the kit to create a mirror with light foil around it.



# Wireless Body Area Network

A new generation of miniaturised sensor systems for personal body area networks

Highly miniaturised and autonomous sensor systems will enable people to wear their personal body area network (BAN), providing them with medical, lifestyle, assisted living, sports or entertainment functions. Thanks to advances in wireless communication, energy scavenging, system integration and sensor technology, it will be possible to develop systems like this in the near future. The almost invisible tiny sensor nodes will enable remote EEG brain activity monitoring of patients in the natural environment, for example. This kind of application will greatly improve the quality of life.



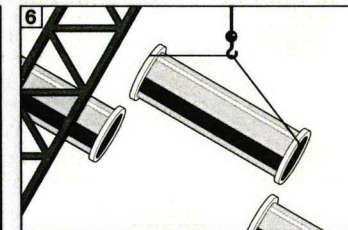
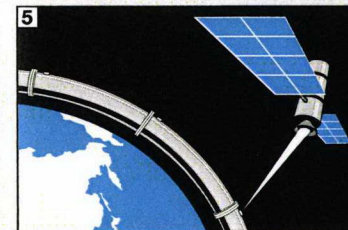
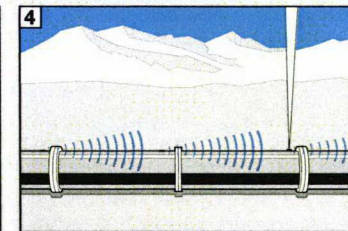
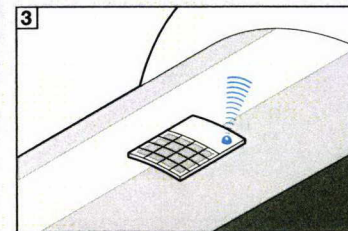
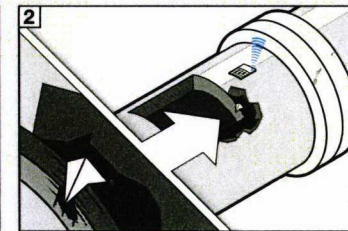
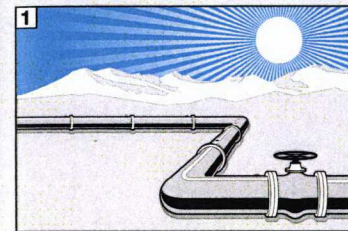
1. Ben, a 13 year old boy, sometimes suffers from epileptic attacks.
2. He has a set of tiny wireless electrodes for EEG monitoring which he attaches to the inside of his baseball cap.
3. The small brain-activity sensors communicate wirelessly with each other, and can automatically connect to his mobile phone when needed.
4. Ben is playing basketball outside with his friends.
5. Analysis of the brain activity signals shows early signs of an epileptic attack.
6. A signal is sent to his telephone instructing him to take his medication.



# Advanced Corrosion Monitoring

Autonomous remote sensor network for corrosion prevention

Early detection of corrosion is an effective way of reducing operational and maintenance costs. Advanced sensor systems will provide cost-effective inspection and monitoring of large, complex corrosion-sensitive objects. The sensors are embedded, simple and inexpensive. They are able to detect corrosion at an early stage. The added value of corrosion monitoring systems becomes obvious when you consider pipelines and installations that are used underground, underwater or in remote areas and extreme climates.



1. An oil pipeline is fitted with a corrosion monitoring system to detect degradation of the coating of the pipeline.
2. Very small cracks in the coating of the pipeline are a precursor to corrosion. Erosion of the coating is detected by one of the sensors distributed across the whole length of the pipeline.
3. The autonomous sensor forwards a signal to neighboring sensor nodes.
4. The signal is forwarded by sensor nodes to a central unit that communicates the signal to a satellite.
5. The satellite forwards the signal to an operating station where the signal is turned into a message indicating the location and the problem. The message is forwarded to the responsible maintenance unit.
6. The maintenance unit locates the problem and replaces the pipe with the damaged coating.



