The Future of the PC

Abstract

This document is an attempt to explain where the Personal Computer may be heading and why. By examining the short history of the PC we can see some clear lessons that remain relevant – and we also see the foundational elements for the makings of the future PC.

It should be noted that much of the information contained in this document is the opinion of its authors. As with any documents of reflection and prediction, readers are encouraged to reach their own conclusions after further research.

Microsoft

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"In the Digital Decade, you'll no longer think of the PC as a tool you use only to carry out specific tasks. It will become something you come to rely on all the time. The power of the PC will be as ubiquitous and reliable as electricity, and vastly more useful than any single device we use today."

Microsoft Chairman, Bill Gates[1]

Bill Gates' "digital decade" is the first decade of the 21st Century – and here in 2007, we can already see amazing differences that have taken place over the last few years. In those years, consumer devices like digital cameras, digital music players and even digital television have become such a part of our lives that we rarely give them a second thought. At the heart of this consumer revolution is the Personal Computer (PC) which acts as the digital hub for all these devices, enabling the storage, editing and printing of photos and the downloading, playing and transferring of digital music. And with more than a million copies of the Media Centre edition of Microsoft Windows being sold every month, even the TV is being managed by the personal computer.

While the "PC effect" on consumers has been big, the impact that the PC has had on business and government has been much more profound. This impact will continue to increase as the capabilities of the PC continue to grow exponentially.

The Ultimate Information Worker Tool

Efficient tools have come to symbolize progress throughout the ages. From the plough in the agricultural age through the steam engine in the industrial age and to the PC in the information age, each of tools reflects the tasks at hand. Today, in the Information Age, it is the PC that enables workers to gather the data they need and allows them to communicate and collaborate with fellow workers.

Of course, the PC continues to evolve much faster than the earlier worker tools. This is not only because the rate of change today has increased so much. This evolution of the PC is so rapid because the PC itself embodies much of the progress of the information age. Today's PC includes the latest advances in microprocessor power, storage capabilities and communication abilities – all three of which continue to evolve at a compound rate – while getting cheaper in the process. The resulting

[1] "Moving into the Digital Decade" - http://www.microsoft.com/presspass/ofnote/10-29digitaldecade.mspx

PC is so powerful and so cheap that the real challenge for business and government is how best to use this ultimate information worker tool to deliver the goals of the organisation.

In order to understand how powerful the PC has become, what follows is a brief history of where the PC has come from and where it might be heading. While we can sometimes worry about the software versions, the speed of the processor or the size of the screen, what is really important is to understand that more than 80% of the computing power of most organisations lives on the desk of its employees. We have an obligation to ensure that we manage that power responsibly and, most importantly – put it to good use.

We will attempt to predict where the future of the PC is heading by looking at its short history and the elements now contained in and supporting the PC. These elements are the seeds from which the future of the PC will grow. The following timeline gives a quick overview of this history and immediate future. Some of the elements on this diagram span many years of development, so tying each to a particular year is not possible nor helpful.

