THE BATTLE OF CONCEPTS: UBIQUITOUS COMPUTING, PERVASIVE COMPUTING AND AMBIENT INTELLIGENCE IN MASS MEDIA.

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ABSTRACT

For the past two decades the concepts of ubiquitous computing, pervasive computing and ambient intelligence have been used to describe the Internet of Things. This paper studies how the three concepts of ubiquitous computing, pervasive computing and ambient intelligence have evolved (or not evolved) through and in mass media. It shows how the concepts have competed with each other in an almost Darwinist way. It suggests that by and large the three concepts are described by the same attributes. However, the success of the implementation of a new concept like ambient intelligence in the established realms of ubiquitous computing and pervasive computing requires a closer link to the public.

Keywords: Ubiquitous computing, pervasive computing, ambient intelligence, mass media, newspaper.

1 INTRODUCTION

In today's technology based environment unobtrusive wireless technology is often described as ubiquitous computing, pervasive computing or ambient intelligence. Xerox introduced the term ubiquitous computing, IBM coined the term pervasive computing and Philips selected the expression ambient intelligence.

It seems difficult to distinguish ambient intelligence from older concepts of pervasive computing and ubiquitous computing, especially if even the creators and sponsors of these terms seem to use them interchangeably:

- The late Mark Weiser at Xerox PARC envisioned in his pioneering research computers not as personal computers, but as a *pervasive* part of everyday life [1] and asked whether the *intelligent agent* was the metaphor for the computer of the future [2];
- Uwe Hansmann, et al. from IBM refer to the slogan "everywhere at anytime" as being – in a nutshell – the goal of both *pervasive* or *ubiquitous* computing, and talk about decentralised *intelligence* [3];
- The Information Society Technologies Advisory Group in the European Framework Program 6 notes that *ubiquitous* computing is one of the key technologies of *ambient intelligence* and that such vision is only possible if *pervasive* networks exist [4].

On the one hand, it has been suggested that the distinction between these terms remain purely academic [5]. On the other hand, there has been critique that ambient intelligence is not clearly distinguished from earlier concepts of pervasive computing or ubiquitous computing and that more effort might be needed to explain the nature of ambient intelligence. [6]

In light of the European Union's research policy in Framework Programme 7 it is justified to review such terms and views, and to sift out the similarities and differences in the past years between the original terms of ubiquitous computing, pervasive computing and ambient intelligence. The purpose of this paper is to show that the battle of concepts of ubiquitous computing, pervasive computing and ambient intelligence also takes place in *daily communication* (section 2). Because the concepts show only marginal differences, the introduction of a new concept is challenging. In the event of ambient intelligence, mass media analysis shows why and where the implementation failed to gain the same popularity as its rival concepts ubiquitous computing and pervasive computing (section 3). The analysis concludes by tentatively suggesting the establishment of own and distinct attributes for a new concept and to not only popularise it through mass media but to also associate it with a popular product or service (section 4).

2 RESEARCH METHOD

2.1 Why Traditional Newspapers Matter

In times of proliferating online services the question might arise why one should research traditional newspapers and not for instance online media. One might also question traditional newspapers as compared to scholarly journals. There are many reasons for focussing such research on traditional newspapers:

First, Gorman and McLean [7] note that although the audience for both US and UK newspapers steadily declined in circulation and readership after World War 2, the New York Times (USA) and the Times (UK) represent important newspapers throughout the 20th Century. They are bought, read and praised for their authoritativeness and comprehensive news coverage, and for serving as records of events. Newspapers have not only experienced changes encouraged by institutional development – i.e. from private forums for political views of the (often) sole owner towards separation of ownership and editorial function – but have responded in the past decade to the challenges of the new media by launching online newspapers. However, according to Gorman and McLean there are also reasons *not* to use online news for the research, but to concentrate on the traditional printed newspapers:

1. there seems to be a trade-off between the need for instant breaking news and accuracy; and
2. the boundaries of news, marketing and advertising become blurred on the Internet as there is often no clear distinction between opinion and factual information.

