Jaakko Suominen
Antti Silvast
J. Tuomas Harviainen

Smelling Machine History: Olfactory Experiences of Information Technology

Cultural analysis of smells: starting points and promises

Over the past decades, the sensory elements of technology have been acknowledged by a growing number of historical studies. Mainly related to the cultural and more recent affective turn in historical scholarship, these studies have emphasized the experience of interactions with technology, the relationship between the body and technology, and the emotional configurations of technological experiences.[1] In doing so, scholars have, on several occasions, examined the visual, auditory, and tactile features of technological devices. Nonetheless, one of the senses has rarely received attention in these discussions: the sense of smell.

The sensing of smells, scents and odors remains "an overlooked topic of historical inquiry", as historian Connie Y. Chiang put it.[2] One explanation for this is that history often is understood as an area for rationality and reason rather than for sensations and senses. As sensations are individual, they are not thoroughly trusted in scientific inquiry.[3] Philosopher Clare Batty, in her essay about olfactory experiences, notes the smudgy characteristics of smells and argues that unlike other senses "smells are not packaged together in space in such a way that these packages can be distinguished from one other and from a common ground."[4] Indeed, of all the senses, smell is particularly subjective, open to interpretation, and shaped by different social and individual preferences.[5] The neglect of smells in scientific circles may also be linked with the history of the hierarchy of senses. During the antiquities, smell was not highly ranked among the senses and in the 18th and 19th centuries, smell became understood as primitive.[6] Odorlessness, in contrast to scent, belonged to the civilized culture of customs. The rendering of this odorlessness, a process called deodorization, has intensified in society, for example in France since the 19th century.[7]

Another reason for the absence of historical research of smell is due to research material – or rather the lack of it. As Chiang notes, in contrast to sight and hearing "we lack a reliable, widely known instrument or system for the measurement and documentation of smell."[8] The first author of this

---

1   See, e.g., Sherry Turkle, *The Second Self*; David E. Nye, *Electrifying America*; Emily Thompson, *The Soundscape of Modernity*; David E. Nye, *American Technological Sublime*.
2   Connie Y. Chiang, "The Nose Knows", 405.
3   Hannu Salmi, "Onko tuoksuilla ja äänillä menneisyys?" ("Do Scents and Sounds have a Past"), 340.
4   Clare Batty, "Smell, Philosophical Perspectives."
5   Chiang, "The Nose Knows", 405.
6   Salmi, "Onko tuoksuilla ja äänillä menneisyys?", 342–343.
7   Alain Corbin, *The Foul and the Fragrant.*

8   Chiang, "The Nose Knows", 405.

article has studied the cultural history of computing from a plethora of popular media sources, such as newspaper and magazine articles, comics and cartoons, documentary films, and fiction. These sources present various important visual, audiovisual, and tactile elements of information technological experiences. However, rarely is there ever any mention of a computer's cultural or contextual odors, which also are absent from most of the influential history of computing studies.[9]

The sense of smell poses an important topic for historical research and histories of technology, in spite of its minor role in previous discussions, the odorlessness of modernity, and the methodological challenges. In this article, we contend that situations in which information technology is used are linked intrinsically with scents on several levels, even as smells rarely provide affordances for direct interaction with technology the same way as vision and touch do.

Sociologist Anthony Synnott divides smells into three categories: natural (e.g. body odor), manufactured (e.g. perfumes), and symbolic (which refers more generally to the metaphors and language produced by smells).[10] All of these categories, though blurred and interchangeable in practice, can be found in our oral historical material on information technological smell experiences as well. Synnott argues that scents should be studied, not only because they are personal, social, and ubiquitous; but also because they trigger memories – or memories trigger experiences of scents.[11] A smell memory can hence function in the mind "like a key" as social historians Kivistö and Laakkonen point out. A smell opens "the closed compartments of the memory" and sparks impressions and sensations.[12] Thus, from a methodological point of view, the study of scents has a marked, but rarely acknowledged connection to oral history research. Historical studies of how people remember smells – as with all oral history – indicates what people did, wanted to do, and believed to be doing at a particular time. Oral sources bring forth people's imagination, symbols of thinking, and desires.[13] Such data is potentially useful for reconstructing not only scent recollections, but the wider experience of information technology in history.[14]

This article approaches these olfactory aspects of memories of technology by drawing on user experiences while applying a cultural historical framework. Historian Hannu Salmi has insisted on the study of the cultural history of senses and sensations.[15] He proposes that similarly to separating the biological sex and social gender, we can also talk about both biological and cultural senses. The biologically inspired research of senses – in this case particularly the sense of smell i.e., olfaction – studies the functioning of the olfactory organs of humans and animals and the ways in which sensations transmit and are interpreted in the brain, among other things. The research may also

---

9   e.g., Jaakko Suominen, *Koneen kokemus* ("Experiences with Machines"); Steven Levy, *Hackers*, Paul N. Edwards, *Closed World;* Michael S. Mahoney, "What Makes the History of Software Hard", Petri Saarikoski, *Koneen lumo* ("The lure of the machine"); Judy Wajcman, *Feminism Confronts Technology*; Jimmy Maher, *The future was here*.
10   Anthony Synnott, "A Sociology of Smell."

11   Synnott, "A Sociology of Smell", 438, 441. See also Brian Moeran, "Marketing Scents and the Anthropology of Smell", 156–157, David Howes, "Olfaction and Transitition", 132.

12   Jorma Kivistö and Simo Laakkonen, "Näkymätön kaupunki" ("The Invisible City"), 161.

13   Alessandro Portelli, "Mikä tekee muistitietotutkimuksesta erityisen?" ("What does make oral historical research special"), 56–58.
14   Folklorists Outi Fingerroos and Riina Haanpää have named this wider focus as "explanatory oral history research" Outi Fingerroos & Riina Haanpää, "Muistitietotutkimuksen ydinkysymyksiä" ("Key questions of oral historical research"), 37.
15   Salmi, "Onko tuoksuilla ja äänillä menneisyys?".

investigate the differences in sensations across age, gender, individuals or between species: as is well-known, there are several species whose sense of smell is significantly better than that of humans.

Smelling turns cultural when people express and give meaning to their experiences of smells, compare and assess scents in relation to one another, and categorize them into good and bad odors. Some of these valuations can be attributed to biology, but many of these appraisals have changed both historically and culturally.[16] Not surprisingly, some social, environmental, and urban historians have studied olfactory elements and their connections to social structures.[17] As Chiang finds in the United States, for example, in the late 19th century and early 20th century sensory stereotypes connected to smell were used for reinforcing social categories such as ethnicity.[18] Here, we look into user experiences of computer history regarding the sense of smell.

Methodology and data

To generate new understanding about the olfactory history of computing from a cultural point of view, this article presents the results from two large, online inquiries of Finnish computer users and hobbyists, addressing their memories about computing, and collected in 2002–2003 and 2013, respectively. Drawing on these data sets, it explores the question **how people recollect the scents of computers and their use**. It also asks how did people's memories about computing scents change or not change during the ten years between the two inquiries. The aim is to demonstrate how different sensations combine with technological remembering and nostalgia. At the same time, by analyzing sensations and sense, the article opens up important new possibilities and methodological avenues for the critical histories of technology: the article asks how to use online oral historical inquiries in the research of history of technology.

Our research data consist mainly of recollections from the 1980s to the early years of the 2000s. Hence, the majority of the data concerns a period when home and microcomputers were relatively normal in Finnish everyday life and computing was no longer merely the concern of highly trained professionals in business and government organizations, contexts to which we turn next. In practice, only few olfactory remembrances were gathered in the study from the mainframe computer era prior to the 1980s.