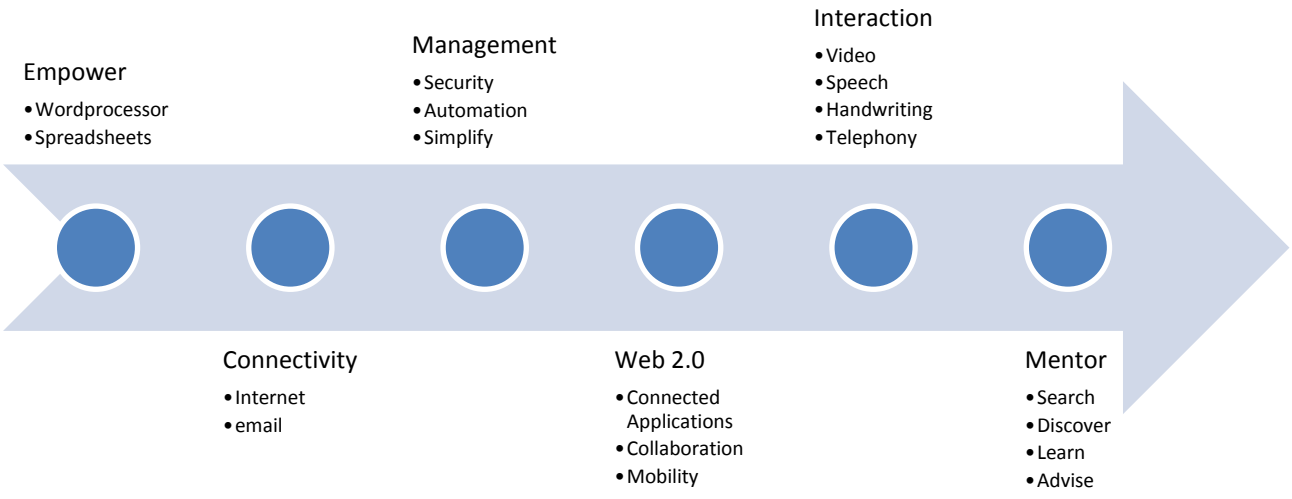

Figure 1 The evolution of the PC

Empower

"Before the mid-1990s, the growth of productivity--the amount of output produced per worker or per hour of work--had been relatively sluggish for more than two decades in this country. As productivity is perhaps the single most important determinant of average living standards ... the so-called productivity slowdown of that earlier period was the source of much concern among economists and policymakers. In the mid-1990s, however, productivity growth picked up in the United States. .... But why did it happen? ... research suggests that the pickup in U.S. productivity growth in the mid-1990s was importantly related to advances in information and communication technologies."

US Federal Reserve Chairman, Ben S. Bernanke[2]

While large computer mainframes, mid-range servers, and task-specific machines such as design workstations occupied many business and government organisations from the early 1960's, it wasn't until the mid-1990's that the PC gained a foothold in the day-to-day operation of business. The combination of increasing computing processing power with the release of personal computer operating systems such as Windows 95 enabled the average information worker to use a computer to achieve their personal business goals.

Additionally, spreadsheet and word processing applications meant that these workers no longer had to rely on computer batch processing or the once ubiquitous "typing pool" to calculate budgets or produce documents.

More importantly, these new technologies enabled business activities and business decisions to be made closer to the people that really matter in business – the customers. By reducing the reliance on the computer data processing centre and empowering the workers who had more direct contact with customers, the information workers in these organisations could make better decisions faster. The result was an increase in overall productivity – not just of one or two organisations, but of the country as a whole.

Connectivity

By the mid-nineties, the scientific and military communities had been using the internet for many years. However, it wasn't until the use of internet browsers such as Mosaic, Netscape and Internet Explorer did it really become popular. By the late nineties, the commercialisation of the internet had occurred with many people seeing the "world wide web" as synonymous with the internet.

[2] http://www.federalreserve.gov/boarddocs/speeches/2006/20060609/default.htm#fn1

The Internet provided access to a huge store of information as well as a virtual single network that the whole world could use. This network also helped create the first minimal cost collaboration tool – email.

Thus by the late 1990's, the PC was not only a personal productivity tool, it had also become a gateway to a world of instantly accessible information and low cost communications.

Management

Unfortunately, the connection of the PC to a world-wide network of other PCs brought with it major security issues. Not only had it become a gateway for quick and easy collaboration, it had become a gateway for overly curious minds and malicious criminals.

In addition to security problems, the speed with which software advances were being made meant that many users brought their own software, solutions and problems to the PC. And because their PC was connected to others in the organisation, the resulting free-for-all meant that the PCs could not easily be managed.

This lack of management created a number of problems:

- **Security**. A lack of security exposed the organisation to many threats including a loss of trust from customers.
- **Stagnation**. With the enormous advances being made in both software and computer hardware, the PC was becoming a substantially more powerful tool. However, the lack of management of the PC meant that it became very difficult to take advantage of these new capabilities because it was so hard to upgrade these PCs.
- **Support**. The growing diversity of PCs made support quite difficult.
- **Cost**. All the above caused PCs to become quite costly – not in themselves, but in their management.

By 2002, it was clear that the amazing capabilities of the PC had become mired in a costly mix of security and manageability difficulties. For Microsoft in particular, this was a major issue - the result of which halted Microsoft Windows software development while a better way was found. After re-engineering the software development process through the "Trustworthy Computing" [3] initiative, Microsoft gave security the highest priority. The initial result in 2004 was Windows XP SP2.