Publications on ubiquitous, pervasive and ambient technology are very unlikely to be instant breaking news. Speed of such news publication, it is here argued, plays a subordinate role. Whether a newspaper article on such topic is published today or tomorrow is generally irrelevant. What interests is not "quick and dirty" but accurate information. While Internet news is appreciated for its topicality, it might be biased by advertising and marketing. The implementation, for instance, of Radio Frequency Identification (RFID) technology – a technology which is associated with the scope of the researched terms – has been marketed and advertised for the past few years by various supplying and integrating industry players. Thus using non-biased, or at least less biased, information sources such as (traditional) well researched newspapers is important for this analysis to avoid possibly sponsored influence.

Second, Manning [8] refers to Lupton and Chapman who stated that "[n]ews media are vital in mediating between specialised forums for the dissemination of medical and public health research and policy and the wider public". According to these authors, news media generally has the ability to make professional domains accessible to much wider audiences through the public sphere. Grossberg et al. [9] argue that media serves public functions in two essential ways: It constitutes publicity by bringing information out to the open, and it constitutes a key portion of what is called the public sphere.

Aiming for accuracy (as compared to speed) one could argue that analysing the terms in scholarly journals would be more appropriate. Given, however, that ubiquitous, pervasive and ambient technology are very likely to be widely implemented in common products and everyday services in the next few years, reducing the analysis to a limited discussion among experts is inappropriate. Newspapers provide for the explanation of these technical terms to the public sphere. It is argued here that the widespread acceptance of such wireless technology will to a large extent depend on the public opinion and not solely on the experts' views.

In summary, it is argued here that if newspapers

1. are accurate key information sources while on-line news are biased towards the breaking news (authority), and
2. support making professional domains more accessible to public (publicity),

then it is justified to research and analyse newspapers for the concepts ubiquitous computing, pervasive computing and ambient intelligence. Consequently, the next question to answer is which newspapers to analyse.

2.2 Empirical Sample

Gunter [10] regards surveys and content analysis as important research methods for media. He states that survey principles may also be applied to content analysis. He further notes that in putting together the content analysis the researcher must work through a number of stages of measuring and sampling:

First, the empirical sample needs to be determined, i.e. the textual element that is to be counted. In order to examine the common notion and daily use of the terms ubiquitous computing, pervasive computing and ambient intelligence this analysis focuses on technology articles in English written newspapers. Since the researched terms emanated in North America (ubiquitous computing and pervasive computing) and Europe (ambient intelligence) the data collection is limited to newspapers from these geographies. The selection criterion for the newspapers within these geographies is that they (a) are written in English language, (b) are generally considered distinguished newspapers whereby financial, conservative and liberal journalism is selected, (c) potentially have dedicated technology sections, and (d) are preferably internationally available.

Second, the population of content to be sampled needs to be determined. Gunter [10] notes that generally researchers must sample a subset of content since the universe content is too large to be analysed in full. Sampling in content analysis often takes place in various steps. The researcher must determine among others source, parts, amount and period:

1. Source and sample: which content sources need to be sampled, i.e. which particular national or international newspapers are to be selected?
   The following newspapers were reviewed in detail the Times, the Financial Times London and the Guardian for in the United Kingdom; in the United States the N.Y. Times, the Wall Street Journal and the Washington Post; and finally in Canada the National Post (former Financial Post) and the Toronto Star. The latter being a local, but quite widely distributed newspaper.
2. Parts: which parts of the newspaper need to be analysed?
   The Factiva database [11] was searched for the Wall Street Journal and the LexisNexis database [12] for all other seven newspapers. Both databases provide according to statements of the editors the complete hardcopy version of the researched newspapers, excluding pictures and graphs. A wildcard was included for each term to allow a broad search: "ubiquitous comput*", "pervasive comput*" and "ambient intellig*".
3. Amount: what is the amount of editions of each newspaper to be analysed?
   239 articles were retrieved that met the above search criteria. A total of 91 were dismissed. These dismissed articles used the terms to describe relations not relevant for this research, e.g. "ubiquitous computer mouse" or "pervasive computer security viruses". In total 148 newspaper articles remained containing at least one of the researched terms.
   Table 1 shows the eight reviewed newspapers with the amount of articles per researched term. A minor amount of articles containing both terms ubiquitous computing and pervasive computing is referenced twice, i.e. once in each respective column.

