

# Human-Computer Interactions in Contemporary Office Environment

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**Abstract.** The article is a voice in the discussion on ergonomics and efficiency in the operation of ITC devices in the context of the office environment and its ongoing changes. Increased mobility which followed technological advances is redefining office work. With the restraint of having to create designated workstations lifted, the possibilities of work-related interaction became more diverse, creating new chances but at the same time also design challenges.

Which aspects of the workspace have proven to be effective in creating a good work environment? Proper temperature and humidity, daylighting, aesthetics, greenery and an interesting view outside are the top of the list; but is there really a single answer to that question? Even within one industry, requirements regarding the optimal workspace may differ, depending on the task at hand. This should be a hint that maybe flexibility and diversity of spaces made available to the employee is the best solution to that problem.

In the first part of the article we explain how the office environment has evolved into what it is today, showing the most important factors influencing that change.

The second stage of the analysis centers around the tools employed in working mobile, focusing on displaying their current limitation and usability in the work-related context.

**Keywords:** Office environment · Productivity

## 1 Introduction

Office buildings and, on a smaller scale, office spaces are a particular type of facilities that have emerged as a result of work specialization, driven by the goals of lowering costs and increasing productivity—being a fine example of economy of scale—starting from allotted divisions within a company to handle specialized task like managing archives, or accounting, and ending with a whole new industry called BPO (business process outsourcing).

The conceptual approach to designing office spaces is closely tied to advancements in technology and management theory. The shift from traditional cellular offices was clearly related to mass production, because the creation of large quantities of identical goods has lead to attempts to standardize and optimize.

The research performed by Frederic Winslow Taylor at Bethlehem Steel has inspired the management consultants that followed to try to apply the same ideas that comprised the so-called scientific management to office work. The experiments were successful—open space was indeed more effective in terms of utilization of floor space, as no space was wasted on partitions and doors, and its openness allowed the managers to get a snapshot view of the whole floor at any given moment, giving them a sense of having control.

After World War II, product lifetimes have gotten shorter due to fashion-driven product design and there was much more data to be processed in the office. Around 1960 Robert Propst at the Herman Miller Research Corporation had conducted a lengthy study, came to the conclusion that in this new data-intensive reality an office worker would benefit from individual private space to process that data, and designed a special type of furniture system, called the Action Office. It was quite elaborate but unfortunately also too expensive, and therefore not that design but a much cheaper version of it has taken the world by storm in the form of the much-despised cubicles.

Then, in the eighties, another paradigm shift took place in management. U.S. companies were outperformed by Japanese and eventually started importing foreign management concepts such as JIT (just in time), and *kaizen*. Production, accounting, management—everything had to be *lean*. Big hierarchical management structures had to be dismantled and small *agile* teams were formed instead. As a result, workplace design had to include an ever increasing amount of collaboration spaces, where those small task groups could work. And that brings us to the office environment we have today, where collaboration not only is still a key aspect, but has reached a new level.

## 2 The Office Environment of Today

Office work is not what it used to be just a few decades ago. Thanks to better network connectivity, distributed systems, miniaturization of computer devices, and a largely electronic flow of documents, there barely is a need for a dedicated office space for an employee anymore. As long as the computing tools were stationary or hard to move around, the concept of the workstation was thriving and ergonomists were tasked with trying to figure out the best relation between the user and the equipment: the monitor, keyboard, desk, and seating instrument. Although this research is still valid, work-related interaction with computers has become more diverse.

Now, a designated workstation is just one of the places where work can be performed on a computer. Other places include: the company's canteen, a café around the corner, open teaming areas, focus areas, a library, or different rooms, some of which look more like they belonged in a fancy club and not in an office business. Portability of computing devices makes that possible but doesn't explain the cause. Why such a great variety of spaces is being provided? Flexibility and creativity are the keywords that can help to shed some light on this phenomenon.

In the survey of emerging real estate trends in 2013 conducted by PwC and the Urban Land Institute [2, p. 45] respondents, when asked about office property types in perspective, have pointed out that “long-term investors are looking for mixed-use angles [...] business space intertwined with lifestyle uses”, and that the occupiers are interested in campuses, returning to cities, and not just “being stuck in an office in the middle of nowhere”. The surrounding facilities grow in importance—employees want to be able to get to work on bikes or “hang out in quirky cafés at lunchtime”.