Finland, with a population of 5.5 million, is a Northern European state. Considering its history of computing, the country shares many similarities with other Western countries. However, its position as a neighbor of the Soviet Union has also given a distinctive flair to Finnish computing historically.[19]

---

16   To build a bridge between biological and cultural smell research, see Jan Löfström, "Aistit, muistot ja neuroantropologia" ("Senses, Memories, and Neuroanthropology"), 15.

17   E.g. Margaret Morse, "Burnt Offerings (Incense)"; Classen et al. *Aroma,* 165–169, Oddrun Sæter, "The Body and the Eye", 187; Löfström, "Lapsuuden hajut, vanhempien tuokset" ("The Smells of Childhood, Scents of Parents"), Kivistö and Laakkonen, "Näkymätön kaupunki" and Simo Laakkonen, "Asphalt Kids and the Matrix City."

18   Chiang, "The Nose Knows", 408.

19   Petri Paju, *"Ilmarisen Suomi" ja sen tekijät.* ("Building 'Ilmarinen's Finland'").

The earliest digital computers were introduced in Finland in the late 1950s and received significant attention in the national media. Between 1965 and 1966, Finland had an estimated 84 computers in operation in the whole country. IBM dominated the markets for computers. Of these machines, over 60 were located in Helsinki, the Finnish capital. Most of these computers were used in businesses and governmental administration. About 3,000 people worked in what was then called electronic information processing. In 1971, the number of mainframe computers was estimated at 210 and the number of "mini computers" at between 700 and 800. Around 7,200 people were professional users of these computers. By 1977, there was an estimated 5,300 computers operating in Finland and by 1980, to number had grown to 12,700.[20] Nonetheless, only few participants to our study referred to experiences of the mainframe or the mini computer era.

After those dates, the number of computers is even more difficult to estimate, because no exact statistics exist. However, many Finns first used home and microcomputers during the 1980s and, for example, the Commodore 64 computer (1982) gained a key position. According to the importing companies, 600 pieces of the C-64 were sold in Finland in 1982, 7,000 in 1983 and tens of thousands after that. Before 1984, about 20,000 VIC-20 computers and 5,000 Sinclair Spectrums were obtained by Finnish consumers.[21] The C-64 had an estimated 66–75 % market share among home computers in Finland in the late 1980s, but there are no exact data on the total amount of individual machines sold. According to computer magazines, there were approximately 150,000 C-64's in Finland during that decade.[22] PC computers were not popularized in the country until the 1990s.

According to the Statistics of Finland, about 25 percent of Finnish households had a home computer, typically a PC compatible in 1996, but over 50 % in 2001 and 70 % in 2006. Less than 10 % of households had an Internet connection in 1996, almost 40 % in 2001 and over 65 % in 2006. According to Hannu Jaakkola, yearly sales of home and personal computers in Finland was over 165 000 machines in Finland and had increased every year since the early 1980s. However, the sales decreased in early 1990s due to economic depression, but increased rapidly after that: in 1994 over 200 000 were sold, in 1999 over 500 000. [23]Thus one can argue that work places and educational institutions were computerized before households which were more largely computerized during 1990s. Most of our informants situate their smell memories and experiences in the first home computer boom in the mid-1980s or in the diffusion of PC technology in the 1990s.

---

20   The numbers have been collected by the first author and are available online at
http://www.tuug.fi/~jaakko/tutkimus/kronologia.html. They are based on professional journals in particular as well as on discussions with Finnish colleagues specialized in in the history of computing. See also Jaakko Suominen, *Sähköaivo sinuiksi, tietokone tutuksi* ("Getting familiar with the electric brain, getting to know the computer"); Suominen, *Koneen kokemus.*
[21] Markku Reunanen, Petri Saarikoski and Jaakko Suominen, "A Pac-Man Clone for VIC-20 (1984): Learning of Game Programming and Birth of Computer Hobbyist Public Sphere in the Early 1980s Finland".

22   Saarikoski, *Koneen lumo*, 103–105; Petri Saarikoski & Jaakko Suominen, "Computer Hobbyists and the Gaming Industry in Finland".
[23] Hannu Jaakkola has collected the statistical data for his studies of diffusion of information technological devices in Finland, and his numbers are based on information received from computer importer associations and market research companies. See e.g. Hannu Jaakkola, Moncef Gabbouj & Yrjö Neuvo, "Fundamentals of technology diffusion and mobile phone case study".

The empirical material was gathered from among Finns by two online inquiries in 2002–2003 and in 2013.[24] In previous publishing about these studies, both have been referred to as "surveys" or "questionnaires".[25] However, in spite of this format, the data can be seen more widely as oral history material that creates manifold possibilities for exploring the near history of technology user experiences. With this in mind, we use the term inquiry or study here, rather than survey to denote the materials.[26]

The respondents and their genders are summarized in Table 1. As is demonstrated, men were over-represented in both of the studies. This only partly corresponds with patterns of computer use in Finland. Statistically significant gender differences in general computer and Internet use have not existed since the early 1980s, although men remain the majority of academically educated technological experts. In 2006, 88 percent of 18 to 64 year-old females in Finland and 85 percent of males of the same age group said they know how to use a computer. Similar patterns emerge in Internet use: during 2013, 83 percent of the female population and 88 percent of the male population had used the Internet over the last three months. Having said that, 80 percent of Finns with a higher degree in technological disciplines were still men in 2012.[27] In other online surveys and inquiries, women have rather been the majority.[28] The respondents in the studies behind this article were also highly educated and relatively young adults: the majority were 16 to 35 years old in the first study, and 25 to 39 years in the second study.

Inquiry Year / Respondents	2002–2003	2013	Total
Female	179 (24 %)	329 (23 %)	508 (23 %)
Male	515 (69 %)	1,119 (77 %)	1,634 (74 %)

---

24   Both of the studies were coordinated by the University of Turku, Faculty of Humanities, Digital Culture. The first study received funding from the ProAct research program of the Finnish Ministry of Employment and the Economy and the Finnish Funding Agency for Technology and Innovation Tekes. The second study was funded by the Kone Foundation. Results from these surveys have been previously summarized in two Finnish research reports published by the University of Turku: Satu Aaltonen, *Tunteita, tulkintoja ja tietotekniikkaa. "* ("Emotions, Interpretations and Information Technology") and Tiia Naskali and Antti Silvast, *Tietokonekerhoista blogosfääriin, pöytäkoneista älypuhelimiin* ("From Computer Clubs to the Blogosphere, from Desktop Computers to Smart Phones").

25 Antti Silvast, "An Oral History of Programming Practices"; Jaakko Suominen, "Koneen tuoksu" ("Scent of a Machine."); Petri Saarikoski, "Unten maille tietotekniikka kainalossa" ("Going to Sleep with Holding Information Technology"), Aaltonen, *Tunteita, tulkintoja ja tietotekniikkaa"* and Naskali and Silvast, *Tietokonekerhoista blogosfääriin, pöytäkoneista älypuhelimiin.*

26   Cf. articles that use survey material as primary material: Shelley Nickles, "'Preserving Women'" and Lewis H. Siegelbaum, "On the Car Culture in the USSR, 1960s–1980s." On the use of oral historical material as one source of technological historical study, see also Tiina Männistö-Funk, "The crossroads of technology and tradition: Vernacular bicycles in rural Finland 1880–1910". Männistö-Funk refers to her materials as "folklore surveys" and "folklore collection surveys," whose collection begun in Finland in the 1950s.

27   Statistics Finland, Aikuiskoulutustutkimus (Adult Education Research), Statistics Finland, Väestön tieto- ja viestintätekniikan käyttö (The Population's Use of Information and Communication Technology), and Statistics Finland, Tieteen ja teknologian henkilövoimavarat (The human resources of science and technology).