Table 1: Unit of Analysis.

Newspapers	**Country**	**ubiquitous computing**	**pervasive computing**	**ambient intelligence**	**Total**
Financial Times London	UK	15	17	1	33
Guardian	UK	9	6	0	14
Times	UK	3	10	2	15
Total UK		*27*	*33*	*3*	*63*
N.Y. Times	USA	19	17	1	37
Wall Street Journal	USA	6	3	0	9
Washington Post	USA	5	6	0	11
Total USA		*30*	*26*	*1*	*57*
National Post	CDN	10	9	2	21
Toronto Star	CDN	1	6	0	7
Total Canada		*11*	*15*	*2*	*28*
Total		**68**	**74**	**6**	**148**

4. Period: the period of time to cover in the survey.
   Newspaper articles were reviewed as far back as 1982. However, the first of the 239 articles containing the wild-carded terms appeared only in 1987 (see section 3.1.2). Newspapers have been reviewed for each full year until the end of 2006.

Third, there might be additional features or *attributes* of the empirical sample about which data are also collected (see section 3.1.1).

2.3 Triangulation in News Media?

Triangulation is a mix of humanistic and scientific research cultures that should replace the divide between qualitative and quantitative research methods [13]. It is a general strategy for gaining different perspectives on the same phenomenon with regard to reliability and validity [14].

One interface that bridges both qualitative and quantitative research methods is coding. On the one hand, Jensen [15] notes that textual output of media has been a central object of analysis in qualitative media studies. Thereby coding can be understood as resource for identifying and retrieving a given

portion of text for examination of structure, qualities or context. On the other hand, for quantitative research code may be taken as an account or representation of a portion of the field of study, capturing certain qualities of (in the case at hand) text for comparison and quantification.

In order to identify and examine the relevant articles and to compare the three terms with one another, the subsequent analysis is based on a qualitative analysis followed by a quantitative analysis. The qualitative analysis gives a chronological view through the three researched terms. But it also focuses on the coded attributes that the authors of the newspaper articles ascribe to them. The quantitative analysis provides the basis for comparing the frequency of the three terms and their pattern of appearance.

3 ANALYSIS

Figure 1 shows the amount of articles published each year on the topics of ubiquitous computing, pervasive computing or ambient intelligence. The first relevant appearances were: 1990 for ubiquitous computing, 1994 for pervasive computing, and 1999 for ambient intelligence. While the amount of article appearances of ubiquitous computing remained quite constant with about 4 articles on average per year as of 1990, sparking an increase around the years 1999 to 2001, there has been an exponential amount of articles referring to the term pervasive computing during the so called dot.com bubble. But the interest in pervasive computing declined as fast as it rose. The average use of pervasive computing per year since 1994 is 6 articles. Finally, the number of articles on ambient intelligence has been relatively low ever since its first occurrence in 1999 with less than one reference in a newspaper article per year on average.