The report [2] showcases the TMT sector (technology, media & telecommunications) as being quite a special case with regard to tenant requirements and expectations, when compared to more traditional sectors such as banking and finance, since much more emphasis is put on creativity, and creative spaces, i.e. spaces that support and help to express the creativity of the employees.

The surge of creativity came with the DotComs at the end of the XX century, when a big idea and a vision of exaggerated and unsubstantiated network effects at an unknown moment in the future was all it would take to attract money from VCs. We know how that ended, but the culture of creativity did not burst along with the bubble.

An article [1, Table 1] mentions several papers from years 1999–2006 that discuss the influence of office environment characteristics on creativity, listing such factors as:

- plants in the office inspiring employees,
- variation in colors,
- multi-discipline groups,
- informal meetings (80 % of the creative ideas are said to come from them),
- coffee lounges to stimulate those informal meetings,
- spaces for meetings and interaction,
- creating breaks with toys,
- sharing desks to stimulate new ideas.

Increased mobility and connectivity has made it possible to work from basically anywhere, and in order to collaborate with others directly one could meet for example at a café. So, is there still a need for a company office? Yes, for many firms an office building is a sign of prestige and a strong branding message. Furthermore, management may be concerned that a café is not the best place to discuss some sensitive projects, because it is less secure than the office. A solution to that problem would be to open a café in the office building itself, so that employees won’t have to use outside services. But in result this leads to the company basically competing with all the fancy places equipped with Wi-Fi where workers could have met instead of meeting at the company. As it was phrased in the CBRE report [4, p. 3], “smart organizations recognize the need to provide a great workplace experience for their employees by creating an environment where they *want to be* rather than where they *have to be*”.

Peter Greenspun [6] wrote, that (paraphrased): “your success in the IT business depends on the extent to which programmers will practically live in your office”. But to make that happen, the facilities must make the employee feel very

comfortable and relaxed, include home cinema, pinball, a piano—everything that an individual might not afford to install at his house and that would increase social bonding at work, giving a stronger sense of community. All spaces should also allow for ad hoc sharing of knowledge, because genius might strike unexpectedly. Hence, IT company premises start to resemble university campuses, one reason for it being that in case of younger employees they may in fact be competing against real university campuses.

ITC businesses are fighting for top talent and if one of them provides extraordinary workspace attractions, making its offices a great place to work, others start feeling the pressure to match or beat that offer. As it turns out, the most important factor when deciding upon a job is flexibility. According to CISCO Global Trends Report 2010, “3 of 5 workers would choose jobs that were lower-paying but had leniency in working outside of the office over higher salaried jobs that lacked flexibility”. On the other hand, if the provided facilities were great, employees would be more likely to stay and work inside the office.

IT and media companies are at the forefront of this undergoing change in office environment, due to their strict reliance on creativity resulting in undertaking attempts to boost it, but offices in other, more conservative sectors also start to follow suit. One cause for that are real estate consulting companies that monitor closely what concepts are being successfully implemented in offices and then try to suggest or implement them in other businesses. A good example of that is CBRE Workplace Strategy, who develop solutions that link business strategy to workplace initiatives.

The other cause for change in workspace is the omnipresence of sustainable building assessment systems. Employee comfort and well-being is becoming a very important factor in those systems. Those systems are all quite similar, LEED and BREEAM being most popular. Let us look at the DGNB System, which was created in Germany and starts getting traction worldwide. The DGNB System [8, p. 15] presents a catalog of evaluation criteria for new office and administrative buildings. A table divides them into sections: Environmental quality (ENV), Economic quality (ECO), Sociocultural and functional quality (SOC), Technical quality (TEC), Process quality (PRO), and Site quality (SITE). It may come as a surprise to some that the most populated section is the one regarding sociocultural and functional quality (SOC), and not the environment (ENV), despite the evaluation systems being commonly described as “green certificates”. Thus, the well-being of users is of great relevance in the assessment. The following criteria are included in the SOC section:

- Thermal Comfort,
- Indoor Air Quality,
- Acoustic Comfort,
- Visual Comfort,
- Occupant Control <sup>1</sup>,
- Quality of Outdoor Spaces,

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<sup>1</sup> Occupant Control—meaning of course the ability of occupants to control thermal and other conditions in the rooms, and *not* monitoring employees by the management.

- Safety and Security,
- Access for All (i.e. universal access),
- Public Access,
- Cyclist Facilities,
- Design and Urban Quality,
- Integration of Public Art,
- Layout Quality.