28   Hanna-Kaisa Kousa, *"Sehän on nimenomaan yks matkan nautinto"* ("It is one of the Pleasures of Traveling").

No Gender Given	50 (7 %)	5 (0.3 %)	55 (3 %)
Total	744	1,453	2,197

Table 1. The responders and their genders (percentage of all respondents) in the two online inquiries.

The two studies had a retrospective underpinning which might have made especially males respond. A dedicated and close relation to information technology has been a primarily a male dominated domain in Finland, at least in the early 2000s. The female respondents may therefore have felt that computers and their use were uninteresting for their generational experience or that their own experiences, competence, and knowledge were not valuable enough for the questionnaires.[29]

As is often the cause with online inquiries, it is typical that respondents are selected by so-called theoretical sampling, and not through random or representative probabilistic sampling of the whole population. [30] The call for responses is spread freely through different communication channels and those who respond are interested in the topic one way or another. The key, hence, is the respondent's own motivation. The respondent has also been able to sense that she has some crucial information on the matters studied. These issues link with the methodological traits of oral history in a more general manner. The particular value of oral history research, as Kieran Downes remarks, lies in being "closest to the community (of dedicated technology users)," raising "the significance of subjective, aesthetic impressions of (technological) equipment," and providing "insight into how (...) technology was perceived by this community."[31] Tiina Männisto-Funk characterizes what she calls "folklore surveys" as "valuable sources documenting many practices that otherwise left few traces" and highlights how written memories have provided an "important way of gathering information about the traditional Finnish way of life" in Finland since the 1950s.[32] With these things in mind, however, oral history research does not reveal "what really happened" or "how things really were" – rather, people's memories are one subjective source of historical knowledge among many others and can be shaped by reconstructions, interpretations, and subjectivity, as well as forgetting.[33] As a result, the research becomes historical insight into user experiences rather than quantitative data, even as it may be collected by surveys that contain statistical information.

The first inquiry from 2002–2003 was larger and comprised 70 open-ended and 19 multiple-choice questions. The 2013 inquiry, whose questions partly overlapped with the first, had 29 open-ended and 16 multiple choice questions. The 2002–2003 questionnaire was divided into seven thematic sections: personal information, computing background, attitudes and information seeking with computers, the use of information technology and its physical and mental impacts, the use of computing in communications, games, and computer history. The more recent question form

---

29   In psychological and sociological studies, the male relation to technology is often portrayed as intimate and even loving. This pleasure that men feel towards technology has been seen as a wall against women. Hilde Corneliussen, "'I Fell in Love with the Machine'." Cf. Jaakko Suominen, "The Computer as a Tool for Love".

30   On theoretical sampling in social science research, especially in qualitative methodology, see Pertti Alasuutari, *Researching Culture*, 152–157.

31   Kieran Downes, "'Perfect Sound Forever'", 308–309.

32   Tiina Männistö-Funk, "The crossroads of technology and tradition", 737, n16.

33   Thomas Misa, "Organizing the history of computing", 3; Taina Ukkonen, "Muistitieto tutkimuksen kohteena ja aineistona" (Memory knowledge as a Research Topic and as Data); Silvast,"An Oral History of Programming Practices", 9–10.

likewise asked for personal information and then covered four thematic areas: first computing experiences, current computers, computer use and hobbies, and computing memories. A question about computing smells appeared in both of the inquiries in the same form: "What kind of scents and smells of information technology do you remember? What situations have they related to?"

In the first study, 59 percent of respondents and, in the second, 48 percent had olfactory memories related of computers. This makes 440 responses in the first study, 698 in the second, and a total of 1,138 answers. In both studies, over a hundred persons either answered the question with a hyphen (-) or said that they do not recall any smells related to computers. Others thought that the question was obscure.

The gender difference was also significant: in the two studies, 71 and 52 percent of male respondents, but only 45 and 36 percent of female respondents, had smell memories in 2002–2003 and 2013 respectively. In both studies, younger respondents recalled smells more often than the older respondents, although those older respondents that did remember scents tended to provide more detailed descriptions. The older respondents had experienced the smell of "burning machines" (i.e., breakdowns, discussed below) more often than younger respondents, which may relate to their longer experience with computer use. All in all, however, it is beyond this study to theorize why not everyone responded to the question about smells – a number of other reasons are possible and the respondents were not required to explain why they left said question unanswered.

In general in data collection, scents and smells may emerge spontaneously, even though these memories are not separately asked. This is because scents are commonly linked to certain environments such as the city.[34] On the other hand, the "cultural odorlessness" of technical equipment[35] could have caused the effect in which smell memories about computing were not activated in the reminiscing situation. Culture of supposed odorlessness appears then in answers.

Even with those who did recall scents, the descriptions of the olfactory elements of computing varied from their length and other qualities. The responders were coarsely categorized to "non-tellers," "list makers," "analyzers," and "scent experts" when analyzing their responses. The *non-tellers* (41 % of all responders in the older study, 52 % in the newer one) either left their response empty or were confused by the question, as noted above.

The *list makers* made up 36 percent of smell recollectors in the 2002–2003 study (no gender differences were visible) and 49 percent in the 2013 study (with men over-represented); typically they mentioned one or more smells that they could think of but did not tell more specifically anything about the background of their smell experience.

Between 2002 and 2003, there were more *analyzers* than list-makers, i.e. 58 percent of those who recalled a smell. However, in 2013, the number of analyzers stood at 30 percent, which was less than the list makers. These subjects described more specifically the situations related to smells or the causes of the odor.

---

34   Kivistö and Laakkonen, "Näkymätön kaupunki", 152.
35   Morse, "Burnt Offerings (Incense)".

Finally, the *scent experts*, who comprised only 5 to 6 percent of the smell recollectors in both of the studies, could make even more specific distinctions about the causes of odors and their properties.[36] It is these scent experts and analyzers and the details of their recollections that are in focus in the remainder of the article.

We pay specific attention to how some smell memories were depicted as more personal (e.g. feelings of nostalgia, experiences of breakdowns), while other computing smells were almost indistinguishable from the environment where they had occurred (e.g. situation and place, other people, working). This is in line with user experience research in general, and emphasizes the way in which the same questions can inspire people to report both item and context related experiences.

Item smell experiences

Scents of disruption

One respondent, a 26-year male, could clearly make specific distinctions about the causes of odors, their properties, and the actions, learning, and occurrences that related to machines. This became evident during a dramatic breakdown that he described:

> "In the late 1980s I made my own joystick for the [Commodore] Amiga that then caused a small short circuit. I can mainly recall the faint broccoli-like burning smell. The stench was in fact so strong that I (luckily) managed to save the machine in time." (Man, 26 years-old, 2003)

The quotation shows that smell memories can be connected to some earlier experiential anomaly, deviance, or unfamiliarity. Jan Löfström proposes that "mundane, ubiquitous smells are often not registered on the conscious level. Or at least the experience of those smells is not stored in the 'memory storage' in a place from which the individual primarily draws upon when 'retrieving data' while recalling the past i.e. consciously constructing impressions about the past."[37] A specific anomaly is also that the respondent compared a burning smell to broccoli and stated that it was unlike anyone other smell.

A lack of familiarity may feel pleasant or unpleasant, but expressions of strangeness explain whether users have previously been in an exceptional place or gotten to know technological phenomena that are new to themselves. Smell, for example, remains in one's mind when it has been somehow related to an exceptional event such as purchasing a novelty, facing it, or the destruction of the machine.

Many scholars have noted how technology becomes visible in the moment of break-down, which thus opens the technological black box.[38] One of the most typical common computer smells in the responses, particularly among older respondents and in the 1980s and the 1990s although not that

---

36   On human ability to recognize smells, see Diane Ackerman, *A Natural History of Senses*, 5; Synnott, "A Sociology of Smell", 440.