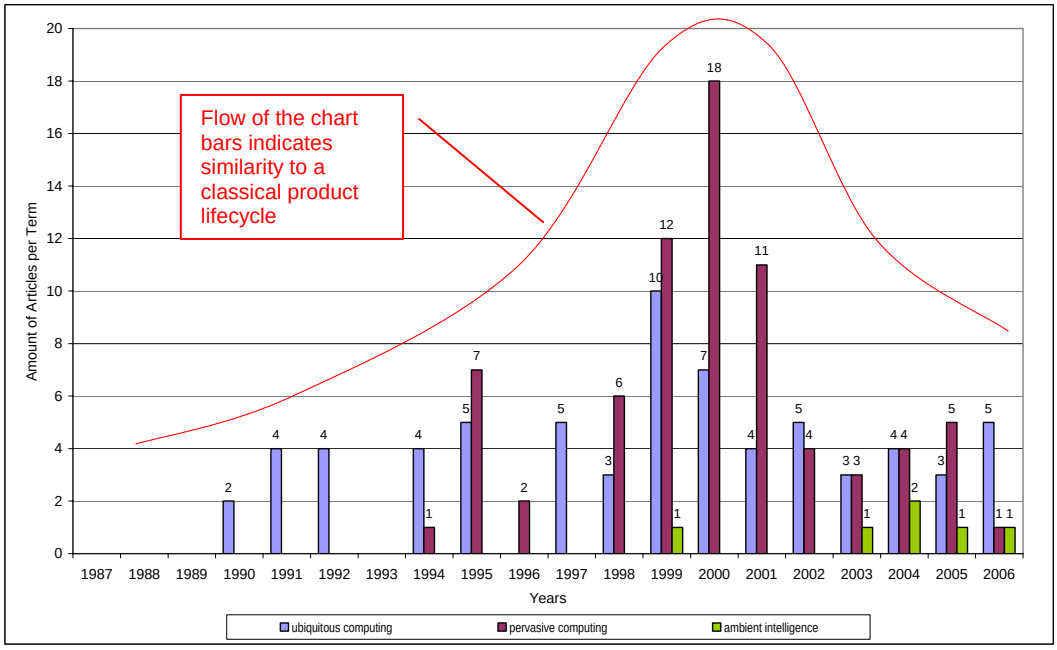

Figure 1: Amount of articles in unit of analysis referencing the researched terms in the years 1990 -2006

The aggregated picture of the three terms resembles the life stages of a product. For analysis purposes the contributions to ubiquitous computing, pervasive computing and ambient intelligence were split into the following 4 phases that compare to that of a product lifecycle:

- Phase 1: 1990 to 1992, "Introduction";
- Phase 2: 1993 to 1996, "Growth";
- Phase 3: 1997 to 2002, "Maturity"; and
- Phase 4: 2003 to 2006, "Decline".

In the past 17 years pervasive computing has been used in fifty percent of the researched newspaper articles, while approximately forty six percent used ubiquitous computing and only about four percent wrote about ambient intelligence (Table 1 and Figure 1). Given that ubiquitous computing was the first of the three terms, and given that this term has been in use seven years longer than pervasive computing the question does arise why pervasive computing became more popular and why ambient intelligence remained unpopular.

3.1 Qualitative Analysis

3.1.1 Introduction

Within the 148 articles (constituting the unit of analysis) the newspaper authors ascribe certain meaning to the three terms ubiquitous computing, pervasive computing and ambient intelligence. The terms have been reviewed for the following attributes:

Attributes	Attribute type
1. Having access *anywhere* at *any time*;	location: "where"
2. Using the technology for *business* or *work*;	
3. Enabling the technology at *home* and for *leisure*;	
4. Deploying the technology through *networks*;	means: "how"
5. Applying *sensor* technology; and	
6. Making the environment *intelligent* and *smart*.	

Two main areas emerge from these attributes: the first three attributes (numbers 1 to 3) touch on the *location* and answer the question "where". The three subsequent attributes (numbers 4 to 6) cover the *means* for such technology and answer the question "how". Each researched term (ubiquitous computing, pervasive computing and ambient intelligence) was interfaced with each of these six attributes.

3.1.2 Ubiquitous Computing

The term ubiquitous computing first appeared in the researched newspapers in 1987. Not in the meaning envisioned by Mark Weiser - and thus not included in the researched articles, but still noteworthy for its early appearance - it was used by Steve Jobs upon decision to build sophisticated, but inexpensive, computers for the higher education market, giving university students and researchers easy access to computing power. Jobs referred to the "Apple II" and noted that it was "a *ubiquitous computing resource* that is powerful, reliable and flexible enough to be used *everywhere* on campus" [own emphasis]. [16] The use of the term in this context obviously relates to desktop computers and not to the wireless communication researched in this paper. But the statement does pick up the concept of computers being ubiquitous and accessible from *anywhere*.