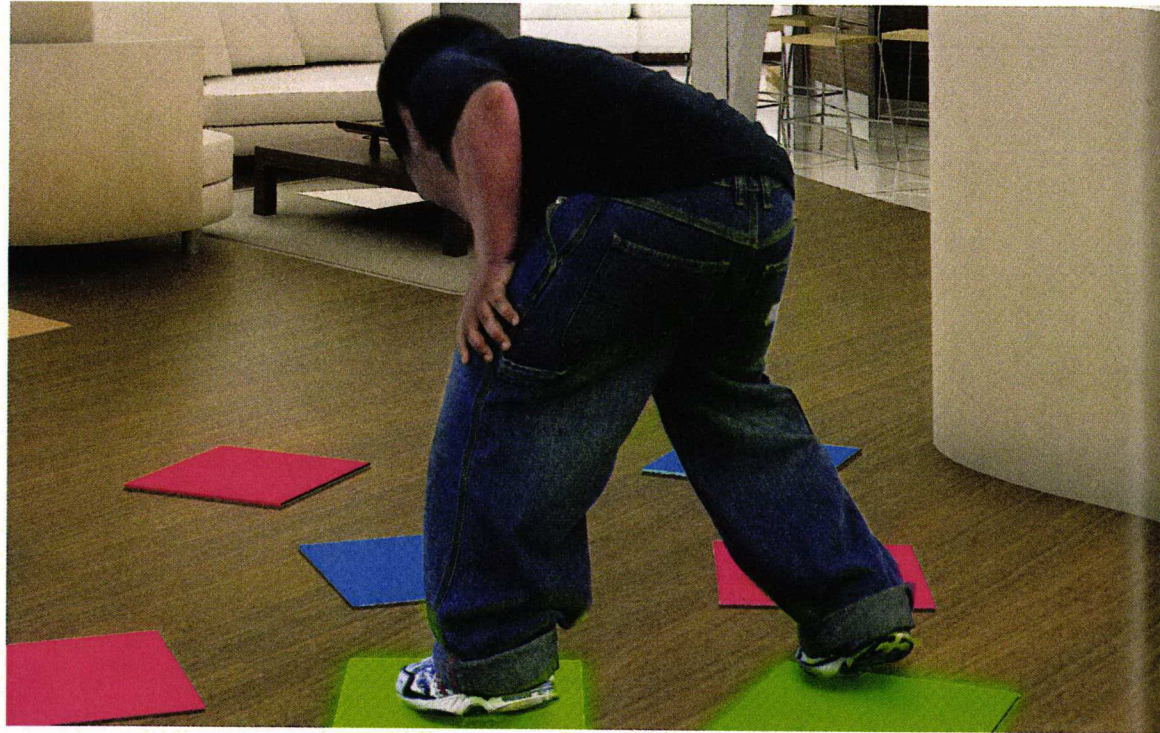
# Wireless Motion Capture

For VR gaming, education and sports

Affordable and handy solutions for motion capture will become possible with miniaturisation and wireless sensor technology. A truly wireless motion capture system contains tiny sensors that can be placed arbitrarily on a body or subject, bringing 3D models to life. Motion capture can be used for a large number of applications, for example human movement analysis in sports and rehabilitation, full-body motion capture for 3D real-time animation, game design, virtual reality, film character creation and much more.



1. Danny invites some friends to play an active video game.
2. He has two sets of small sensors in different colors, integrated in elastic straps that can be worn on the body like a sweatband.
3. A game setting appears on a large 3D screen in front of the wall.
4. They put on the straps which register all their movements, heart rate and brain activity
5. The sensors automatically match the virtual models on the screen.
6. The game starts and the characters on the screen respond to the movements of the players.



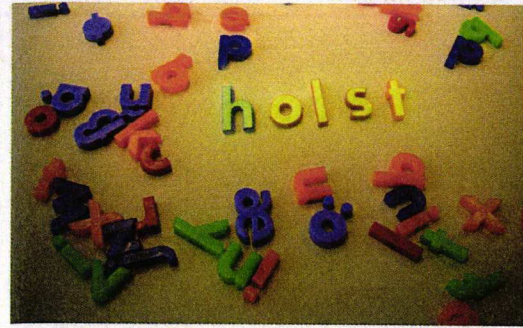
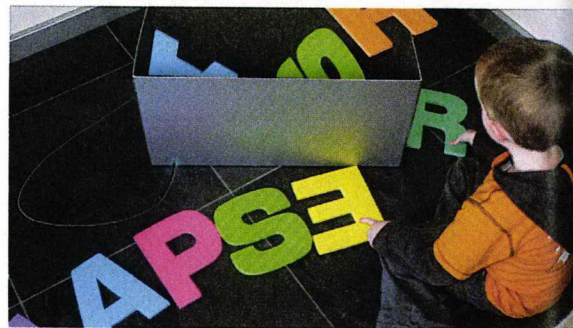
## Smart Playing Tiles

Smart, pressure-sensitive light-emitting tiles that encourage active play among young children

A common complaint: young children do not get enough exercise. Hide-and-seek and street soccer have given way to gaming and computer messaging. Smart playing tiles are designed to encourage young children to play physically active games. The tiles are pressure sensitive and emit light. They have integrated wireless network technology and radio identification (RFID), distributed intelligence and computational power for more complex functionality.



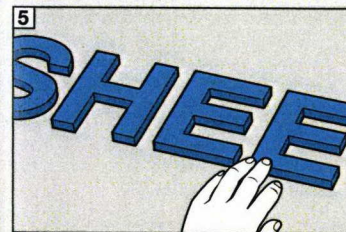
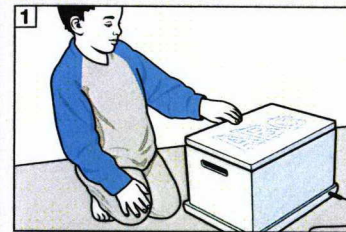
1. Freddy, 8 years old, is going to visit his friend Sam. He is wearing a bag with his favorite toys.
2. He takes his set of magic tiles. Sam had already put his own magic tiles on the ground.
3. The tiles offer all kind of playing possibilities; for one of the games, all of the tiles are spread over the room.
4. By stepping on a tile, all the tiles in the room are activated and start to emit light.
5. The flexible tiles communicate with each other and sense every touch on the surface.
6. Several tiles light up in the same color, Freddy touches one of them and wins a point. Whoever collects most points, wins the game.