37   Löfström "Lapsuuden hajut, vanhempien tuoksut", 242.

38   Latour, *Reassembling the Social*; Paul N. Edwards, "Infrastructure and Modernity"; Antti Silvast, *Anticipating Interruptions*; Susanna Paasonen, "As networks fail: Affect, technology, and the notion of the user"; Trond Lundemo, "Why Things Don't Work", 13.

much later, was the so-called "smell of magic smoke": an unpleasant stink caused by burning or smoldering compounds. This scent was not usually related to the everyday use of computers, but rather to dramatic, although sometimes predictable, exceptional situations. On the other hand, the "normal" smell of a heated machine that had been used for long was also identified as "burning." Many respondents recalled stories about short circuits and breakdowns of computers, which manifested as smoke and the smell of burned components and plastics.

Burning, smoke, or related smells were mentioned by 59 percent of those who recalled computing scents in the earlier study, 34 percent in the second, with men recalling these smells slightly more often than women, while the older recollecting said odors more often than the younger respondents in both of the studies. It is telling that breakdowns smelled much "less" often now, according to the informants, which we reflect on below. In sum, this indicates either that computer technology and the risk of its physical breakdown is becoming less conspicuous in everyday life or that the respondents contained many active tinkerers of their computers in the 1980s and the 1990s.

The smells described in the data are broadly associated with three situations: the deployment of a new machine, the breakdown of some part of a machine, and normal situations of use.[39] In "normal use," the scent of a machine has not been noted because the user has become accustomed to it or the scent has been absorbed in the environment. According to Marks, we often use the sense of smell to survive, to recognize, for example, dangers related to food, gas or even to technology.[40] Smoke, smog, taste, color, and bad smells especially earlier brought risks such as pollutants to the public attention, albeit such indicators have been increasingly removed by processes such as the chlorination of water.[41]

Hence, instead of nostalgia, the scent memory can be associated with traumatic or unpleasant experiences. As was stated above, the purpose of the "magic smoke" narratives might be to describe exceptional situations, foreshadowing the risks of computer use and even boasting about risky behavior.

> "No-one can forget the smell when the PC machine lets its steams out… The smell is horrible and doubtless even dangerous to the person that has to deal with the stink. Luckily, current factory smokes are no match for the original ;-P" (Man, 54 years-old, 2013)

There are examples in other fields, for example industries like manufactured gas, where citizens have criticized odors and smells as "nauseating," "offensive," or a "nuisance," which has then contributed to the creation of fines and injunctions that reduce these bad smells.[42] Perhaps a similar development is behind why both computers and their breakdowns now "smell less" to people than before. This observation extends even further to smells that could have been, more or less, purposive. Some respondents (of the 2013 data) knew of the strong and peculiar "Apple smell":

---

39   Aaltonen, *Tunteita, tulkintoja ja tietotekniikkaa (Feelings, Interpretations and Information Technology)*, 109.
40   Marks, "Thinking Multisensory Culture", 130.
41   Richard E. Jackson, "Recognizing Emerging Environmental Problems".
42   Joel E. Tarr, "Toxic Legacy".

"Apple's new machine packages have a fairly strong odor when opened," as a 33 year-old man said in the 2013 inquiry. In online discussions and journalistic articles, however, it has been noted that these kinds of computing scents can generate nausea or even allergic reactions, as some i.e. the scent sensitive, react to strong scents intensely.[43] That the sensory elements of computers are becoming more "neutral," to a certain degree, is apparent here and was also suggested by the findings from the two inquiries ten years apart.

Nostalgia triggered by smells

In spite of the typicality of illustrations of traumatic – or sometimes heroic (in the case of e.g., overclocking) – break-down situations, describing smell experiences seems to have been a positive experience for many respondents. In addition, bad smells may have been nostalgic in some situations. As mentioned above, positive experiences were frequently linked with obtaining or using new technology. In this sense, the data contained a specific kind of *new technology smell* that was most often – but not always – described as pleasant and lingering, a special experience. This seems to be an actual smell and not merely a nostalgic retrospective reconstruction. This scent was mentioned by 22 percent of all the respondents that recalled scents in 2002 and 2003, and 16 percent in 2013; in both cases, somewhat more often by male than a female respondents. As with breakdowns, one notes a historical change here: the share of people who remember that new technology smells of anything at all seems to be waning and the remembrances that people now have are more laconic, less analytical, than ten years before.

The earliest that these sort of box opening smells appear were in the early 1980s' home computers, but there were also more general or more recent connection, like the aforementioned "Apple smell."[44] Nevertheless, the shift towards the use of (new) home computers also meant a shift to more personal smell experiences.

> "The basic smell of new electronics when you open the package. I will forever remember what my first Commodore 64 computer smelt like when the package was opened. Nothing matches that. Well maybe fresh sweet rolls." (Man, 26 years-old, 2003)

A realistic sense perception about the chemical-induced scent of a new product turns to cultural reminiscence when the subject starts to explain, distinguish, and assess the scent experience. A description by a 25 year-old woman in 2003 is interesting because in her instance, the breeze of novelty connects to an entire lifestyle or epoch: "the smell of new plastic when you buy a new machine or a component … is reminiscent of technology, evolution, progress." To the respondent, as for a few others in the data, the smell of new plastic is the metonymy of the technological system; it is a peep-hole or part of a larger whole.

---

43   See, for example, Asher Moses, "Rotten smell raises Apple toxin fears".
44   While a few older respondents recollected the smell of mainframe computing centers, as we note below, there were no recollections about transporting and installing new mainframe computers and what that smelled like. However, such situations of appropriating new technology have been amply documented in photographs.

Additionally, because this refers precisely to a *new* plastic and component smell, the scent for its part signifies going forward, progress, and evolution that concern the individual user as well as the technologized society. This is probably what Synnott means when he writes about symbolic scents.[46] It is also comparable with the debate about specific technologies or materials being symbols of progress and certain eras.[47]

The data shows that opening up new products is not an insignificant and pointless, mundane situation. Marketing researchers have drawn attention to the sensory traits and smell design of greeting a new product, which has been utilized, for example, in the auto industry, and in shopping malls and department stores.[48]

The quotation from the 26-year-old man also shows how involved a subject may be when recalling a past novelty, in this case the symbol of a whole computer hobbyist generation, the Commodore 64. Once again, the response can be explained, at the same time, within the context of use in a specific era and the cultural logic of smelling. Even though the quotation does not clearly demonstrate this, the opening of the box of the novel Commodore was probably charged with strong prior expectations. Expectations were quite possibly that high because the subject knew about the popularity and the possibilities of the Commodore. Another possibility is that the popular historic flagpole status of Commodore has retrospectively made the opening of the package so significant that the subject wanted to relate this in the inquiry – even if in practice, the scent created by opening the package would not have been exceptional or any different than opening any other box containing a machine.

Referring to the scent of sweet rolls is a comical effect added to the comment, something that brings the respondent back to the ground, to reality, where technology is not supposed to exhibit a remarkable and pleasant smell, unlike a fresh sweet roll, whose mention is a reference to a (non-technological) world of nostalgia. The subject distinguished "hard technology" and "soft cozy everyday life." Synnott argues that the primary role of scents in society is aesthetic.[49] In this sense, descriptions about fragrant machines and box openings are aestheticizing and their authors might have directed themselves towards a beautiful and harmonic expression, which deepens the experience of beauty that is connected with scents.