Windows XP Service Pack 2 with Advanced Security Technologies was designed by Microsoft explicitly to provide proactive protection for Windows XP. The updates and enhancements in Service Pack 2 focused on three main areas:

- **Stronger security settings**. Service Pack 2 established stronger default security settings and included updates with new features and tools designed to help customers better defend their systems and information from hackers, viruses and other security threats. That meant

[3] http://www.microsoft.com/mscorp/twc/default.mspx

safer browsing and communications for consumers plus an improved security infrastructure for businesses.

- **Increased manageability and control**. Service Pack 2 made it easier to configure and manage security resources with new functionality, more accessible and intuitive security tools, and the new Windows Security Centre.
- **Improved and more-secure experiences**. Service Pack 2 included updates for key drivers, updated support for new technologies such as Wi-Fi and Bluetooth - especially around security - and security updates for other key features, all of which provided a safer end-user experience and thus enabled more productive and enjoyable computing.

Windows XP Service Pack 2 was remarkable in many ways. This was a wholesale upgrade to the Operating System (and over 200MB in size), yet it was free to end users. Additionally, the ability to deliver such a large in-place software upgrade to literally hundreds of millions of users has yet to be surpassed.

Alongside Windows XP SP2 came better technology for managing and installing software on PCs. This addressed the other management issues that confronted organisations that were trying to leverage the power of PCs throughout their organisation. These technologies included Active Directory (which managed all resources on the network including printers, PCs and of course identity access and management) as well as System Centre and the Business Desktop Deployment (BDD) tool.

Figure 2 Business Desktop Deployment

The combination of these tools, along with the skill to use them correctly, meant that organisations could manage the PCs and upgrade them to fully exploit the advances that were continually being made in software and hardware. The result was a safe, reliable and efficient PC that was easy to use and very easy to maintain.

Web 2.0

The recent history of the Internet has seen enormous changes to the old models of how people publish and consume information on the Web. Instead of simply viewing information on static Web pages, users now publish their own content through blogs, wikis, webcasts and podcasts. Instead of visiting many different sites for information, users now combine data, content, and applications from different sources to create their own user experiences and applications. Users are taking these technologies into their own hands to form rich online communities where they can share knowledge and work collaboratively.

These new technologies, new application design patterns, and new business models—commonly and collectively referred to as Web 2.0—are transforming the shape of both public Internet and private intranet applications. They represent a significant opportunity for government and businesses that can embrace the changes and harness the creativity of their employees, partners, and extended customer communities and the collective value of their knowledge and intelligence.

Web 2.0 characteristics include:

- Rich user experience
- Data-driven architecture
- User-driven business applications
- Collective intelligence
- Low cost deployment and maintenance[4]

Before the advent of Web 2.0, many pundits suggested that the internet spelled the end of the PC – and that all functionality could be delivered through a “thin-client” or browser-only device. However, Web 2.0 relies on both the abundance of network bandwidth as well as the power of the PC. Highly successful commercial applications such as Apple’s iTunes and Microsoft’s Virtual Earth rely on the rich functionality of the PC to enhance the user’s experience and understanding of the entertainment or information that is delivered to them. These are both sophisticated applications, however, in each case the skills required to operate these applications are minimal – and no user manual is necessary.

[4] “Bringing Web 2.0 to the Enterprise with Office 2007” - http://www.microsoft.com/downloads/details.aspx?FamilyID=8b48bd31-f043-4ab4-96eb-c6e958fe4ec9&DisplayLang=en

Figure 3 Apple iTunes and Microsoft Virtual Earth

The ability of the PC to engage users, offer easier input through intuitive navigation and reduce complexity has seen previously "web only based" companies such as Yahoo! and Google offer many applications that run on the PC.

Similar examples can be seen from "software as a service" companies. The idea behind "software as a service" is that the functionality of the software can be delivered over the internet - without the software actually being installed onsite. This approach has the potential to save money by reducing the operational costs of maintaining server based software. Again, companies such as salesforce.com that rely on internet-based software are now expanding their services to additionally offer client-installed software that takes advantage of the richness – and mobility - of the PC.

More and more, we are seeing the "software as a service" model being extended to "software and services" whereby some software is delivered to run a rich user interface on the PC and other software is used on remote servers to deliver services over the internet.

Mobility

"..(T)he first microprocessor only had 22 hundred transistors. We are looking at something a million times that complex in the next generations—a billion transistors. What that gives us in the way of flexibility to design products is phenomenal."