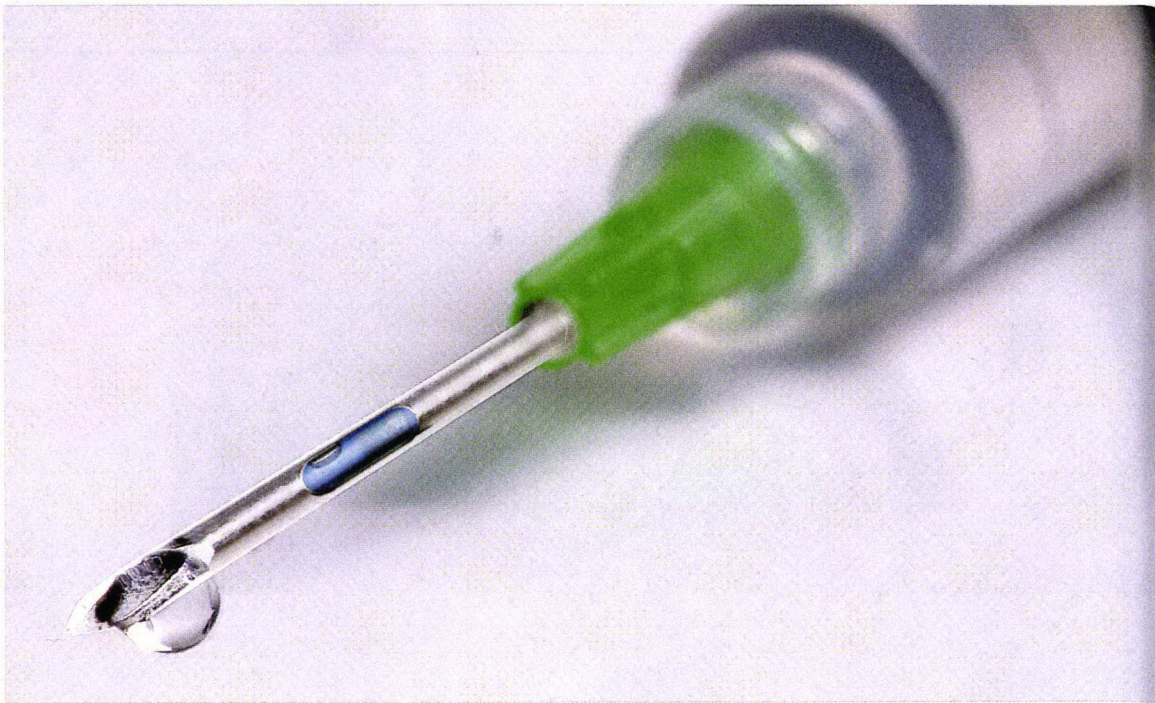
## LumiDo – Active Learning

A reading and maths learning game for children based on physical interaction with smart light-emitting characters and numbers

In this digital age, many children grow up behind computer screens, often with individualised on-screen entertainment and education. LumiDo is a physically interactive character and number game that makes learning tangible and fun; it lets children 'play' again. A child can form combinations of letters or numbers to discover new words or calculations that light up when the letters or numbers are correctly sequenced.



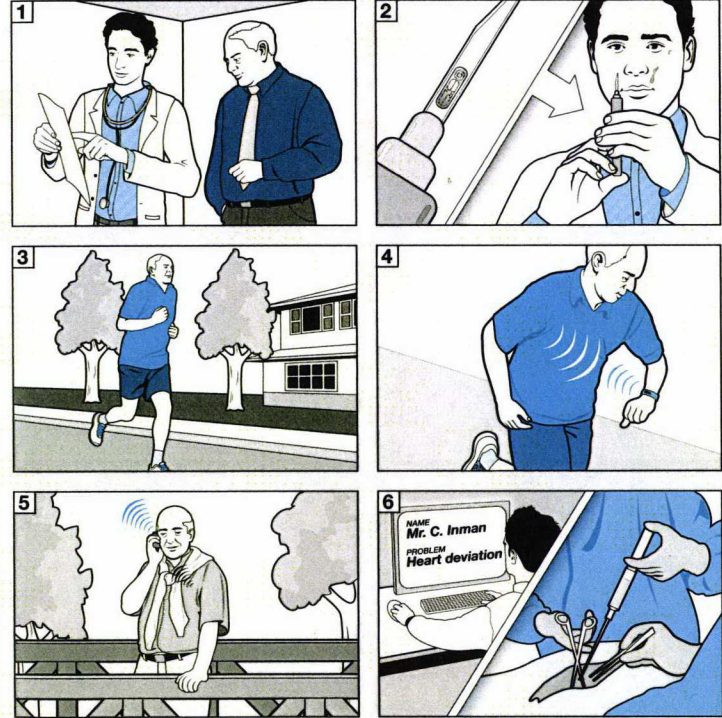
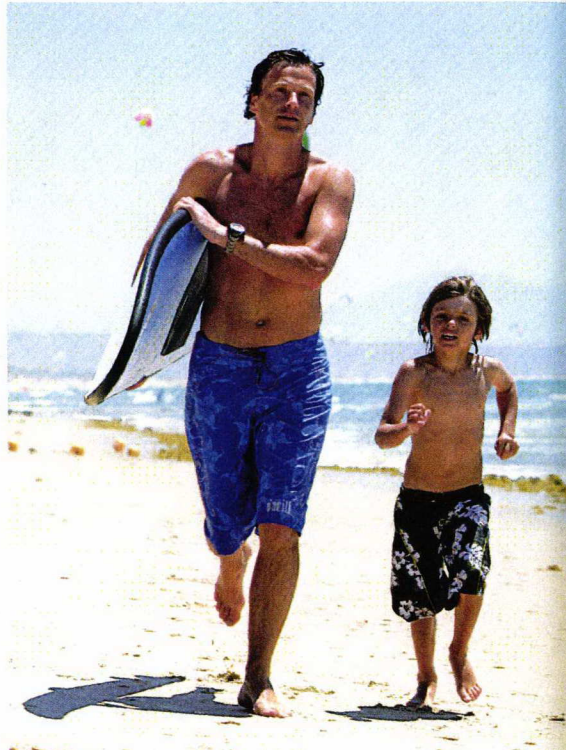
1. Joey, a child of 5, is sitting on the ground playing. In front of him is a box with the LumiDo character set. The characters have been inductively recharged in the box.
2. He knocks the box over and the characters fall on the floor.
3. Joey takes one of the characters and puts another one next to it, nothing special happens.
4. When he adds another one, an intriguing light appears. All characters of the combination light up, indicating that the combination forms a correctly spelled word. At the same time, a voice pronounces the correctly spelled word from small speakers incorporated in the characters.
5. When Joey adds another character, the new combination no longer forms a correct word anymore and the light fades out. He tries to add some other characters but nothing happens.
6. At a certain moment he adds the right character to form another 'longer' word. This word lights up and is pronounced.