Further, the scent of a machine at the other end of its life cycle – both realistically and symbolically – was seen as worth mentioning by at least some of the respondents. Notes about old technology, typically a dusty machine were, however, rarer than descriptions of novelty. Nonetheless, one could suppose that a mature technology has a specific scent that the subjects did not deem as good. Old computers may have a certain "smell of death" that is commonly associated with people, sickness

---

46   Synnott, "A Sociology of Smell."
47   See e.g. Eric Schatzberg, Wings of Wood, Wings of Metal, 44, 56–63. See also Suominen, *Koneen kokemus*, 32.
48   See for example Ann Marie Fiore, Xinlu Yah, and Eunah Yoh, "Effects of a Product Display and Environmental Fragrancing on Approach Responses and Pleasurable Experiences" and Deborah Mitchell, Barbara E. Kahn, and Susan C. Knasko, "There's Something in the Air".

49   Synnott, "A Sociology of Smell", 453.

and rotting and whose complete removal is an essential part of defeating illness, disinfecting.[50] Even if the death of computers smells different than that of living creatures, it nonetheless exists:[51]

> "A new computer smells of novelty and an old one reeks of burning dust." (Woman, 28 years-old, 2003)

Environmental Smell Experiences

The scent of technology environment

Some scents are associated with a particular location like a work place, a school, home, or an event. Basically, a division into item-related (e.g., device, packaging) and environmental (e.g., people, context, ventilation) can be observed from the responses. This section focuses on these environmental smell experiences. Their content can be coarsely divided to two further categories, computer-based and human-based smells.

The quotes in the data about computer-based smells were highly versatile. They, like other smells, were difficult to categorize. Their historical change makes the categorization even more difficult: as has already been mentioned, current computers smell less than they once did. Salmi claims that the sense of smell is often associated with the inability of explaining which sensation is in question.[52] Marks, in turn, notes that smell appears to be the least transferable and translatable of all senses. At the same, it is the most personal sense.[53] Low writes about the sense of smell as "the mute sense," whose sensations are difficult to described but which cannot be turned off, unlike other senses. It is possible to shut one's eyes and ears, but scent is sensed with every breath, even if you hold your nose.[54]

This is also visible in the computing data: many respondents write, for example, about the smell of silicon, electricity, plastic or ozone. The scent of the "scentless" is described by comparing it to something else, whose scent is as difficult to classify. Older respondents in the first study recalled the scent of the sterile and dry air of mainframe computer centers in particular. Many also mentioned the smells of printers, diskettes, ink, and paper. Thus, all of the answers portray specific periods and changes in computer use environments and with technologies. Low remarks that scents are typically described through other senses, for example as weak or as strong (cf. sense) or as sweet or sour (cf. taste).[55]

In addition to scents directly related to computers, their accessories and functioning, people also described such scents that machines had acquired after long-term use. These are those signs of technology's death or its anticipation that were already referenced above. These scents were associated in the depictions, for example, of cigarettes or dust, and they were commonly portrayed

---

50   Corbin, *The Foul and the Fragrant*, 90; Salmi, "Onko tuoksuilla ja äänillä menneisyys?" ("Do Scents and Sounds have a Past?"), 356.

51   On death of machines and machine relations, see Jaakko Suominen, "Hurma, himo, häpeä ja hylkääminen" ("From Fascination to Rejection.").

52   Salmi, "Onko tuoksuilla ja äänillä menneisyys?" ("Do Scents and Sounds have a Past?"), 248.

53   Marks, "Thinking Multisensory Culture", 126.

54   Low, "Ruminations on Smell as a Sociocultural Phenomenon", 399.

55   Low, "Ruminations on Smell as a Sociocultural Phenomenon", 399.

as negative. These smells can be named as *peripheral smells* and which can be used to define the thing as unpleasant, if the ingrained smell is not somehow familiar and pleasant to the user. Mentions of these kinds of stenches were, however, much rarer than descriptions of smoking or burning:

> "One time I rented a Sega Megadrive home console. It smelt of cigarettes. Yuck." (Man, 33 years-old, 2003)

User and place related smells

Human-related "computer scents" were likewise predominantly negative. However, such scents were mentioned by only 8 to 9 percent of those who remembered smells. In many of the other categories, men recalled scents better than women, however, here the situation was reversed. Between 2002 and 2003, 12 percent of women respondents and 7 percent of men respondents reported human-based scents. The difference was similar, but smaller in 2013: 6 percent of females and 5 percent of males recalled user smells. Older respondents also described such smells slightly more often than the younger in the first study, though the difference was smaller in the newer survey. The mentions might have remained rare because human-based scents and smells were perhaps not seen as related to computing but rather outside of it, as general and obvious factors that were not necessary to mention in the inquiry.

Human-based smells were connected with sweat and other secretions. Human-based scents and smells are often related to everyday life situations, although even these scents have exceptions – or situations, where the routines of smelling are broken, for example when moving from one space to the other:

> "The home of my acquaintances had a peculiar smell. I visited there because he needed a lot of my advice about using the computer. We were not friends otherwise. Whenever I entered their hallway, I got this feeling that this is an alien world and in this house I only have a specific function." (Man, 29 years-old, 2003)

In this response, the experience of unfamiliarity and otherness is connected with an original "foreign world" smell, which the subject does not describe in greater detail. He does not directly say that it was bad, but apparently the respondent did not feel himself at home with the smell, which. in its own way denotes that the smell was bad.

In many descriptions of smelling users, a gender difference was visible: users who smelt bad, if their gender was mentioned, were without exception described as men. Both male and female respondents wrote about male computer users that smelt bad. For example, a 25-year-old woman in 2003 marked that the university's common computer room "smells simply bad" if "the room has had too many men in the area working on exercises". Sometimes the scent emanated not from others but oneself: a 33-years-old man in 2013 spoke in a sarcastic tone about not showering in a three-day LAN's and game JAM's and returning home to his wife.

In the 2002–2003 study, women mentioned these smells slightly more often than men, though in 2013 their shares were about the same. Nonetheless, the older result at least indicates a gendered difference between the good-smelling self and the bad-smelling 'other'. The smell defines the group and the individual and is transmitted during social interaction.[56] Poor personal hygiene has been particularly linked with stereotypical descriptions of male nerds[57] and its shows how a passionate user has, like Joseph Weizenbaum has defined it, a compulsive character, in contrast to the civilized norm.[58] Whereas after exercise it is at least normal, if not completely acceptable, to smell of sweat (good sweat), after computer use, which is considered non-physical, this kind of deviant deodorization is not as acceptable (bad sweat). Whereas the former is seen as achieved, the latter type of sweat is perceived as negligent.

On the other hand, bringing up male hackers' smell can precisely be a gendering categorization. Synnott notes, referring to Kipling, that men are in a way supposed to smell of cigarettes, alcohol, and sweat; where as women must smell good, clean, and attractive. According to Synnott "the politics of scents and smells" does not only concern genders, but also social classes and ethnic groups that are distinguished and ranked according to smells.[59]

Gendered smell memories can again be explained by physiological, as well as by cultural factors, or be seen through the perspective of concrete history of use and logic of recalling. Articulating male smells in the study can mean repeating nerd stereotypes and strengthening them: nerdy men are portrayed as what they are "supposed to be like." It may also be the case that in the computer class there have been more men, even though the users who have sat for long in the classroom may have smelt regardless of gender. In this sense, the response may indicate a certain period's gendered traits of computer use and studying. What might have been at stake is the stronger sweating and scent of the male gender, the attribution of all strong sweating to the males in the room, or that bringing out the possible smell of women were considered less appropriate than of men.