During 1990 and 1994 the term ubiquitous computing was primarily related to miniaturising *office* equipment. The challenge was to design technology that would promote organizational cohesion and that would discover effective processes for fitting technology into the pattern of working life. [17] To such extent, computing would become ubiquitous by computerising life as it is [18] with computers that got smaller and smaller [19], and in the end did not look like computers anymore and were *everywhere* [20]. It was implied that computer power would be on tap like water or electricity. [17]

As of 1994 the notion of extending the dispersion of microchips buried throughout the support stems of terminals and small devices in walls and ceilings of primarily *enterprises* [21] extended slightly to the application of computers into life style items [22]. But the concept of ubiquitous computing was not only moving the information era towards turning virtually everything into a personal computer [23] and embedding computers beyond the *office* also throughout the *home* [24] and for *leisure* [25]. As of the mid nineties the term was also used to address mobile computing [26], especially in Europe where Nokia sold Internet enabled handhelds [27]. The concept of having access to information from any location with any (handheld) device carried on into the new millennium.

3.1.3 Pervasive Computing

As compared to the term ubiquitous computing, the term pervasive computing first appeared four years later in 1994 in the researched newspapers. Novell's Chairman Robert J. Frankenberg outlined his strategic direction for Novell by connecting people to people and to information. [28] Within the next one and a half years pervasive computing was used exclusively in the researched articles in connection with Novell's business enabling people to connect any place at any time [29], i.e. to deliver "information to computer users wherever and whenever they might need it" [30].

After the headline interest in pervasive computing declined, it re-surfaced in 1998 in IBM's post-PC [31] world, meaning that computers were *everywhere*, not just on one's desktop [32]. While one year later Sun Microsystems' pervasive computing philosophy was that "the computer is the network" [33], IBM was more focussed on the device and the appliances [34], such as handhelds, wireless computers, mobile phones. Around the turn of the millennium the interest in pervasive computing grew exponentially. Not surprisingly pervasive computing was declared a buzz word [35] during the peak of the dot.com bubble. The objective during that time was that (consumer) electronic devices had to be constantly connected to the Internet [36] and that one had to always be in touch [37]. The technology hype fostered examples of use from grocery stores [38] over smart fabrics [39] and wearable computers [40] to bio-mechatronics and medical telematics [41].

From the year 2001 onwards the use of the term pervasive computing dropped radically. Until end of 2006 the term was used in the previous manner and it included *sensor* technology [42] but altogether less extensively.

3.1.4 Ambient Intelligence

In 1999 the term ambient intelligence appeared for the first time and – until 2003 – the only time in the researched newspapers. The director of Philips elaborated about the digital *home* and how ambient intelligence could with speech and gesture provide *anything, anytime* and *anywhere*. [43] The use of the term remained wondrously but steadily low in the first years of the new millennium. Ambient intelligence was used for instance to describe technology that disappears into its surroundings [44] as well as a bridge between the real and digital world [45].

3.1.5 Evaluation

Since IBM supported and used the term pervasive computing one could be inclined to assume that the popularity of the term has something to do with the influence of the worldwide largest IT company. While the influence and importance of the sponsoring entity will certainly have fostered the strong status of the term pervasive computing it cannot have been the only factor. For Philips is also a well known and leading international company in the electronics industry. But with six articles since 1999 Philips' ambient intelligence did not at all have such fulminant adoption – at least not in the researched newspapers. So there must be other factors to be considered.

First, one can derive from the newspaper articles that both terms ubiquitous computing and pervasive computing have been used in the contexts of mobile technology such as *mobile phones*, handhelds and wireless computers. According to the International Telecommunications Union (ITU) [46], mobile phone subscriptions in the developed countries have increased from 5.2 mobile phones per 100 inhabitants in 1994 to 76.8 mobile phones per 100 inhabitants in 2004. One can thus infer that the association of the increasing proliferation of mobile phones with which one is connected *anywhere* for both *work* and *leisure* supported the popularity of the terms ubiquitous computing and pervasive computing.

