

# **The computer disappears, the environment becomes smart**

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## **Introduction**

The artist Joost Verhagen represents spaces in an original way by using colours, texture and forms. He invokes thoughts and feelings with his works of art. The concept of ambient intelligence also deals with space, but especially with spaces that are organized as smart environments. Intelligence in environments arises when a space becomes sensitive for the presence of people and responds to their desires and needs.

This paper describes in brief how men have adapted the space they live in and how a smart environment can respond to people. The notion of smart is investigated as well as the technology that enables it. Ambient intelligence or ambient intelligence raises questions. With questions like "How do people experience intelligent environment?" and "What ethical dilemmas are emerging?" this contribution is concluded.

## **Man furnishes his environment**

Throughout history, people have creatively intervened in their environment. What man has added consisted for many centuries mainly of static objects such as mounds, walls, houses, roads, canals, ports, levees, water pipes and signage. Men need safe places to live and trails around the country go with cattle, merchandise or armies. He wants to live in houses that protect against harsh weather and that offer comfort. People depend on each other: hamlets, villages and cities are established. Sometimes on a mound, sometimes surrounded by a canal or a wall. To provide necessities of life fields are laid out and are fenced-off to define the property and stop unwanted animals.

Only when in the 19-and 20-th century the technical development offered opportunities to do so static and dynamic elements were applied in the environment. Dynamic means that there is a response to events or to certain situations. Think of the rail crossings, traffic lights, thermostats for controlling heating and feedback systems in machinery.

At the beginning of the 21-st century this development even goes on further. In the physical environment virtually invisible systems are made that offer a notion of what is happening. Who is present, what does that person, what are his needs and feelings? Because observations are linked with information about the person and for example about his habits, preferences, health and work, an awareness is created of the context in which people live and work. We refer in this context to personalization. The person is not an anonymous figure in the area. Context awareness goes a step further. It also includes information on tools available to support the person's own activities and intentions, to protect him against danger and to seduce him into safe and healthy behavior. Based on context awareness ambient intelligence can adapt the environment to advance the quality of life, safety, health, job satisfaction and comfort.

To realize ambient intelligence it is necessary that the environment can respond to or interact with human beings. The space must be enabled to adapt dynamically in a way that man experiences this reaction as natural and intuitively understandable. Think of many ambient

factors as lightning that changes in brightness and color and of textile or other materials may change in color, stiffness and texture.



**Hospital room that reassures patients (Source: Philips)**

But also think of sound, music and narration. Or images, video or texts appearing in fabrics and screens or projected on walls, floors or windows. Think of ways to work with fragrances or air flow. Do not forget the many personal devices that people carry with them: PDAs and smart phones in which many features are present. And what is important: these devices can communicate with each other and the environment. Robots can also play an important role. Of course, traditional options abound as opening and shutting doors and windows, or enabling or disabling devices.

## **Intelligence from different perspectives**

Four important questions should be made about concepts such as smart, clever and intelligent. The first question concerns the interpretation of an observation made by a computer. How can a meaning be attributed to a perception? How can an understandable image be constructed of the environment in such a way that context awareness arises? An observation can be interpreted in different ways. An analysis should be made that takes into account distinguished alternatives and their properties. In the analysis also other information about the environment and about people is involved. It concerns interpretations that have a high degree of probability.

Consider the example of an emergency in a complex building where many people are present that want to leave the building safely. It is necessary to know which parts of the building are unsafe, where people are present, if people with physical limitations are present, which routes are safe, what alarms, signage systems, broadcasting equipment, communications facilities are available and whether they function properly.

The second question is about the reasoning process that from the emerged understanding of the situation comes to a decision which response is given in the environment or which interaction is initiated. What is the objective which it aims? In the determination uncertainties come in and the best option should be chosen. In our example the challenge is to make a decision about a safe escape route for anyone, including for those in wheelchairs.

The third question is about how the reaction is given. The presentation of the decision plays an important role in the acceptance and effectiveness. A choice is to be made from the set of

adaptions that are outlined above and to take into account preferences and limitations of the person.

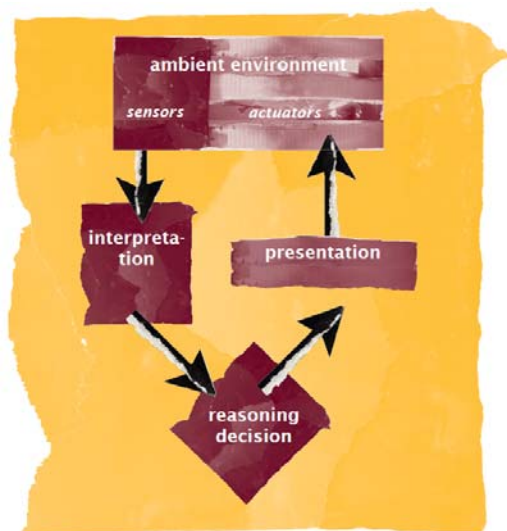
In the example we can think of dynamic arrows indicating escape routes on the walls or floors, the closing of passages in a dangerous direction, controlling lighting, giving instructions over loudspeakers, screens or smartphones.