In addition to gender with male-populated common computer rooms, it is also worth considering questions of spatiality. The ideal of technology use, in addition to certain social traits, is increasing privatization and individualization. The goal is to own your machine and use it individually, a factor that as increased exponentially with ubiquitous computing and mobile technologies. Due to this, the "bad smell" of the computer class signifies for many recollectors a by-passed phase of computer use, where computers and their use environment had to be shared with other users.[60] Getting a personal device was an act of deodorization of technology. Indeed, a woman in her 40s mentions this directly in the newer inquiry:

---

56   Low, "Ruminations on Smell as a Sociocultural Phenomenon", 398.
57   See for example Tanja Sihvonen, "Hakkerius vs. rakkaus." ("Hackerism vs. love"). On the change of nerd imagery and "good" vs. "bad" nerds, see Lori Kendall, "'White and Nerdy'". See also Turkle, *The Second Self*, 183–218.
58 Joseph Weizenbaum, *Computer Power and Human Reason*, 116.
59   Synnott, "A Sociology of Smell", 449–452. See also Low "Ruminations on Smell as a Sociocultural Phenomenon", 402 and Classen et al. *Aroma,* 162-169. Low, 403, notes that many even bad smells are accepted if their source is known (e.g. strong cheese). On male "heavy" scents and female "lighter" and "finer" scents see Löfström, "Lapsuuden hajut, vanhempien tuoksut", 249.

60   On the relation between individualization, civilizing process, and smells, see Corbin, *The Foul and the Fragrant*, 101 – 102.

> "The sweat and heat of computer rooms in schools -> by the way, this is an excellent reason to purchase your own computer." (Woman, 42 years-old, 2013.)

The smell of work

Though a basic difference between human-based and computer-based environmental smells can be made, we can, in addition, illustrate a more ambiguous third class that can be named as the *smell of work*. The smell of work can be related to intensive computer use or gaming and the "bad air" that follows, but this is, surprisingly, linked to positive things. If the user spends long days in front of the computer, he or she must take care of their bodily needs. From this, computers are associated with certain outside scents that are often viewed as positive. They relate to food, drinks, and stimulants – pizza, hamburgers, coke, often coffee or cigarettes, in this case in a positive sense – sometimes even the wet summer air. Approximately 7 percent of respondents had these kind of scent experiences in 2002 and 2003, with 5 percent reporting similar results in 2013, while older respondents had them slightly more often than the younger (13 % of over 40 and 6 % of under 25 in 2002-2003, 3 % of over 40 and 2 % of under 25 in 2013).

> "Moist summer air, the nightly coding sessions of youth." (Man, 33 years-old, 2003).

Even though this description and others about eating in front of the computer and taking coffee breaks relate to fulfilling bodily needs, they are also social rituals which link individual computing experiences to the broader context of computer use or Finnish work. Certain food and drink are again signs of the nerd culture, but coffee breaks and smoking can relate to the characteristics of intensive work, the needed breaks, and thinking work, which have a significantly longer history than the age of microcomputers.

Discussion and Conclusions

hajamuistoihin vaikuttavat luonnollisesti sekä muisteltavan ajankohdan konteksti sekä muistelukonteksti ja muistelukonteksissa mahdollisesti muistelun kohteelle määrittyvä kulttuurisen markkerin rooli.(tms.)

By examining the historical, cultural, political, and economic dimensions of sensations and senses, the article poses a methodological and theoretical contribution to the cultural history of technology. This contribution posits a novel, sensory dimension to the history of technology by means of a user experience memories method. Through this method, we argue that scent memories are affected by the context of the reminiscent period and the context of remembering itself, as well as the cultural marker of the object of memory. Based on our results, we propose that the smell landscape of information technology can be divided to two broad categories: item smell experiences and environmental smell experiences. These main categories can be further divided to scents of disruption and nostalgia triggered by smells; whereas the latter subdivides to the scent of technology environments, user and place-related smells, and smell of working with computers. .

The following computing scent landscapes can be illustrated based on people's memories and by comparing them in the 2002–2003 and 2013 inquiries. The study made it clear that the smell landscape of using a microcomputer in the 1980s is different than the situation of the computer class in the 1990s. These differences in spaces of use and technological concern not only machines, but also, for example, printing equipment, storage media, and the requirements of temperatures and humidity levels in the facilities. In the same manner, they may be linked to requirements about personal hygiene or differences among the share of men and women as users of computers.

While the computer users of the 1960s and the 1970s have vivid images of "dry" computing centers, the 1980s' experience begins from a new machine or opening a game package, which is mixed with the "specific smell" of the Commodore 64, Commodore Amiga, or other home computers that have been turned on for a long time. At the turn of the 1980s and the 1990s, the smell environment is marked by heating, television-smelling monitors as well as the scent of 5 ¼ floppy disks and their packages, ink jet printers, and later more often by laser printers. All the while, the computing smell landscape has contained smells of users, the food and beverages of the users, the opening of new packages, ingrained dirt, and overheated computers. The history of the smelling microcomputer is about as long as the history of the microwaved pizza. The source of the computing smoke might have changed and the results highlight the outcomes of a certain era's hobby, failures of overclocking the processors of PC computers, and the resulting "factory smokes." Smells therefore evolve on time dimensions of different durations.

As for the current computing olfactory landscape, the clearest difference between the two investigated periods has to be about how much less information technology now creates odor according to the subjects. Overall, fewer respondents recalled computing scents in 2013 than they did in 2002 and 2003. Reminisces of computer smells had become less analytic and more list-like than before. Further, there were fewer visible gender and age differences among the rememberers. The same waning of memories is true for particular kinds of smells: both with the positive "new computer smell" and more derogatory "burned computer smell," the share of subjects who remembered these smells had clearly declined between the two studies.

Our use of online inquiries as oral historical materials and their theoretical sampling do not afford systematic quantitative comparisons of the two studies from 2002-2003 and 2013, respectively. However, more qualitatively, the two studies do clearly indicate how much less information technology now creates odor according to the respondents.

Several factors may have contributed to this decline of computer odors. Citizens' and consumers' worries and complaints about "offensive" technological smells have been influential with provisions as diverse as water supply and the gas industry;[61] with computing, worries about nausea and allergies being caused by the "new computer smell[62]" can be as big a factor as impending fears about computer breakdowns and whiffs of potentially toxic "factory smoke." Another possible influence concerns the increasing mass production and standardization of computers: perhaps the diversity of possible sensations is reduced as computing infrastructures have become more

---

61   Tarr, "Toxic Legacy" and Jackson, "Recognizing Emerging Environmental Problems."

62   See for example Asher Moses, "Rotten smell raises Apple toxin fears".

standardized, little by little. Then, one main avenue for future history of technology studies on olfactory memories is to focus systematically on technical smells, component manufacture, and history of materials, which we could not fit into this article.

However, even if computers now smell less, it should be stressed that other scents associated with computers did not become less recognizable between the two studies. Human-based scents and the odors of work and places – the school computer room, computer parties, food and drinks, and related things – were still remembered as often in 2013 as they were ten years earlier. Perhaps this is because perceptions and expectations about smells have a longer life cycle than many physical technological artifacts do. Shared habits such as working hard at the computer and taking a coffee break seem to persist in people's memories, even as technologies and their smells change. Indeed, these conventional and interpreted sides of smells may even receive more attention than before as information technology becomes more and more "deodorized."

Bibliography

Archival Sources

Data from the inquiry "Milloin kuulit ensimmäistä kertaa tietokoneista?" ("When did you First Hear about Computers?"), in Finnish, 2002-2003 (744 respondents). In possession of the University of Turku, Digital Culture.

Data from the inquiry "Tietokonekerhoista blogosfääriin, pöytäkoneista älypuhelimiin: Kokemuksia tietokoneharrastamisen arkipäiväistymisestä" ("From Computer Clubs to the Blogosphere, from Desktop Computers to Smart Phones: Experiences about Domesticating Computer Hobbies"), in Finnish, 2013 (1453 respondents). In possession of the University of Turku, Digital Culture.

Published Sources

Aaltonen, Satu. *Tunteita, tulkintoja ja tietotekniikkaa. "Milloin kuulit ensimmäistä kertaa tietokoneista?"-kyselyn tuloksia. ("Emotions, Interpretations and Information Technology: Results from the Survey "When Did You First Hear about Computers?)* Turku: University of Turku, 2004.