Second, the flow of the chart in Figure 1 shows that the term ambient intelligence with its first newspaper appearance in 1999 missed the wave of the dot.com bubble. The economic and personal setbacks after the dot.com bubble burst at the beginning of the millennium left more than a bitter aftertaste which made it difficult for the term to gain ground. While the interest in the terms ubiquitous computing and pervasive computing declined, it is here argued that there was little chance for the term ambient intelligence to become popular. Public and newspapers lost interest altogether.

Third, one might *speculate* [47], there have been political and force majeure influences during the introduction of the ambient intelligence hindering the proliferation of concept:

1. The term was not created by the authorities but by a (private) entity, namely Philips. This might have lead to resistance by the Brussels authorities to use and push such term;
2. Although there was effort to associate the (private) term publicly by introducing it through University authorities, a strong association with Philips as “creator” of the term ambient intelligence might have remained; and
3. The terrorist attacks of September 11, 2001 might have throttled the use of this ambient intelligence technology. As ambient intelligence is an open concept with open standards and large communications potential, it did not fit into the new and strict security standards introduced after 9/11.

3.2 Quantitative Analysis

3.2.1 Introduction

Figure 2 shows all attributes ("anywhere, any time", “home, leisure", "business, work", "network", "sensor" and "intelligent, smart") for all researched terms (ubiquitous computing, pervasive computing and ambient intelligence) in the researched newspapers over the past 17 years.

Within the three attributes relating to the *means* (“how”), networking appears in 64 newspaper articles and is the most related “how” attribute while sensor technology only accounts for about half as many references (35) and intelligence is attributed in 45 cases. Within the three attributes relating to *location* (“where”), the access through ubiquitous computing, pervasive computing or ambient intelligence shall in the majority of cases be anywhere at any time (58), directly followed by the desire to deploy such technology from home or for leisure (53). The office and the relation to *work* are referenced 41 times within the unit of analysis. The reason for this decline being that the line separating work form leisure is more and more blurred [25]. Working space in the modern office is not confined to an office building anymore, but increasingly takes place for instance at home, at airports or in hotel lobbies. [48]

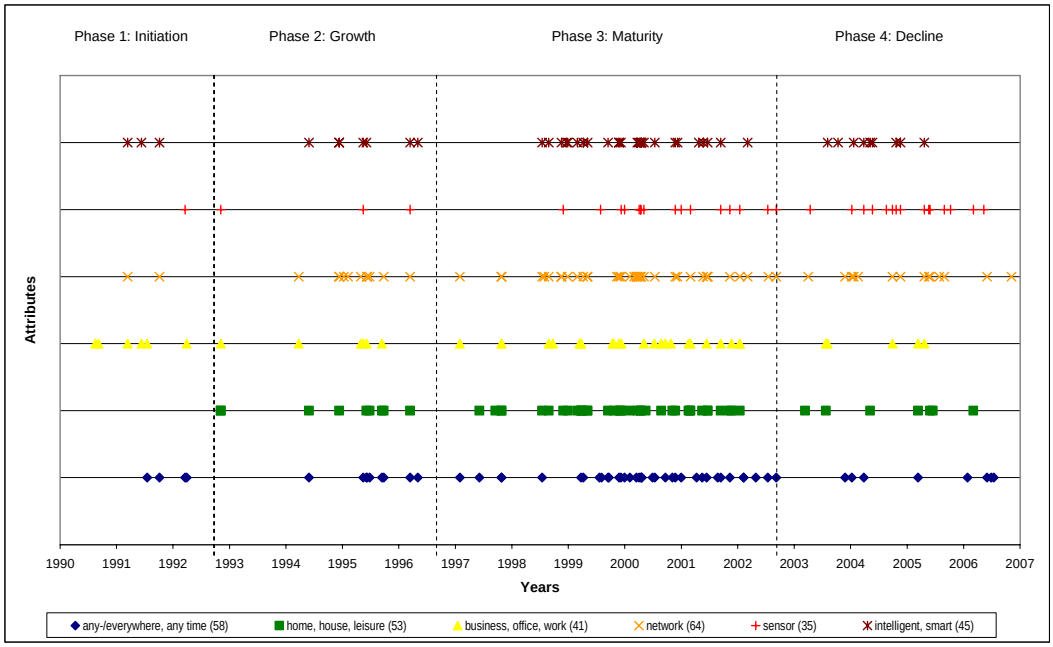

Figure 2: Attributes per year for all three researched terms (in parentheses the aggregate amount per attribute).