Intel co-founder, Gordon E. Moore[5]

Of course one of the big things that makes a "personal computer" personal is its ability to travel with the person. Both business and government have realized that a mobile computer has many advantages over one that is deskbound. These benefits of "taking the power with you" include:

- **Better customer interaction**. Whether you're a finance person trying to approve an applicant's loan or a social worker helping a family, having all the information at your fingertips increases customer satisfaction dramatically.
- **Input at the source**. Taking notes, numbers or measurements in the field ensures that you can enter the information once, verify its accuracy and quickly recall it while still on site.
- **Flexibility at work**. PC Mobility gives Information Workers more flexibility about when and how they work. Whether it's after hours, on a plane or in the suburbs this flexibility creates happier and more efficient workers.
- **Proximity**. As we move to more of a seamless computing world, smart devices like PCs will be able to easily interact with other devices such as audio and video systems, other PCs and home and office automation systems. This augments the power of the PC, enabling it and its user, to interact with the immediate environment to create a very engaging experience.

In February 2005, mobile PC sales surpassed desktop PCs and analyst firm IDC expects that sales of mobile PCs will continue to grow at about 15% for businesses and 20% for consumers at least until 2010.[6]

Mobility brings with it some additional requirements. Because the relative cost of a mobile PC is quite low, risks such as physical damage or loss of the device while in the field are of less concern. However, mobility does highlight new issues in security and manageability. Microsoft's Windows Vista operating system addresses these concerns directly with such features as:

- **BitLocker Drive Encryption**. This full-disc encryption technology ensures that even if a mobile PC is lost or stolen, the data on that PC cannot be read. This ensures that sensitive data such as Cabinet decisions, patient data or personnel information remains as secure as your password or smart card.
- **Microsoft Network Access Protection (NAP)**. This policy enforcement platform built into Windows Vista and Windows Server "Longhorn" helps ensure that only safe devices can access networks.

[5] http://www.intel.com/technology/mooreslaw/index.htm
[6] http://www.microsoft.com/presspass/exec/poole/05-23WinHEC06.mspx

- **Network Centre**. This allows the user to remain connected when away from their usual desk. Whether it's in a meeting in the same building or in a remote office or through a public wireless hotspot, the user can quickly select which network to connect to. This reduces support calls and helps to maintain a high level of security.

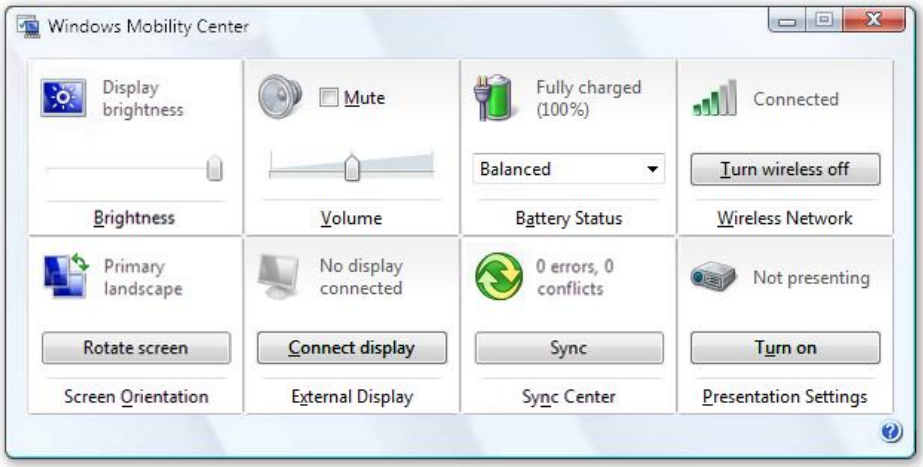

Figure 4 Windows Vista Mobility Centre

- **Mobility Centre**. Such features as power usage, presentation settings and synchronisation of data are easily controlled in this screen. The sum of these features further reduces the need for a deskbound PC – and makes "taking the power with you" much easier and safer than it was in the past. Mobility increases the potential use of the PC and that's one of the many reasons that mobile PCs outsell deskbound PCs.

Interaction

In the 1970's, the interaction with computers consisted of punched cards for input and paper reports for output. By its nature, that required a specialised team whose job consisted mainly of interacting with the computer on behalf of the ultimate end users.