Ackerman, Diane. *A Natural History of the Senses*. New York: Vintage Books, 1991.

Alasuutari, Pertti. *Researching Culture: Qualitative Method and Cultural Studies*. London: Sage, 1995.

Batty, Clare. "Smell, Philosophical Perspectives." In *Encyclopedia of the Mind* edited by Harold Pashler. London: SAGE.

Boym, Svetlana. *The Future of Nostalgia*. New York: Basic Books, 2001.

Chiang, Connie Y. "The Nose Knows: The Sense of Smell in American History." *The Journal of American History* 95, no. 2 (2008): 405–416.

Classen, Constance, David Howes, and Anthony Synnott, eds. *Aroma: The Cultural History of Smell.* London: Routledge, 1994.

Corbin, Alain. *The Foul and the Fragrant: Odor and the French Social Imagination*. Translated from French by Miriam L. Kochan, Roy Porter, and Christopher Prendergast. Cambridge, MA: Harvard University Press, 1986.

Corneliussen, Hilde. "'I fell in love with the machine'. Women's pleasure in computing." *Information, Communication & Ethics in Society* 3 (2005): 233–241.

Downes, Kieran. "'Perfect Sound Forever': Innovation, Aesthetics, and the Re-making of Compact Disc Playback." *Technology and Culture* 51, no. 2 (2010): 305–331.

Edwards, Paul N. *The Closed World: Computers and Politics of Discourse in Cold War America*. Cambridge, MA: MIT Press, 1996.

Edwards, Paul N. "Infrastructure and Modernity: Force, Time and Social Organization in the History of Sociotechnical Systems." In *Modernity and Technology*, edited by Thomas Misa, Philip Brey and Andrew Feenberg, 185–225. Cambridge, MA: MIT Press, 2003.

Fingerroos, Outi. "Muisti, kertomus ja oral history -liike." ("Memory, Narrative, and the Oral History Movement.") In *Medeiasta pronssisoturiin: Kuka tekee menneestä historiaa?*, edited by Pertti Grönholm and Anna Sivula, 60–81. Turku: Turun Historiallinen Yhdistys, 2010.

Fingerroos, Outi & Haanpää, Riina. "Muistitietotutkimuksen ydinkysymyksiä" ("Key questions of oral historical research"). In Muistitietotutkimus: Metodologisia kysymyksiä, edited by Outi Fingerroos, Riina Haanpää, Anne Heimo ja Ulla-Maija Peltonen, 25–48. Tietolipas 2014. Helsinki: SKS.

Fiore, Ann Marie, Xinlu Yah, and Eunah Joh. "Effects of a Product Display and Environmental Fragrancing on Approach Responses and Pleasurable Experiences." *Psychology & Marketing* 17, no. 1 (2000): 27–54.

Försti, Teija. *Vauhtikausi. Autoilun sukupuoli 1920-luvun Suomessa* (The Age of Speed: Automobility's Gender in the 1920s Finland). Doctoral dissertation. Turku: University of Turku, 2013.

Howes, David "Olfaction and Transition." In The Varities of Sensory Experience. A Sourcebook in the Anthropology of Senses, edited by David Howes, 128–147. Toronto: Toronto University Press 1991.

Jaakkola, Hannu, Gabboj, Moncef. & Neuvo, Yrjö 1998. Fundamentals of technology diffusion and mobile phone case study. Circuits, Systems and Signal Processing, 17, Issue 3 (May 1998), 421–448.

Jackson, Richard E. "Recognizing Emerging Environmental Problems: The Case of Chlorinated Solvents in Groundwater." *Technology and Culture* 45, no. 1 (2004): 55–79.

Kendall, Lori. "'White and Nerdy': Computers, Race, and the Nerd Stereotype." *Journal of Popular Culture* 44, no. 3 (2011): 505–524.

Kivistö Jorma and Simo Laakkonen. "Näkymätön kaupunki. Hajujen historia muistojen kuvaamana." ("The Invisible City: The History of Smells Represented by Memories.") In *Näkökulmia Helsingin ympäristöhistoriaan. Kaupungin ja ympäristön muutos 1800- ja 1900-luvuilla*, edited by Simo Laakkonen, Sari Laurila, Pekka Kansanen, and Harry Schulman, 152–163. Helsinki: Helsingin kaupungin tietokeskus and Edita, 2001.

Kousa, Hanna-Kaisa. "Sehän on nimenomaan yks matkan nautinto": matkailijoiden tiedonhankinta internetissä ("It is one of the Pleasures of Traveling: How Travelers Obtain Information from the Internet"). Unpublished master's thesis of Digital Culture. Turku: University of Turku, 2010.

Latour, Bruno. *Reassembling the Social: An Introduction to Actor-Network-Theory*. Oxford, UK: Oxford University Press, 2005.

Lundemo, Trond."Why Things Don't Work: Imagining New Technologies From The Electric Life to the Digital." In *Experiencing the Media: Assemblages and Cross-overs*, edited by Tanja Sihvonen & Pasi Väliaho, 13–28. Turku, University of Turku 2003.

Low, Kelvin. "Ruminations on Smell as a Sociocultural Phenomenon." *Current Sociology* 53, no. 3 (2005): 397–417.

Löfström, Jan. "Lapsuuden hajut, vanhempien tuoksut" ("The Smells of Childhood, Scents of Parents"). In *Arjen säikeet – aikakuvia arkielämään, sivilisaatioon ja kansankulttuuriin*, edited by Bo Lönnqvist, 234–254. Jyväskylä: Atena, 2000.

Löfström, Jan. "Aistit, muistot ja neuroantropologia" ("Senses, Memories, and Neuroanthropology"). *Elore* 17, no. 1 (2010): 12–16.

Maher, Jimmy. *The Future was Here: The Commodore Amiga*. Cambridge, MA: MIT Press, 2012.

Marks, Laura U. "Thinking Multisensory Culture." *Paragraph* 31, no. 2 (2008): 123–137.

Mitchell, Deborah J., Barbara E. Kahn, and Susan C. Knasko. "There's Something in the Air: Effects of Congruent or Incongruent Ambient Odor on Consumer Decision Making." *Journal of Consumer Research* 22, no. 2 (1995): 229–238.

Misa,Thomas. "Organizing the history of computing: 'Lessons learned' at the Charles Babbage Institute." In *History of Nordic Computing 2,* edited by John Impagliazzo, Timo Jarvi and Petri Paju, 1–12. Berlin: Springer .

Moeran, Brian. "Marketing Scents and the Anthropology of Smell." *Social Anthropology / Anthropologie Sociale* 15, no. 2 (2007): 153–168.

Morse, Margaret. "Burnt Offerings (Incense). Body Odors and the Olfactory Arts in Digital Culture" A Paper presented in ISEA2000 conference, Forum des Images, Grande-Galerie Nouveau, available online: http://www.thing.net/~jmarketo/textsby/incense.shtml.

Moses, Asher. "Rotten smell raises Apple toxin fears." *The Sydney Morning Herald,* 2 October 2008, available online: http://www.smh.com.au/news/technology/biztech/rotten-smell-raises-apple-toxin-fears/2008/10/02/1222651250932.html.

Männistö-Funk, Tiina. "The crossroads of technology and tradition: Vernacular bicycles in rural Finland 1880–1910". *Technology and Culture* 52, no. 4 (2011): 733–756.

Naskali, Tiia & Silvast, Antti. *Tietokonekerhoista blogosfääriin, pöytäkoneista älypuhelimiin – kokemuksia tietokoneharrastamisen arkipäiväistymisestä* ("From computer clubs to blogosphere – experiences on computer hobbyism becoming mundane"). Pori: University of Turku, 2014. Available online: http://urn.fi/URN:ISBN:978-951-29-5747-7

Nickles, Shelley. "Refrigerator Design as Social Process in the 1930s." *Technology and Culture* 43, no. 4 (2002): 693–727.