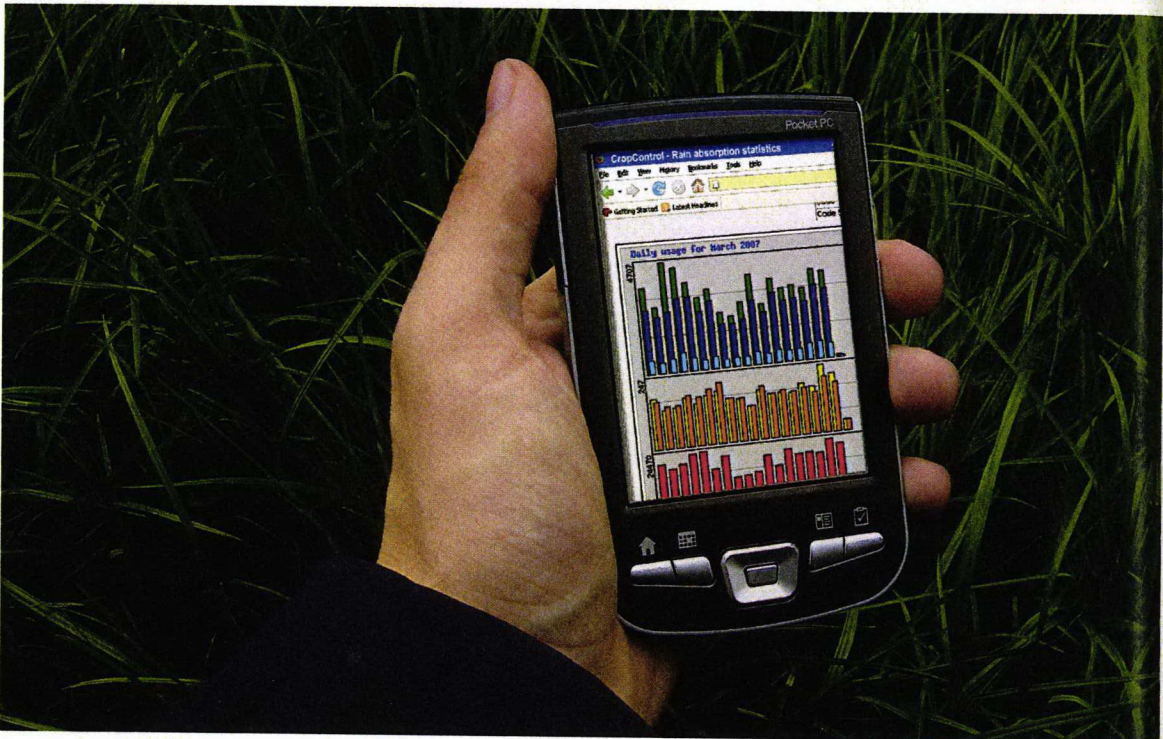
# In-Body Sensing

The seamless early warning health monitoring solution

In the future, battery-free wireless intelligent sensor modules implanted in the body will enable seamless continuous health monitoring. Tiny sensor devices collect and interpret physiological and biological information and communicate if deviations in vital properties are detected. Ultimately, microscopic implants with sensor functionality will be able to operate autonomously for the lifetime of its wearer.