As we can see, points are being awarded not only for assuring psycho-physical comfort, but also for the quality of outdoor spaces, layout, design, and even integration of art. With building assessment being so ubiquitous, new office development will have to take those aspects into account in order to get a high score and proof of high quality at the same time.

### 3 Usability and Portability of Devices

As much as has been said about flexibility and mobility being the driving force behind current changes in the office environment, the mobility of the tools being used is still quite limited, or more accurately: the portability of the right tools required for a non-trivial tasks is. The barriers in the evolution of work concepts are not architectural but technological.

There is a productivity gap between desktops/laptops and smaller computing devices. Smart phones and small tablets are undoubtedly mobile, because they can fit into the pocket and therefore be easily carried around practically anywhere, but on the other hand they are almost useless for doing most “serious work”, and by serious work we mean performing tasks such as:

1. editing a complicated spreadsheet,
2. developing and compiling a computer program,
3. doing a side-by-side comparison of two documents,
4. writing a chapter of a book or a report.

The first two tasks show how limited the capabilities of those highly portable devices are. As long as they only run simplified versions of desktop applications under the control of special-purpose operating systems (and because of that), they cannot be considered a viable general replacement for desktop and laptop computers, even after the other issues are addressed, and the device has sufficient processing power (many of them already have). It is the choice of architecture that has the most impact on what software tools will be available on a given platform, limiting user’s selection.

It is impossible to perform the third task on smaller devices simply due to the small form factor of their displays (all other tasks are affected by this as well), and it is probably the hardest problem to overcome. For a device to be truly portable and accessible anytime, anywhere, it would have to fit into a pocket—the device would have to be less than 3.5” (for a shirt pocket) or 5” wide (for a jacket pocket), that being the shorter dimension, while the longer edge could be

roughly about 1.4 times that. Therefore, only the bigger version of the device would make comparing two texts side-by-side doable, barely, and only under the assumption that line lengths would not exceed 80 characters, give or take. In the old days it was considered good practice to keep code line lengths under 80 characters, because the standard terminal was  $80 \times 25$ , but nowadays many software projects do not honor that rule, taking advantage of usually quite large desktop displays used for development.

What would be a good solution to this problem, other than having to use for example a full-size laptop? In the case of the device fitting into a jacket, having a screen that folds in half and was originally 10" wide would be a good start. Unfortunately the shirt pocket display wouldn't be wide enough even when built from two pocket-sized parts. A possible answer could be a display made of thin elastic film with shape memory that can be folded multiple times and that returns to the original shape when taken out of the pocket.

In the case of screen size, the more is generally the better, especially for software developers. For this group of users even a 15" laptop screen would be considered small, but still acceptable on the go if no other choice is available. Jeff Atwood [9] once wrote, that one can never have too much screen space, and suggested using a setup with not even one but multiple large monitors. If one was to follow that advice, it would basically mean a come back to stationary desktop workstations. So the user would still be free to roam company premises, enjoying the creativity-boosting facilities, but actual coding would have to be performed at a designated place.

The last task is related to text input. We can disregard speech interface (it is distracting others, too ambiguous, and not expressive when it comes to input symbols: it is unclear whether something is a word, a symbol, or a control sequence) and handwriting (it is expressive but has too much variation in general, requiring the input handling software to be extremely context-aware). That leaves us with the keyboard as the most reliable method for text input, with a one-to-one relationship between input and output symbols.

The on-screen virtual keyboard available on mobile devices is a poor substitute for the traditional keyboard for a few reasons. First of all, it lacks tactile feedback—by comparison, when operating a physical keyboard, during key presses and while hovering fingers over it the brain receives sensory feedback from the fingers and the shape of the keys instantly tells if the finger “registered” correctly on the center of the key, or if it was moved a bit to the side, and which side that was. While it is possible to provide audible feedback from a virtual keyboard, passing on all that extra information, like offset, would come at the price of the sound becoming too complicated to decipher. Therefore, such finger position information is usually not presented and, as a consequence, the user can be less confident when using such an input method.

The problem is more widespread. Over the recent years we could observe a rapid reduction of tactile feedback in the design of devices—from the flattening of keyboards to replacing buttons with a “touch” interface. Touch, but not feel, one could add, because the primary and often only feedback received is visual.

Physical buttons, sliders, or dials available in the older generation of equipment provided greater control and, what is very important, could be easily operated by a person with impaired vision. They were also of benefit to anyone who did not want to avert their eyes from whatever they were doing in order to look at the interface. It is deeply concerning to encounter examples of flat, attention-grabbing interfaces being used on automobile dashboards. But let us return to the office setting.