From practicing and by using feedback from users understanding of the effectiveness and feasibility can emerge.

From previous calamities the smart environment can learn lessons. The environment can become a learning system by analyzing former experiences.

The fourth question is related to the above. In other words: how can an environment behave as an intelligent, learning system? If this is possible, immediately the question occurs whether an environment can anticipate human needs. So it acts only reactively but also proactively.

It can be summarized in a generic diagram. It is an extended version of the sense-think-act paradigm



**The dataflow in ambient intelligence**

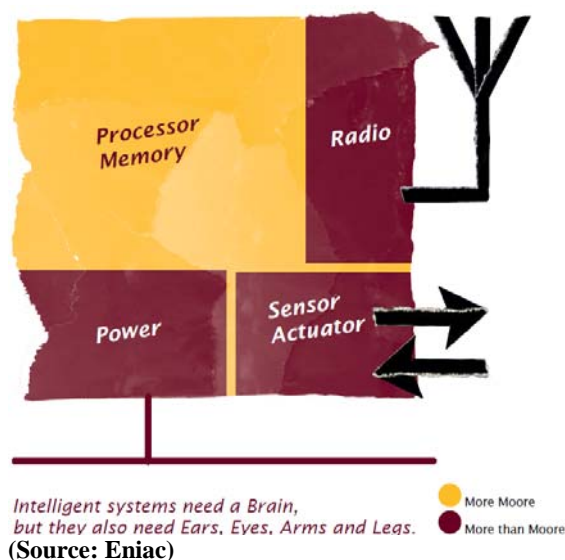
By giving importance to forms of intelligence in the environment the notion of ambient intelligence as an umbrella concept has got an important place in talking about the smart environment. The following summarizes the main characteristics of ambient intelligence together

Embedding	<i>Devices are invisible in the environment</i>
Context awareness	<i>The environment recognizes you and your specific circumstances.</i>
Personalisation	<i>Services are tailored to your desires and needs.</i>
Adaption	<i>The environment adapts automatically to you.</i>
Anticipation	<i>The environment anticipates automatically your needs.</i>

**Key characteristics of ambient intelligence**

## The computer disappears

Above, a sketch of a smart environment is given. It is clear that there have been many technological developments and many are still to come to enable a smart environment. The most important development is that computer technology is so fundamental that it is absorbed in things of everyday life. For that reason this technology is no longer noticed as something that distinguishes from them. The computer disappears into the fabric of everyday life. The high degree of miniaturization has been made possible by the development of micro-and nano-electronics. A second development that in the past computers were mainly characterized by the metaphor of brains: they were thinking, calculating and had a memory. The trend of the past ten years is that computer technology is enriched with ears, eyes and other senses - sensors - with a mouth that symbolizes communication and with arms and legs - actuators- to do things in the physical world.



## How do people experience their smart environment?

In the future development of smart environments there are not only technical challenges. Important is how much people will appreciate these environments. Is the used technology

really so transparent that people intuitively understand what's happening? Is the environment really so empathic that feelings are recognized and will those feelings be taken into account? Does ambient intelligence really evokes the experience of safety and comfort, or are people irritated because they fall from control of the environment? Does the environment offer enough support or are well meant actions experienced as annoying?

It is wise to assume that the designers have a long pathway to go in organizing environments in such a way that people feel happy in it. It is therefore important that from the outset people are involved in thinking and in deciding about the clever design of their surroundings. Not only in their own home but also in the workplace and public areas. Let people feel how a prototype is experienced. Especially because people develop different lifestyles. People are more mobile and are on the move frequently. They find themselves frequently in other environments. Think of the house, car, street, office, factory, gym, stadium and shopping center.

The life of many people is often very demanding. How do they communicate with each other? What do they expect at home as comfort after a busy day? The aging population is increasing. How can smart technology be used to promote the independence and to multiply quality of life in such a way that loneliness decreases and the feeling of safety increases?

## **Ethical aspects**

If in many environments sensors are embedded that observe and identify us, what happens with all information obtained? It is an issue on the World Wide Web, where people leave many digital traces. There is plenty of information about many people on the web. Is that information published with the consent of those involved? Is privacy safeguarded on the net? There is discussion about this "dark" side of the Internet. Are smart environments equipped with protection against this potential "dark" side?

Another ethical aspect, trust, concerns the question if we can rely on the integrity of information in the smart environment. Think of issues such as the identity of individuals, the interpretation of language, feelings, intentions. What are the consequences if the system goes wrong in a way that leads to incorrect actions that injures people or causes damage?

Again, from the first ideas of ambient intelligence concepts ethical aspects of privacy, trust, freedom and human dignity should be involved. A lot of troubles can be prevented if attention is paid to these aspects. If not then environments may arise in which people do not feel comfortable or safe. Moreover, such environments are often difficultly to be corrected afterwards.

## **Finally**

Technological developments often seem to be an autonomous process. Progress is unstoppable. However developments can be influenced. Many beautiful things can be created if integrity and human dignity are kept in mind. Beautiful in the sense of an inherent beauty: technology remains fascinating. But also beautiful in the sense that people experience joy