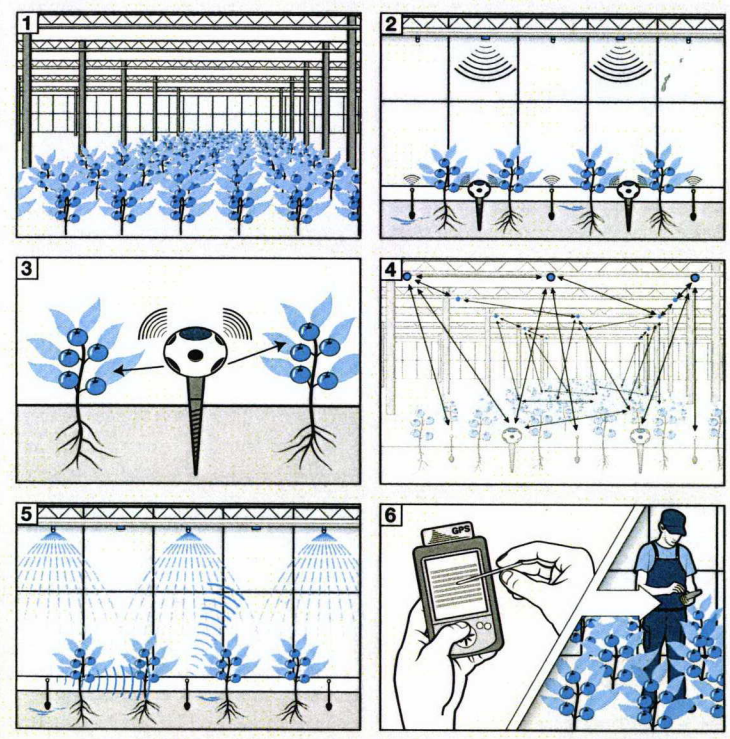
1. Collin, 61 years old, visits his doctor for the latest health sensor which is the size of a rice grain.
2. The miniaturized device for monitoring heart rate and body core temperature is inserted in his breast using a special needle.
3. He is a fanatic sportsman, he goes running every day.
4. The sensor is connected to a tiny transponder and a processing unit which sends the relevant data of his heart rate and core temperature to his wrist device. His training schedule automatically adjusts to his physical performance.
5. Two years later, the sensor registers abnormal patterns in the heart rate, and via an internet connection it makes the diagnosis while he is calling his wife.
6. A visit to his doctor is scheduled automatically because of the serious heart disorder. The doctor refers him to hospital for a life saving operation.



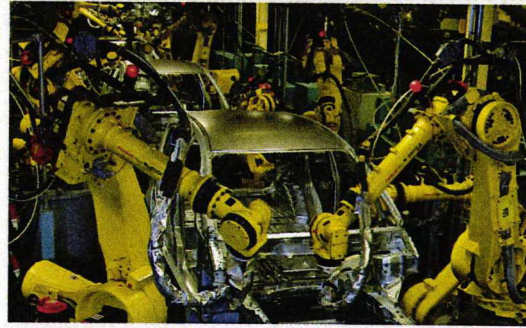
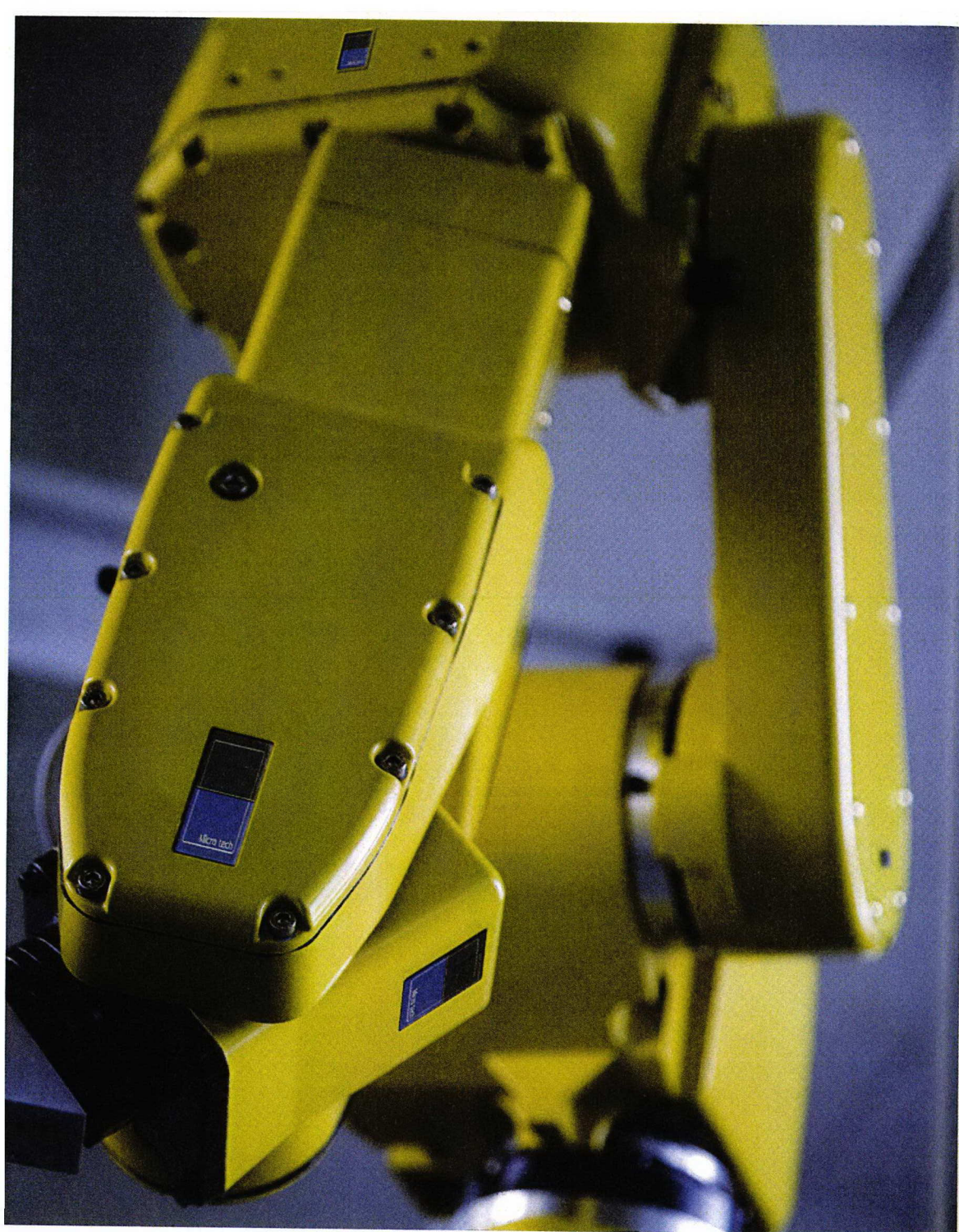
# Distributed Environmental Sensing