We have come a long way since the punched card interfaces of the mainframes. Today, we expect the output of PCs to be printed, on the screen, via pictures, video and sound. All these elements make it very easy for us to understand the information that is being presented to us.

This richness of interaction with the PC can also be found in its input devices. For example, in 2002, Microsoft released the Tablet PC. This represented a distinct evolution of the standard mobile PC by allowing users to input data with a digital pen as well as a standard keyboard or mouse.

Tablet PCs, which run a superset of Windows XP or Windows Vista, have special screens which use an active digitizer to enable users to write directly on the screen to control their PC and to input information as handwriting or drawing.

Figure 5 TabletPC

This process -- called inking -- enables users to add "digital ink" to a full range of Windows applications, which appears as natural-looking handwriting on the screen. The digitized handwriting can be converted to standard text through handwriting recognition, or it can remain as handwritten text. Both the converted text in typeface and the cursive handwritten text function equally well as data formats in Windows applications and platforms -- that is, both forms of text can be sent as e-mail in Microsoft Outlook and exchanged as documents in Microsoft Word, and can be sent from the Tablet PC to a desktop computer or a Pocket PC, which can display the text in the same character format that it was sent in.[7]

Ink entry, including text and gesture input and recognition is just another step in the direction of “natural interfaces”. Such interfaces use existing human communications such as handwriting and speech to greatly reduce the training costs required to operate PCs and increases their capabilities.

Speech recognition is built into Windows Vista allowing full interaction with the PC without the use of keyboard or mouse. This is extremely useful for many applications, but of particular help to people with disabilities. For example, the use of speech on the PC allows the operation of websites – even if those websites were not designed with speech in mind.[8]

The Multimodal User Interface Group at Microsoft Research in Redmond, USA and in Beijing, China is exploring research in advanced natural user interface technologies. Natural communication with machines or with other people via machines is critical to bringing the benefits of networked computers to the mass market. A computer user interface must cater to the human senses of sight,

[7] http://www.microsoft.com/presspass/Features/2002/oct02/10-29TabletInking.mspx
[8] http://www.microsoft.com/enable/

sound, and touch, which are used to navigate physical surroundings. New technologies are emerging that can support human-machine communications with features that are natural to humans.

Computer Hardware advances are also helping. It is likely that projection devices will become much cheaper than they are today. This allows large screens to be displayed from very small devices by projecting the screen image to a flat surface like a wall or desk. Combining this technology with visual recognition software allows these large surfaces to also be used as input devices. Hand gestures and physical objects such as pens, paper or other storage devices can all be used to facilitate a more natural conversation with the PC.

The personal computer is becoming more than just a data entry and information retrieval tool. By using its ever increasing power to more naturally converse with users, the PC can itself become a tool that we use to interact with other computers, businesses and people.

Mentor

"In a new world of work, where collaboration, business intelligence and prioritizing scarce time and attention are critical factors for success, the tools we use must evolve in ways that do not add new complexity for people who already feel the pressure of an 'always-on' world and ever-rising expectations for productivity"

Microsoft Chairman, Bill Gates[9]

The cost of computers has dropped dramatically over the last ten years – leading to a dramatic increase in the rate of change generally and a huge increase in the amount of information collected. Today workers are faced with a sometimes overwhelming amount of information, including emails, customer interactions and raw data. It is becoming increasingly difficult to quickly sift through this information in order to arrive at the correct decision or to provide the relevant information.

New ways of using the PC's power to simplify life for its user are high on the list of requirements. But just simplifying is not enough. The PC of the future will be able to sift through the information that is delivered to it, as well as go and search for information that is relevant to the user. After gathering this information, the PC will be able to alert the user and inform him or her of the implications of this new intelligence – and perhaps recommend a course of action.

To extend this scenario further, one could imagine the PC becoming almost the equivalent of a mentor for its user – and essentially guide the user through the information jungle that is today's business and government, as well as help schedule and organise their business day.

[9] http://www.microsoft.com/uk/businesscentral/business-technology/software-tips/bill-gates-future-software.mspx

The mentor concept could be extended to include business rules, policy awareness and so on such that the user can focus on the exceptions while the PC manages the more routine part of the day. This will of course dramatically reduce training costs and allow employees to get “up to speed” much faster.

