AmI-Technology at Work – A Sociological Perspective Covering Aspects of Occupational Safety and Health (OSH)

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Abstract. Ambient Intelligence (AmI) technologies are becoming increasingly widespread in working life. Some of these are specific applications already integrated in the workflow, while others are ambitious strategies on the verge of immediate industrial implementation. However different they may be, they are commonly discussed under the shared term of "ambient intelligence" as a conceptual catch-all. In the present article, the author reflects on this somewhat simple definition and, with the aid of technology-centred definitions on the one hand and issues of the sociology of work relating to human-centricity on the other, he facilitates more instructive access to the responsible application of AmI technologies in the world of work.

Keywords: ambient intelligence, mobile ICT, mental stresses, alienation, surveillance.

1 Introduction

Ambient Intelligence (AmI) is a much-discussed term. Intelligent houses are inhabited by smart objects and the human carriers of these technical artefacts. Intelligent cars with smart tyres and computers provide increasing assistance in the transportation of their occupants to their destinations and intelligent factories support the employees there with a multitude of assistance systems. While the fields of application of AmI are manifold, how AmI is viewed is one-sided. The star of interactivity is all too often hailed with blind faith in technology and progress, without a judicious pause to estimate the consequences in good time. The present first attempt at an account of AmI from the point of view of the philosophy and sociology of work aims to give pointers to ways of remedying this deficit in industrial applications of AmI.

To afford simple and clearly structured access to the subject, I shall start with a technology-centred attempt at a definition and with the concept of "smartness". By analogy with Taylor and Focault, I shall outline, in propositions, the typical characteristics of AmI in the following. A resultant performance specification for the application of AmI technologies will follow at a later date.

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2 The Delimitation of Technical Artefacts – What Counts as AmI?

A noteworthy problem in the debate on Ambient Intelligence is the remarkable confusion surrounding the definition of what AmI is. What is usually encountered is a whole potpourri of technical concepts, actual/potential applications and scenarios. As usual for a theme from the realm of social megatrends, the situation is acerbated by the fact that, for economic and/or political reasons, all manner of activists jump onto the bandwagon in a bid for their share of the cake in terms of funding and market access. Any discussion of this topic worth taking seriously ought to make a determined effort to conceptually demarcate the subject-matter beforehand. This demarcation derives its value not so much from a watertight and eternal definition, but rather from the exclusion of what falls outside its conceptual bounds. With this in mind, I have attempted in the following a thematic delimitation based on the technical artefact and on the rough architecture of the artefacts involved in interaction. In the following, a more abstract discussion of the sociology and implications for the philosophy of work should be able to dock onto this construct. Point of departure for a definition:

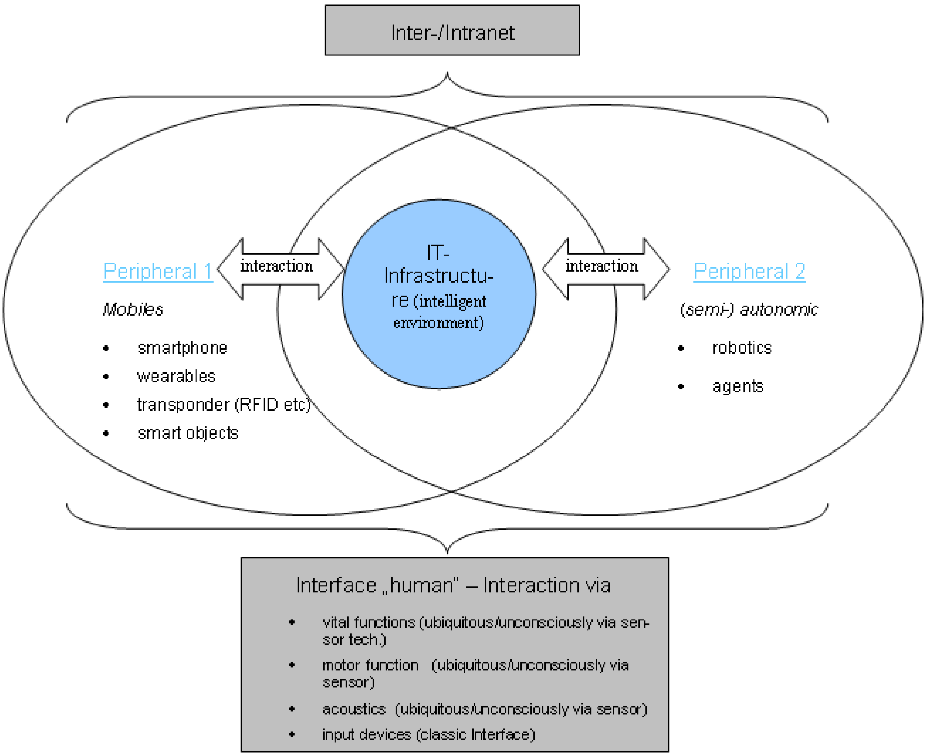

Fig. 1. Idealized representation - AmI

AmI designates an IT-networked environment (room, truck or the like) that, with the aid of mobile information and communication terminals and/or acoustic, motor and other signals, is usually intuitively usable, often processing information autonomously with the aid of sensors, and is usually constantly switched on (see Fig. 1). The purpose of its practical applications can currently be found in the assistance (e.g. data glasses, driving assistants, data mirrors etc.) of a huge range of work actions, the collection/processing of information (warehouse inventories, logistics, tracking etc.) and the (partial) automation of processes.

The figure clearly shows that AmI is by no means a single technical artefact such as data glasses or a smartphone, but always involves a complex interplay of a central and networked IT infrastructure with computer units, peripheral and on the whole passive artefacts such as smartphones and transponders (see Figure 1, Peripheral 1), peripherally active artefacts such as software agents and robotics applications (see Figure 1, Peripheral 2), an Inter/intranet access for data sourcing and an often extremely elaborate human interface.

It should be borne in mind here that the examples are equivalents that do not all have to be present to satisfy the definition of Ami.

2.1 Smart or Not Smart?

In the AmI debate, one term is conspicuous through its omnipresence: smart.

The idea is that "smart" objects should stand apart from existing technologies thanks to such attributes as user-centred assistance, intelligence and autonomy and thus enrich the lives of the people who use them. At the same time, frequently cited examples of smartness give rise to considerable doubts about the mentioned properties:

"Examples of smart objects are car tires that tell the driver when the air pressure is decreasing." [1].

This dilution of the definition of smart leads to confusion about the subject of discussion. The artefact in the cited example (car tire) is anything but smart. It is a trivial machine:

> "A trivial machine is characterized by a clear relationship between its 'input' (stimulus, cause) and its 'output' (reaction, effect). This invariant relationship is the 'machine'. Since this relationship is fixed for all time, it is a deterministic system; and since an output once observed for a certain input will be the same for the same input at a later date, it is also a predictable system" [2].

In terms of the tire, this means that precisely whenever a certain minimum pressure is reached, a warning signal is issued. This function couldn't be more trivial. Such artefacts are explicitly disregarded here. The world is familiar with them in myriad guises and knows more or less how to respond to them and how to deal with them. Complex machines, on the other hand, operate entirely differently:

> "The so-called 'non-trivial' machine is (…) in a sense trivial in that it – like the 'trivial machine' – is a machine, i.e. conforms to a precisely defined rule. An observer who is

> unfamiliar with the mechanism and therefore has a black box in front of him has very poor chances of uncovering the logic of a 'non-trivial machine' by experimentation, for instance" [2].

Complex machines therefore become black boxes in that they change their inherent internal operative state. They perform different functions in relation to their experience and/or, in practical terms, through supplementary dynamic information from an external source like the Internet that is integrated into the operative process in specific situations. The results of their action are not therefore predictable for an outside observer.