Sensors spread out in a mesh network for environment monitoring

There is a demand for the comprehensive, inexpensive and reliable monitoring and control of physical environments. Miniaturised autonomous wireless sensors are the future solution for observing, assessing and controlling agricultural practice and the environment. Distributed sensing can be used to monitor surface, soil and water contamination, ecosystem and habitat research as well as quality control.



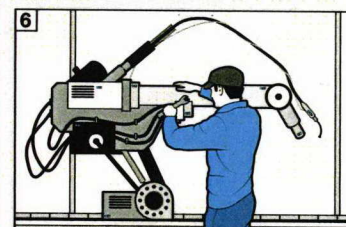
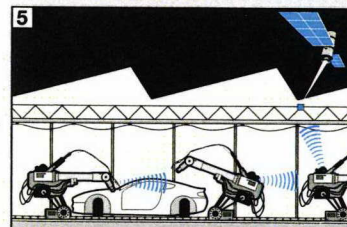
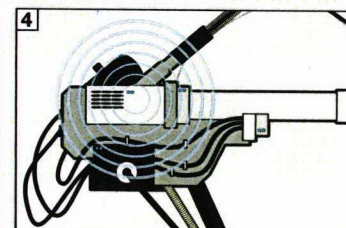
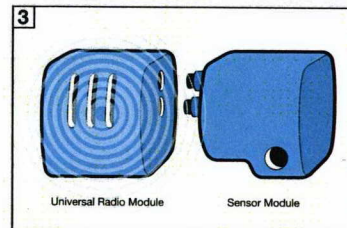
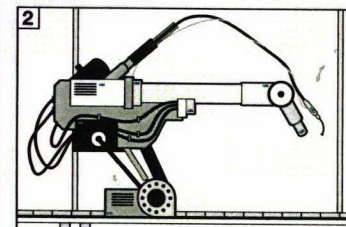
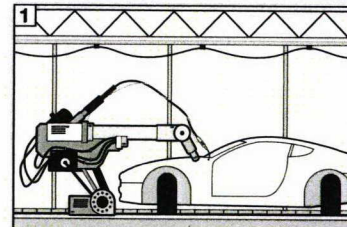
1. A large greenhouse in the Netherlands, in 2012.
2. Autonomous wireless sensor units are placed all over the greenhouse; underground, at ground level and under the roof panels.
3. The sensors scavenge energy from the environment and share and broadcast relevant information up to 20 meters.
4. Different kinds of sensors create a large sensor network with distributed intelligence.
5. The web of sensors links to the greenhouse's system for controlling light intensity, watering, drainage and pesticides.
6. The control process needed for the growth is performed automatically. The farmer receives a message when a deviation from the norm has been observed by the system.



# Advanced Industrial Monitoring

Wireless, autonomous and miniaturised mesh networking to monitor machine health and industrial processes

Monitoring equipment and processes in manufacturing plants is crucial for optimising and controlling production to achieve maximum throughput at the required quality levels. Smart wireless autonomous sensor nodes operate in a network using energy from the environment to optimise machine control. Wireless sensing enables remote monitoring at machine, process and plant level. Industrial automation will make predictive maintenance possible, allowing for proper intervention before real problems occur.



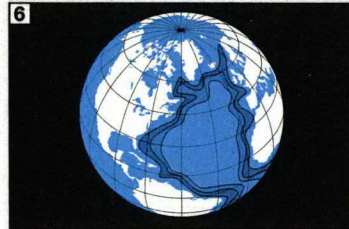
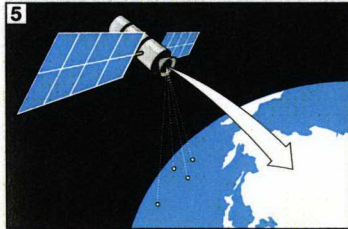
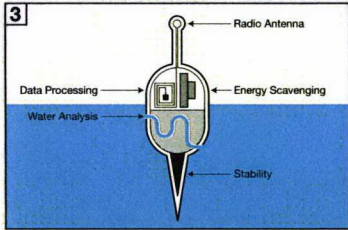
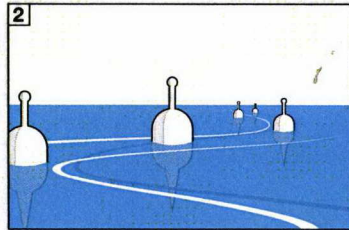
1. A very large manufacturing plant for automated production of cars.
2. All machinery is equipped with wireless sensors that monitor different parameters and overall performance.
3. The sensors are linked to very small RF transducer modules about the size of a dice, making wireless data transfer possible.
4. One of the sensors observes that one of the pivot points of a welding robot is wearing out.
5. A status report is sent automatically to the service company using the network of wireless sensors.
6. The welding robot is repaired before any real problem has occurred.