To be able to do all this, the PC requires very specific information about the user. This will include understanding who the user communicates with and on what issues – this is also known as the “social network” of the user. This network enables the user (or the PC) to find experts in particular fields based on previous communications and responses. Additionally, the PC will need to know the schedule of the user so that any interruption will be respectful of the time – and balanced with the urgency of the information. For example, the release of a new government policy may not require the interruption of a phone call, but perhaps an important call from a family member will cause an interruption.

Additionally, through the understanding of gestures and other natural interfaces, the PC will recognise a user’s frustration and offer help or a different method of interaction based on the situation.

The ingredients for much of this future scenario are already starting to take shape. For example:

- **Search**. Search is a very powerful feature of Windows Vista whereby the PC indexes the data contained on it – and potentially frequented intranet sites – so that all relevant information can be quickly retrieved. Not only does this help the user instantly find an application, an old case note or perhaps an email; it greatly simplifies the initial storage of that information because the user no longer needs to create a classification system such as a directory structure.
- **Windows Workflow Foundation**. This is part of the .NET Framework (available on Windows XP and included in Windows Vista). It embeds a workflow engine within the PC such that simple workflows like application screen flow or complex workflows like business rules are available to the applications running on the PC.
- **RSS Feed Support**. Another feature of Windows Vista, this functionality gathers Really Simple Syndication (RSS) feeds and stores them for use in applications throughout the PC. Applications such as Internet Explorer, Outlook and Vista Gadgets can filter this information and present it to the user in easily readable formats.
- **Office Communicator**. When combined with presence detection software such as Live Communication Server, the PC can identify when the user – and those in his social network - is in a meeting, out of the office and so on.

In many cases, the PC will not know what the user requires. In these cases, the PC’s power can be used to enable much easier discovery for the user. As already mentioned, very sophisticated programs such as Virtual Earth rely on the graphics capability of the PC to make that application very intuitive. Perhaps the best example of this approach of discoverability is in today’s games.

Figure 6 A scene from Second Life

Again, using the inbuilt graphics, sound and processing power of the PC, navigating vast corridors or even virtual worlds in a game to reach an objective requires almost no training or manuals with today's games. And some of these games are themselves becoming real business tools – an example of which is Second Life where real business meetings – and real business transactions - take place in a virtual world.[10] This kind of navigation is likely to expand in usage because the "real world" is a metaphor people understand. For example, imagine if each government department or government service is a shopfront in a virtual shopping mall. After virtually walking to the shop, the citizen could see all the offerings as brochures on the wall or talk to a person (represented as an avatar) to clarify some aspects of the offering. This virtual face-to-face interaction can take place where the physical location of the government departments and their citizens can be spread across large geographical areas.

Again, some of the basic ingredients for this discoverability are here in today's business software:

- **Office Ribbon**. The latest incarnation of Office examines what the user is doing and adjusts the options accordingly. These options are presented in a graphical "ribbon". Other features such as "smart art" allow the user to quickly present their ideas through a guidance system.
- **Task Centres**. Using the idea of "task centres", Vista allows the user to examine and discover various functions associated with tasks such as mobility, network and sharing, accessibility and so on.

[10] www.secondlife.com

- **Windows Presentation Foundation**. Part of the .NET Framework in Windows Vista, WPF makes building rich graphical environments much easier than it has been in the past. By allowing developers to specify what they want to see (as opposed to the detailed instructions for how it is to be constructed) we expect to see many more visually rich mainstream applications.

Conclusion

Computing processing power, storage capacity and network bandwidth continue to grow at an amazing rate. Some of this growth is being used to drive server-based services, such as core business processes, either within the local data centre or delivered as "software as a service" over the internet. The impact of this growth is increasingly being felt at the edge of the network where we see increasingly productive user-focused computing, such as computer/human interaction and mentor-based functions. By moving these functions to the network edge in the form of the PC, the following advantages are realized:

- Your services can move closer to your customer
- Data entry accuracy is increased – and in many cases, data is entered by your customer
- The interaction with services and business processes become much more engaging and more easily understood

Whatever form factor the PC takes – from desktop, to laptop, tablet or "ultra mobile", we will see it become even more powerful and in turn even more valued in the organisation of the future. It will be a personal mentor for guiding users through their day, helping them automatically deal with the routine, understand the relevant and enable them to magnify their effectiveness in the organisation.

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