Paasonen, Susanna. "As networks fail: Affect, technology, and the notion of the user." *Television & New Media*. Published online before print October 8, 2014, doi:10.1177/1527476414552906.

Paju, Petri. *"Ilmarisen Suomi" ja sen tekijät. Matematiikkakonekomitea ja tietokoneen rakentaminen kansallisena kysymyksenä 1950-luvulla* ("Building 'Ilmarinen's Finland': The Committee for Mathematical Machines and Computer Contruction as a National Project in the 1950s"). Annales Universitatis Turkuensis C 269. Turku: University of Turku.

Reunanen, Markku, Saarikoski, Petri & Suominen, Jaakko. "A Pac-Man Clone for VIC-20 (1984): Learning of Game Programming and Birth of Computer Hobbyist Public Sphere in the Early 1980s Finland." Forthcoming.

Saarikoski, Petri. *Koneen lumo: Mikrotietokoneharrastus Suomessa 1970-luvulta 1990-luvun puoliväliin*. ("The Lure of the Machine. The Personal Computer Interest in Finland from the 1970s to the mid-1990s") Jyväskylä: Jyväskylän yliopisto, 2004.

Saarikoski, Petri. "Unten maille tietoktekniikka kainalossa: unimuistot ja tietotekniikan arkipäiväistyminen." ("Going to Sleep with Holding Information Technology: Sleep Memories and the Domestication of Information Technology"). *Tekniikan Waiheita* 29, no. 4 (2011): 26–38.

Saarikoski, Petri & Suominen, Jaakko (2009): "Computer Hobbyists and the Gaming Industry in Finland." IEEE Annals of the History of Computing, July-September 2009 (vol. 31 no. 3), 20–33.

Sæter, Oddrun. "The Body and the Eye: Perspectives, Technologies, and Practices of Urbanism." *Space and Culture* 14 (2011): 183–196.

Salmi, Hannu. "Onko tuoksuilla ja äänillä menneisyys? Aistiympäristöjen historia tutkimuskohteena" ("Do Scents and Sounds have a Past? The History of the Sense Environment as a Research Object"). In *Kulttuurihistoria. Johdatus tutkimukseen*, edited by Kari Immonen and Maarit Leskelä, 339–357. Helsinki: SKS, 2001.

Schatzberg, Eric. *Wings of Wood, Wings of Metal. Culture and Technical Choice in American Airplane Materials, 1914-1945*. Princeton, New Jersey: Princeton University Press, 1999.

Siegelbaum, Lewis H. "On the Side: Car Culture in the USSR, 1960s-1980s." *Technology and Culture* 50, no. 1 (2009): 1–22.

Sihvonen, Tanja. "Hakkerius vs. rakkaus. Tietokoneharrastajan intohimot, ihmissuhteet ja identiteetit populaarielokuvan kuvaamina" ("Hackerism vs. love: The Passions, Human Relations, and Identities of Computer Hobbyists as Portrayed in a Popular Movie"). In *Digirakkaus*, edited by Ulla Paunonen and Jaakko Suominen, 111–126. Turku and Pori: Turun yliopisto, 2004.

Silvast, Antti. *Anticipating Interruptions: Security and Risk in a Liberalized Electricity Infrastructure*. Doctoral thesis, University of Helsinki, Department of Social Research, Sociology. Helsinki: University of Helsinki. Available online: http://urn.fi/URN:ISBN:978-952-10-7683-1

Silvast, Antti. "An Oral History of Programming Practices: Gender and Age Dynamics and Digital (Dis)Engagement Among Computer Programmers in Finland." *Human Technology* 11, no. 1 (2015): 4–29.

Statistics Finland, Aikuiskoulutustutkimus ("Adult Education Research"), 2006.

Statistics Finland, Väestön tieto- ja viestintätekniikan käyttö ("The Population's Use of Information and Communication Technology"), 2009.

Statistics Finland, Tieteen ja teknologian henkilövoimavarat ("The Human Resources of Science and Technology"), 2012.

Suominen, Jaakko. *Sähköaivo sinuiksi, tietokone tutuksi. Tietotekniikan kulttuurihistoriaa* ("Getting familiar with the electric brain, getting to know the computer. Cultural history of information technology"). Jyväskylän yliopiston Nykykulttuurin tutkimuskeskuksen julkaisuja 67. Jyväskylä: University of Jyväskylä, 2000.

Suominen, Jaakko. *Koneen kokemus. Tietoteknistyvä kulttuuri modernisoituvassa Suomessa 1920-luvulta 1970-luvulle* ("Experiences with Machines. Computerised Culture in the Process of Finnish Modernisation from the 1920s to the 1970s"). Tampere: Vastapaino, 2003.

Suominen, Jaakko & Parikka, Jussi. "Sublimated Attractions – The Introduction of Early Computers in Finland in the late 1950s as a Mediated Experience." *Media History* 16:3 (August 2010), 319–340.

Suominen, Jaakko."Koneen tuoksu. Tietotekniikan kulttuurihistoriaa haistelemassa." ("Scent of a Machine. An Olfactory History of Information Technology") *Tekniikan Waiheita* 29(2011): 4, 5–25.

Suominen, Jaakko. "The Computer as a Tool for Love – A Cultural History of Technology." Yearbook 2010 of the Institute for Advanced Studies on Science, Technology and Society. Edited by Arno Bammé, Günter Getzinger and Bernhard Wieser, 139–159. München and Wien, Profil, 2011. Available online: http://jaasuo.files.wordpress.com/2011/05/ifz_y-b-_10_suom_22_5.pdf

Suominen, Jaakko. "Hurma, himo, häpeä ja hylkääminen. Kaarroksia konesuhteissa." ("From Fascination to Rejection: Life-Cycle of Techno Affairs") In *Digirakkaus II*. Edited by Petri Saarikoski, Ulla Heinonen, Riikka Turtiainen, 17–32. Kulttuurituotannon ja maisemantutkimuksen koulutusohjelman julkaisuja XXXI. Pori: Turun yliopisto, 2011.

Synnott, Anthony. "A sociology of smell." *Canadian Review of Sociology & Anthropology* 28, no. 4 (1991): 437–459.

Tarr, Joel A. "Toxic Legacy: The Environmental Impact of the Manufactured Gas Industry in the United States." *Technology and Culture* 55, no. 1 (2014), 107–147.

Thompson, Emily. *The Soundscape of Modernity: Architectural Acoustics and the Culture of Listening in America, 1900-1933*. Cambridge, Massachusetts, London, England: The MIT Press.

Turkle, Sherry. *The Second Self. Computers and the Human Spirit.* Twentieth Anniversary Edition. Camridge, Massachusetts, London, England: The MIT Press, 2004.

Ukkonen, Taina. "Muistitieto tutkimuksen kohteena ja aineistona" ("Memory Knowledge as a Research Topic and as Data"). *Elore* 7, 1 (2000), http://www.elore.fi/arkisto/2_00/ukk200.html

Veenis, Milena. "Consumption in East Germany. The Seduction and Betrayal of Things." *Journal of Material Culture* 4, no. 1 (1999): 79–112.

Wajcman, Judy. Feminism Confronts Technology. London: Polity Press.

Wasiak, Patryk. "Playing and Copying: Social Practices of Home Computer Users in Poland During the 1980s." In *Hacking Europe*, edited by Geerz Albers and Ruth Oldenziel, 129–150. Berlin: Springer, 2014.

Weizenbaum, Joseph. *Computer Power and Human Reason. From Judgement to Calculation*. San Francisco: W. H. Freeman and Company, 1976.