# Nomadic Sensors

A mobile autonomous long-distance sensor system

Worldwide monitoring of pollution, weather and migration patterns becomes possible by using large numbers of autonomous miniaturised sensors that float, are attached to organisms or are placed at fixed locations. These power-efficient sensors will, for example, provide continuous reading of the oceans and can be used for measuring the temperature, salinity and chemical composition of the water. Currents will take the sensors all over the ocean and data will be transferred by radio signal.

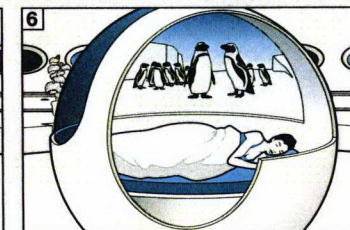
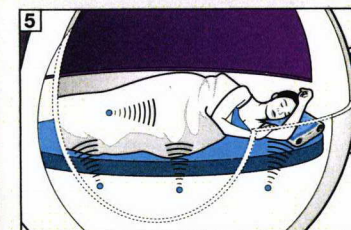
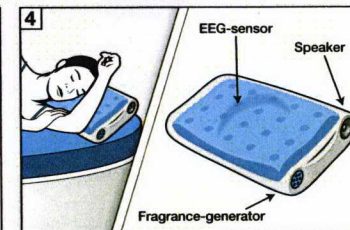


1. Large numbers of floating sensors are thrown in the sea at different locations in the world for studying pollution levels.
2. The sensors float with the currents in the ocean.
3. Water flows through the sensor, which takes measurements and analyzes the water quality.
4. The energy for sensing and data transmission is generated from solar foil and the temperature difference between water and air.
5. The signal from the sensors is tracked by satellites at 400 km altitude.
6. Information is used to map currents, temperature and water pollution, in order to take the correct policy measures.

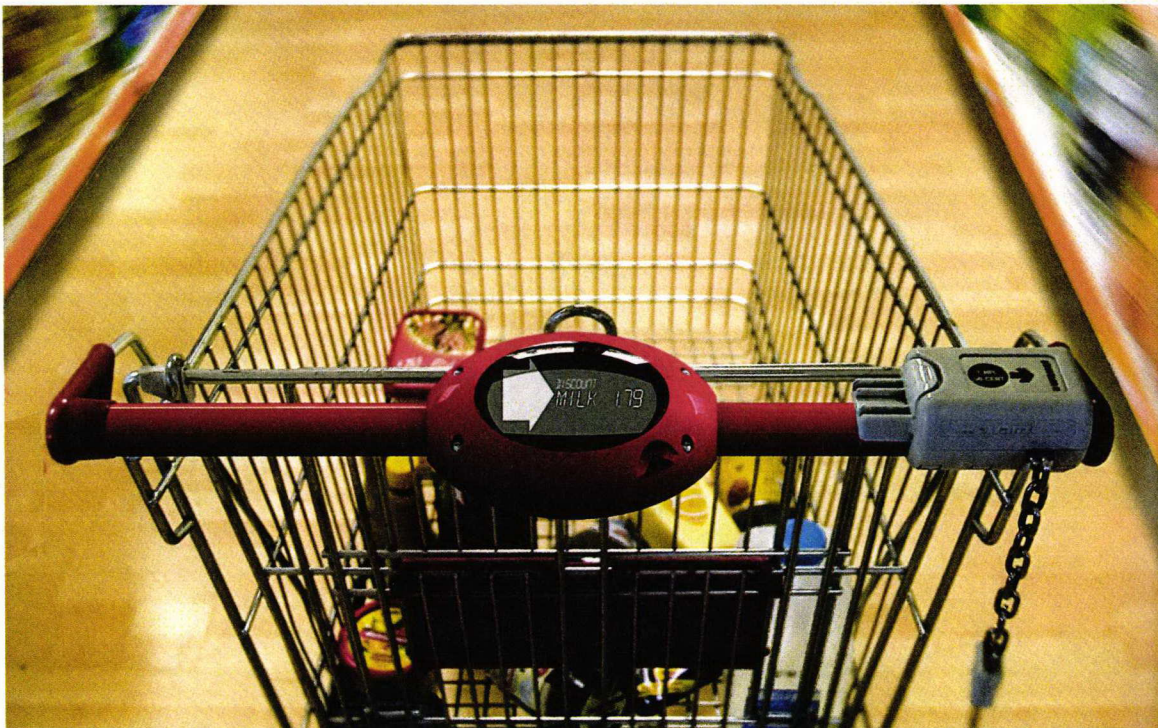
# Smart Sensing Bed

The sleep ambience for a perfect night's rest and invisible health monitoring and stimulation

People spend about one third of their lives in their beds. The bed of the future optimises people's sleep whilst watching over them, providing all kinds of stimulatory input. In addition to generating stimuli for relaxation, learning and entertainment, the bed can also monitor a person's health during sleep and provide interactive advice on health and nutrition.