Example: To stay with our tyre, we can imagine the following situation. A tyre suddenly loses pressure. Thanks to its sensors, the car computer recognises the state, knows on the basis of its experience (fatigue recognition sensors) about the driver's reactions (slow in this case), also has via an Internet link current details of approaching road works and decides not to an issue a signal to the driver, but to autonomously initiate a braking process.

An outside observer would not be able to understand why one vehicle suddenly brakes (driver tired) and another, identical one doesn't (driver alert). The technology has the quality of a black box and is smart. In the following, only technologies that through interaction are smart in this sense are to be subsumed under the term "ambient intelligence". In addition, there is also mention in the following of industrial applications of AmI, in which it, like every technology, is given a context-dependent quality.

3 Assessment of the Ascribed Attributes of AmI

3.1 AmI Is Human-Centric

Whenever there is mention of AmI in public discussion and in popular scientific media, it is commonly assumed to be fundamentally different from conventional technologies. Technology is no longer a cumbersome, physically graspable thing that often hinders people with its shortcomings, but a universally available resource that has now assumed objective form (cf.[3]).

> "Whereas in the age of the mainframe and PCs computing capacity was still a scarce resource, new technologies and continuing progress in the field of information and communication technologies promise the omnipresent availability of information and services. At the centre of this is no longer the machine with its technical capacities and limitations, but the human being with his/her personal needs and wishes. The computer now only operates in the background as an unobtrusive but constantly available electronic assistant." [1].

What we see here is the romantic interpretation of a technical revelation. This should be treated with distrust. The question of what is human-centric about AmI can be quickly investigated and explained on the basis of examples of scenarios (partly real, partly invented):

Example I - AmI-supported order-picking:
The production line workers of a car maker are supplied with the components they need by workmates known as pickers. The components are stored in a neighbouring racking bay, which is fully computer-controlled. The central computer is informed a short time in advance of the vehicle variants being assembled. Via a head-mounted display (HMD) linked to the central computer, the pickers are informed according to the context in which rack the parts needed by production line workers can be found.

Example II - AmI-supported light control:
The office workplaces of a leading insurance company are equipped with eye-blink sensors and other sensors to monitor employees' vital data. By cleverly processing the sensor information in the central computer, the system is aware of the onset of employees' fatigue and lack of concentration in the course of the day. As a result, the light colour is reduced to 17,000 kelvin, a bluish light that has a performance-enhancing effect on the hormone balance.

Taylorism-Critical Assessment. By means of the examples given above, real application scenarios and the technically possible illustrate the kind of human-centricity implicit in AmI. It serves mainly as an elevation of scientific management, a Taylorisation of the workplace (cf. [4] [11]), to a new, unprecedented level.

Proposition: AmI potentially separates mental work from physical labour and results in knowledge expropriation, the downskilling of the affected groups of employees, and thus to a casualisation of their work.

Typical of AmI is the central storage of experiential knowledge and expert knowledge in a central database. Order picking is a good example for explaining this: the computer management of storage locations, walking routes and current production/parts needs means the provision of a great deal of experiential knowledge. Before AmI technologies (and their forerunners) were introduced, experienced skilled workers were needed to flawlessly handle the complex tasks associated with the frequent product changes on the production line. This knowledge is now centrally stored and made available to the unskilled labourers via their displays. The knowledge is now exclusive, with the expected consequence that workers become increasingly dependent and their work becomes increasingly casual. The separation of work from personal skills and from a comprehensive work experience will result in considerable mental stress as a result of the experience of alienation.