In order to discuss the quantitative differences in the attributes (section 3.1.1), the following Table 2 shows the nominal counts and percentages for each attribute:

Table 2: Overview attribute quantities (nominal term count and percentages of total; in italics the most relevant figures by quantity).

	Attribute	**ubiquitous computing**		**pervasive computing**		**ambient intelligence**		**Total**	
		nominal	%	nominal	%	nominal	%	nominal	%
location	Anywhere, anytime	*31*	*53.4%*	*26*	44.8%	1	1.7%	58	100%
	Home, leisure	19	35.8%	*32*	*60.4%*	2	3.8%	53	100%
	Business, work	*26*	*63.4%*	14	34.1%	1	2.4%	41	100%
means	Networks	*23*	35.9%	*39*	*60.9%*	2	3.1%	64	100%
	Sensor	19	*54.3%*	13	37.1%	*3*	*8.6%*	35	100%
	Intelligent, smart	19	42.2%	22	*48.9%*	*4*	*8.9%*	45	100%
	Total	**137**	**46.3%**	**146**	**49.3%**	**13**	**4.4%**	**296**	**100%**

3.2.2 Ubiquitous Computing

As Table 2 shows, within the first three attributes relating to *location* ("where") the access *anywhere* at *any time* (31 referenced articles) is nominally the most important. It is followed by access to information at *work* (26 referenced articles) and finally from *home* (19 referenced articles). By contrast, the attributes relating to means ("how") show 23 references for *network* and 19 articles each for *sensor* and *intelligent* technology.

As compared to the other terms the attribute *work* (63.4%) is still the most relevant, however, followed by *sensor* which is not a location ("where") attribute but a means ("how") attribute. With an overall nominal count of 137 the term ubiquitous computing is on average slightly below one publication per 148 newspaper articles.

3.2.3 Pervasive Computing

Noticeable is the great amount of combinations relating to the deployment of technology at *home* and for *leisure* (26 and 32 references) and especially the decline in *business* and the *work* (only 14 articles) as compared to the corresponding attribute describing ubiquitous computing. Within the attributes relating to *means* ("how") *networking*

stands out (39 references), while *sensor* technology (13 references) decreased substantially compared to the respective attribute in ubiquitous computing.

In this term concept, the attribute *networks* (60.9%) is the most important as compared to the overall attribute appearances. It is followed by home (60.4%) and a second means ("how") attribute *intelligent* (48.9%).

On average, the term pervasive computing is practically present in every researched newspaper article (146 nominal counts on 148 articles).

3.2.4 Ambient Intelligence

Because there were only 6 references by the end of 2006 for the term ambient intelligence a quantitative evaluation is quite difficult. Looking at the distribution of the attributes, those relating to the means attributes ("how"), namely *network* (2 references), *sensor* (3 references) and *intelligent* (4 references) stand out to be more in the focus of interest than the location attributes ("where") *home* (2 references) and *anywhere*, *work* (each with one reference).

Relative to the attributes of the other two terms, the most important attributes for ambient intelligence are *intelligent* (8.9%) as well as *sensor* (8.6%). Third in row is the attribute *home* (3.8%). The term ambient intelligence is on average only mentioned in every 8th newspaper article.

3.2.5 Evaluation

Ambient intelligence is the most difficult term to judge because of the relatively few occurrences of the concept. From the missing presence in the researched newspapers one can infer that ambient intelligence is not a very popular term.