1. After a busy and stressful day, Loreena has an appointment with some of her friends; they enjoy several tasty snacks.
2. Late at night, she arrives at home and goes to her sphere shaped bed.
3. The bed welcomes her with a friendly voice and she lies down.
4. Loreena's brain activity is monitored by a specially shaped pillow which monitors the phase of sleep in order to know what kind of stimuli are required for her.
5. Body temperature, heart rate and blood pressure are also monitored by small wireless sensors in the bed, blanket and pillow.
6. Bed temperature and light levels are adjusted to match the sleeping phase. Sound odor and visual impulses are used to let Loreena sleep optimally and to stimulate the brain so that it results in a healthier attitude towards her lifestyle. This ensures a very deep and effective sleep.



# Intelligent Store Environments

Future shopping facilities

Exchange of information between producers, transporters, retailers and their customers has an effect on all parts of the supply chain. This vision is made possible by advances in networking and identification technology: RFID chips, indoor and outdoor systems to locate goods and people, customer profiling, supplier partnering, home delivery and augmented reality will all help stores to become 'intelligent' and to compete with the on-line world of virtual shopping.



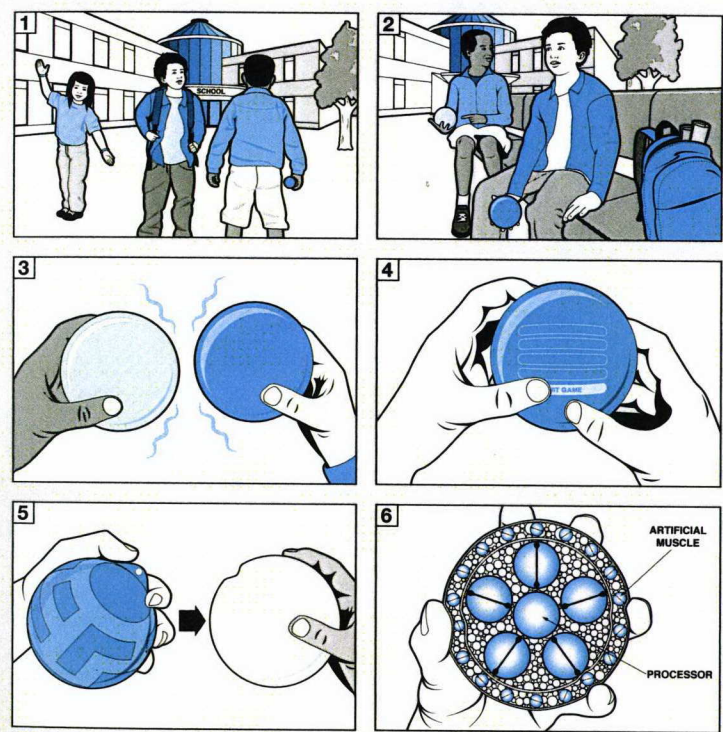
1. Lena is in the supermarket, buying her weekly groceries.
2. All shelves are equipped with RFID technology to register the tagged products on the shelf. They also have a price display and wireless communication for data exchange.
3. The shelves form an extensive network; the shopping carts and baskets have wireless communication, RFID reader and display.
4. The RFID reader in the cart reads the loyalty card in Lena's pocket so it knows her preferences; this is communicated to the wireless network.
5. When products are held near the cart, price and additional information is displayed. Products are registered as soon they are placed in the cart. The system advises other products based on the contents of the cart and her shopping behavior.
6. The radio technology and cart display direct Lena towards the shelf where the system's suggestion can be found.



# 'GO' – Interactive Gaming Ball

The flexible video gaming device of the next generation

The 'GO' interactive gaming ball adds a new dimension of playing fun to traditional video gaming. New technologies will enable the development of radically innovative gaming and entertainment concepts in the years to come. 'GO' is a flexible knead ball displaying a video game on the outside. 'GO' can actively change shape as well as react to pressure from users' hands. 'GO' has an extremely physical interaction with the user and with 'GO' balls of other users.



1. Jimmy and Phil meet each other at the school yard.
2. They are each playing with a special ball called 'GO'.
3. The balls make contact, an electronic handshake is performed and the game starts.
4. 'GO' is a ball with a soft and flexible video touch screen all round.
5. The games influence each other and the ball changes shape according to the actions of the opponent; touching one ball influences the behavior of the other ball.
6. Inside of the ball are a large number of wireless connections between sensors and actuators; the system senses the player's touch and gives feedback by changing its shape.

# Colophon

**Composition**

Aeneas Fletterman

**Project management**

Else Embregts

**Graphic design**

Locografix

**Printing**

Drukkerij en Uitgeversbedrijf Lecturis BV

**Foreword and introduction**

Jo De Boeck, Jaap Lombaers

**Visualization**

Spark Design Engineering

XvO Photography

**Photos Advanced Industrial Monitoring**

NedCar

**Concept development**

TNO Science and Industry - Aeneas Fletterman, Karl

Sewalt

Spark Design Engineering

TU/e – Industrial Design

University of Twente – Industrial Design Engineering

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