In addition to the lack of tactile feedback, the on-screen keyboard is simply too small, when compared to a physical keyboard in which the main block of keys alone is almost 12" wide. And finally, a virtual keyboard obscures the premium space of the already small display. To solve this dilemma, external bluetooth keyboards are sometimes used. To have the best of both worlds, foldable keyboards have been manufactured, such as the 4-part foldable Stowaway keyboard from the good old days of Palm and PocketPC.

The use of a full-size physical keyboard brings big productivity gains. Fast typists, like pianists, don't look at the keyboard while typing. After months of practice with a keyboard its general layout is memorized along with many common short series of key presses (recalling what finger combination handles them best, what are the displacements between key coordinates, etc.), and they can be combined into longer, fast passages almost unconsciously.

Foldable keyboards are the portable counterpart of the traditional keyboard, but even a small deviation from the traditional layout may generate usability problems. For example one customer that bought a Verbatim Wireless Bluetooth Folding Keyboard on Amazon wrote in a review [10] that he had to return it because he just could not get used to it. The actual experience is interesting:

The fatal flaw [...] is the keyboard layout. It is sort of laid out like a standard keyboard, and they tried to make up for its size by making the letter keys larger and the number and function keys smaller. Even so, the relative positions are off slightly from a standard keyboard, and not all the letter keys are the same size. The V key for instance is twice as wide and the adjacent B key. The 1 key is centered of the W, not slightly to the left of the Q, that's where the escape key is on this one. Also the tiny backspace and tab buttons throw me off and I find I often am hitting keys I don't intend.

The examples discussed show that efficiency-preserving portability is still an open issue of HCI, with no clear solution, because productivity and portability are often opposite goals. This makes desktops and laptops still the best choice for involving, non-trivial tasks, even when it comes at the price of reduced mobility.

## 4 Conclusion

As we have seen so far, the office environment has evolved over the course of the XX century, with the last generation of workplaces putting strong emphasis on flexibility, various types of collaboration, comfort, and promoting creativity.

When the new kinds of office spaces offered are related to the creative thought process and social interaction, the use of computers can be an orthogonal issue, because it does not have to influence the layout. There are however companies experimenting with an organizational culture imposing special types of HCI, such as firms in which the employee, or even the director, does not have his own desk but can instead use whatever “hot-desk” terminal or conference room he desires that is available at the moment, or can alternatively connect to the corporate network from the outside. Most of the space in such offices is open space, with a few added team work and conference rooms, leaving HR and accounting as the only closed areas with limited and controlled access.

Whether such experiments prove successful in different office sectors, remains to be seen. Nevertheless, both architectural surroundings and the design of interfaces have a great impact on the type, quality and efficiency of work that can be done, and therefore are an integral part of studying the changing contemporary office environment.

## References

1. Vink, P., de Korte, E., Blok, M., Groenesteijn, L.: Effects of the office environment on health and productivity 1: effects of coffee corner position. In: Dainoff, M.J. (ed.) HCII 2007 and EHAWC 2007. LNCS, vol. 4566, pp. 157–162. Springer, Heidelberg (2007)
2. PwC and the Urban Land Institute: Emerging Trends in Real Estate Europe 2013. PwC and the Urban Land Institute, London (2013)
3. CBRE: Poland Office Occupiers Survey—What’s Next? 2013. CBRE, Warsaw (2013)
4. CBRE: The evolving Workplace. How U.S. Office Space is Changing. CBRE Research and Consulting, July 2014
5. Davis, M.C., Leach, D.J., Clegg, C.W.: The physical environment of the office: contemporary and emerging issues. In: Hodgkinson, G.P., Ford, J.K. (eds.) *International Review of Industrial and Organizational Psychology*, vol. 26, pp. 193–235. Wiley, Chichester (2011)
6. Greenspun, P.: Managing Software Engineers (2002). <http://philip.greenspun.com/ancient-history/managing-software-engineers>
7. CABB: The impact of office design on business performance, CABB (2005)
8. DGNB: Excellence defined. Sustainable building with a systems approach. DGNB—German Sustainable Building Council (2012)
9. Atwood, J.: Three Monitors For Every User, 4 April 2010. <http://blog.codinghorror.com/three-monitors-for-every-user/>
10. Horne, A.: Review of the Verbatim Wireless Bluetooth Folding Keyboard, 7 July 2011. <http://www.amazon.com/review/R2WAM0KB2EOERJ/>