First, the term ambient intelligence – being a European term – was not used so scarcely because more US/Canadian newspapers were researched in the unit of analysis. As Table 1 indicates, from the overall six references to ambient intelligence three were in the UK and three in North America, i.e. evenly distributed. What strikes is not only the limited use of ambient intelligence from 1999 through 2006, but the continuing use of the other two terms ubiquitous computing and pervasive computing even after introduction of the ambient intelligence in 1999.

Second, comparing the results of the individual attribute outputs of the researched terms among each other shows that there is a shift in importance from the *location* attributes ("where") to the *means* attributes ("how") (Table 2): Overall the term ubiquitous computing has more references in the *location* attributes (76 location / 61 means) than the other two terms. The term pervasive computing has an almost balanced focus between both attribute types (72 location / 74 means). And lastly, ambient intelligence shows the shift towards the *means* attributes (4 location / 9 means). This evaluation is also reflected at the single attribute level: ubiquitous computing refers the most to the attribute anywhere at anytime ("where"), while there is a shift in pervasive computing to networking and lastly to intelligence in ambient intelligence ("how").

Third, as compared to these differences at the individual attribute level, the *aggregation* per attribute over the past 17 years does not show significant differences. The patterns in Figure 2 for each attribute are very similar and only reveal marginal variances. It is important to note that the attributes relating to ambient intelligence have only contributed minimally to such patterns. Only 4.4% of the attributes are related to ambient intelligence (Table 2) and they only contribute as of 1999 (Figure 1). Likewise the attributes from 1990 to 1993 only pertain to ubiquitous computing as the term pervasive computing only appeared in 1994. Therefore, all together one can state that the constant patterns of appearance of the attributes in Figure 2 are given by ubiquitous computing and pervasive computing.

4 CONCLUSION

News media have become the modern day forum for the representation of public opinion. [49] It has not been the goal of this research to analyse whether the reporting in the newspapers is accurate and from what evidence it was collected. The goal of this research is to show the diffusion of these new concepts of ubiquitous computing, pervasive computing and ambient intelligence to the public.

First, it is concluded that while there are variances in the use of the attributes pertaining to each researched concept – ubiquitous computing relates more to work environment, pervasive computing relates more to networks, and ambient intelligence relates more to smart/sensor – each of the three terms is described by all six attributes. Thus scientifically there might be a difference between the terms ubiquitous computing, pervasive computing and ambient intelligence. By and large, however, such distinction proves unimportant in the daily use of the terms.

Second, because the concept ambient intelligence was only coined in 1998, it seems obvious that Europeans would have used the established terms ubiquitous computing and pervasive computing before creating its own. Interestingly, however, in the eight years the term ambient intelligence has been in use, the newspapers did not change their language. Nor did the UK newspapers abandon the North American terms ubiquitous computing or pervasive computing. On the contrary, the amount of newspaper articles with the established terms ubiquitous computing and pervasive computing

grew and it seems as though the term ambient intelligence was – to the extent it has been used – only added to the repertoire.

Third, the introduction of a new concept such as ambient intelligence needs not only be accompanied by means that are or will be widely popular (such as a mobile phone), but the general public also needs to be able to relate to such means. Both the qualitative as well as the quantitative analysis have shown that the public makes associations to attributes like *home*, *work* and *networks*. But there is much less reference on dissemination of intelligent sensor technology (as promoted by the concept of ambient intelligence). A new concept should

1. not already be occupied by attributes used in other terms, and
2. it should be associated to a technology that the general public relates to.

This means that the concept of ambient intelligence should especially *not* be used for attributes *anywhere*, *home*, *work*, and *networks* as these are in public well established with the concepts of ubiquitous computing and pervasive computing. It is questionable whether the concept of ambient intelligence could succeed relating to the attributes *sensor* and *intelligence* as these are also – however clearly less – used by the other two concepts. If it is to succeed as term, it is here tentatively argued that such concept for ambient intelligence would need to be associated with a popular product or service that is *understood* by the public (like for instance the diffusion of mobiles by Nokia in Europe).

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