3.2 AmI Is Ubiquitous

The ubiquitous computing accompanying AmI technology refers to the form of computing that is becoming characteristic of the 21st century (cf. [3]). Its essence lies in the omnipresence of information technology owing to wireless and wide-area networking, and in the seamless and invisible integration of this networking into everyday (working) life. At present, mobile workers can still be recognized as such by the notebooks or tablet PCs perched on their knees. By contrast, ubiquitous computing refers to the inconspicuous integration in the background of mobile IT terminal devices which provide access to the ubiquitous IT infrastructure. Wearables of various types are already available on the market. Rather than themselves being the direct focus of human attention as is currently the case, they are instead to form a natural component of a partly virtual objectivity enhanced by IT, which the subject must deal with either consciously or unconsciously. The environment itself becomes the interface. This property, too, is interpreted by the digital avant-garde as a starry-eyed prophecy:

"There is more information available at our fingertips during a walk in the woods than in any computer system, yet people find a walk among trees relaxing and computers frustrating. Machines that fit the human environment, instead of forcing humans to enter theirs, will make using a computer as refreshing as taking a walk in the woods." (cf. [3]).

This assessment is notable for its naive carefreeness, which has more in common with science-fiction fantasies than with the human environment and in particular the working environment in the prevailing power structures. The following digression is intended to describe an essential problem of this assessment, the panoptic nature of AmI:

The panopticum is a concept devised by the philosopher Jeremy Bentham (cf. [5]) for the design of factory workplaces, schools and prisons and which enables a single observer to oversee a large number of people simultaneously. A typical characteristic of a panoptic building was and continues to be the facility for observing persons from a central location. Some traditional factories featuring a raised observation point which cannot be looked into from the workers' workplaces are an example. Common prison buildings feature a central observation tower, from which the cell wings branch outwards. This architectural arrangement enables a guard to observe areas without himself being visible by those he is observing. As a result, not only may fewer guards suffice, which is desirable for economic reasons; it may even be possible to dispense with the guards altogether, either temporarily or permanently. Ignorance of whether or not one is under observation at a given time leads to internalization of surveillance and thereby to an exceptionally economic means of imposing discipline (cf. [6]). Bentham, like other utilitarians after him, believed himself to be on the moral high ground. Michel Foucault later recognized this principle of discipline as an essential aspect of modern society (cf. [7]). Pointedly, the proposition is as follows:

AmI risks becoming the digital equivalent of the panopticum.

As already established, environments become intelligent when they feature a range of sensor equipment which is interconnected and delivers information for interpretation at a central point. In work scenarios, the sensors may register not only the position of the workers, but also their vital data, implicit communication such as facial expressions, and of course periods of time. The worker is thus continually under omnipresent digital eyes, the presence of which he is conscious of to a greater or lesser degree. Mobile IT-supported work involving smartphones, notebooks and similar devices already gives workers grounds to fear that their every step is being monitored and that movement profiles are being generated; this fear sadly is often not unfounded [8]. Whereas a smartphone could at least be switched off (albeit requiring justification later) and an e-mail left unanswered until the next break, the invisibility and potential ubiquity of AmI leads to a total loss of control over the technical artefacts. Unless restrictions are consciously imposed, human beings are entirely at the mercy of AmI and produce data at every step by their mere being. In the opinion of BEIGEWUM, the Austrian Advisory Council for Society, Economic and Environmental Alternatives, the consequence that is to be feared is that the active subject will be degraded to a *forced consumer or occupant of AmI* (cf. [9]). Zygmunt Bauman goes as far as to see in the digitalized post-modern world a postpanoptic system of surveillance and discipline (cf. [10]). This world, he argues, is characterized by the fact that its key equivalents are not directly physically tangible in form (the central server as opposed to the watchtower) and will also not necessarily be tied to a particular location. AmI technologies satisfy these criteria, and could potentially be the digital equivalent of the panopticum in the postmodern world, implementing it by ubiquitous surveillance technologies, the objectivity of which can no longer be observed and the transparency of which progressively decreases.

4 Performance Specification for the Use of AmI Technologies

The formulated proposition and its discussion have revealed a significant risk and the negative potential of AmI technology. At the present time, these technologies are becoming gradually but increasingly widespread in the home and in industrial fields of application. There is still time for governments to act in consciously shaping this technology. In an ethical performance specification, the formulated problems are set against criteria that attempt to solve or prevent them arising. The performance specification is in preparation and can be made available on request even in advance of publication.

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