The PC Evolution and Diaspora

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Abstract. This paper examines the development, evolution, and diaspora of the personal computer. An overview of the Innovation Diffusion Technology (IDT) model is presented. Using this as a framework, the personal computer is categorized from multiple perspectives. The direction, durability, and mutations (the diaspora) of the personal computer are presented using Ansoff's model of diversification.

Introduction

In August of 2011 Hewlett Packard, the world's largest seller of PCs, confirmed it was looking to sell off its personal computing business—possibly getting out of the hardware game altogether and dropping its tablet and smartphone operations as well. This event along with IBM's decision in 2004 to sell its PC business line to Lenovo, a China-based firm, is a harbinger that the low-margin PC business may not be worth pursuing. Concurrently the rise of alternatives to traditional PCs, the tablet(s), continues unabated—with forecasts through 2011 at 60 million tablets and in 2012 to be 90 million units [1]. There still will be over 100 million PCs sold worldwide for several years because people need them for certain tasks [2]. Many of the habits we associate with personal computers can be carried out with touchscreen and an Internet connection—done anywhere, and quickly. The iPhone has demonstrated what could be done with a relatively small device that could single task very well. With Android and Apple netbooks being circulated, this idea of a small, relatively inexpensive device connected to back-end services is the leading edge of a paradigm-shifting platform—along with the application layer in the private cloud [3].

According to Brodkin [4], "since the personal computer debuted in 1971, a Darwin-esque evolution process has lifted the PC from modest beginnings to its prevailing role as an indispensable part of life in the 21st century" … "evolving from clunky commercial flops to slick, high-powered machines that play a vital role in our daily lives, both for work and play." Personal computers have been the technology engine drivers from Intel to Microsoft to Dell to HP to Google to Facebook. But the rise of mobile computing is upending the technology business and is simultaneously redefining what is a personal computer and how we use it [1, 5].

This paper is a sector case study that seeks to examine the development, evolution, and diaspora of the personal computer. The remainder of this paper proceeds as follows. First, we present an overview of the IDT model and discuss innovation characteristics. Then we categorize the personal computer from multiple perspectives using this as a framework. Finally, we comment on the direction, durability, and mutations (the diaspora) of the personal computer using Ansoff's model of diversification.

Overview of Diffusion of Innovation

Diffusion of innovation theory [6] describes the process through which new ideas, practices, or technologies are spread into a social system. According to Murray [7], diffusion of innovation theory holds that innovation diffusion is a general process, not bound by the type of innovation studied, by who the adopters are, or by place or culture, such that the process through which an innovation becomes diffused has universal applications to all fields that develop innovations. Diffusion is defined as the process in which an innovation is communicated through certain channels over time among the members of a social system. Innovation is an idea, practice, or object that is perceived as new by an individual or other unit of adoption. In addition, innovation also does not necessarily mean better or that the new idea is more beneficial to an individual. Whereas innovation can refer to something abstract, like an idea, it can also be concrete, like a new piece of technology. This article focuses specifically on the personal computer as a particular type of innovation of interest.

Rogers [6, 8] suggested that there were/are four main elements in the diffusion process:
- The innovation
- The communication channels through which the innovation is diffused
- Time
- The social system

The end results [9] of diffusion are adoption, implementation, and institutionalization. Diffusion researchers across many academic disciplines have identified a consistent process through which innovations are diffused into social systems. There is generally a period of slow growth, followed by more rapid expansion, followed ultimately by a plateau or another slow growth period. Different characteristics of the innovation, communication channels, and social system are likely to have varying influences at different times throughout the diffusion process [10].

Individuals vary in their willingness to accept new ideas and change [11]. Rogers [6] classified adopters into the following five categories on the basis of their rates of adoption:
- Innovators, who are among the first 2.5% in the population to adopt the innovation and demonstrate an adventurous, cosmopolite nature.
- Early adopters, who fall into the next 13.5% of adopters and who are integrated closely into the social network and are often opinion leaders.
- The early majority, who are the next 34% of adopters and are described as deliberate followers.
- The late majority, the next 34% who are often skeptical of the innovation at first but eventually succumb to peer pressure.
- Laggards, who are the final 16% and who tend to be more traditional and isolated compared with earlier adopters. Individuals who are among the last to adopt an innovation often exhibit the longest decision-making processes prior to deciding.
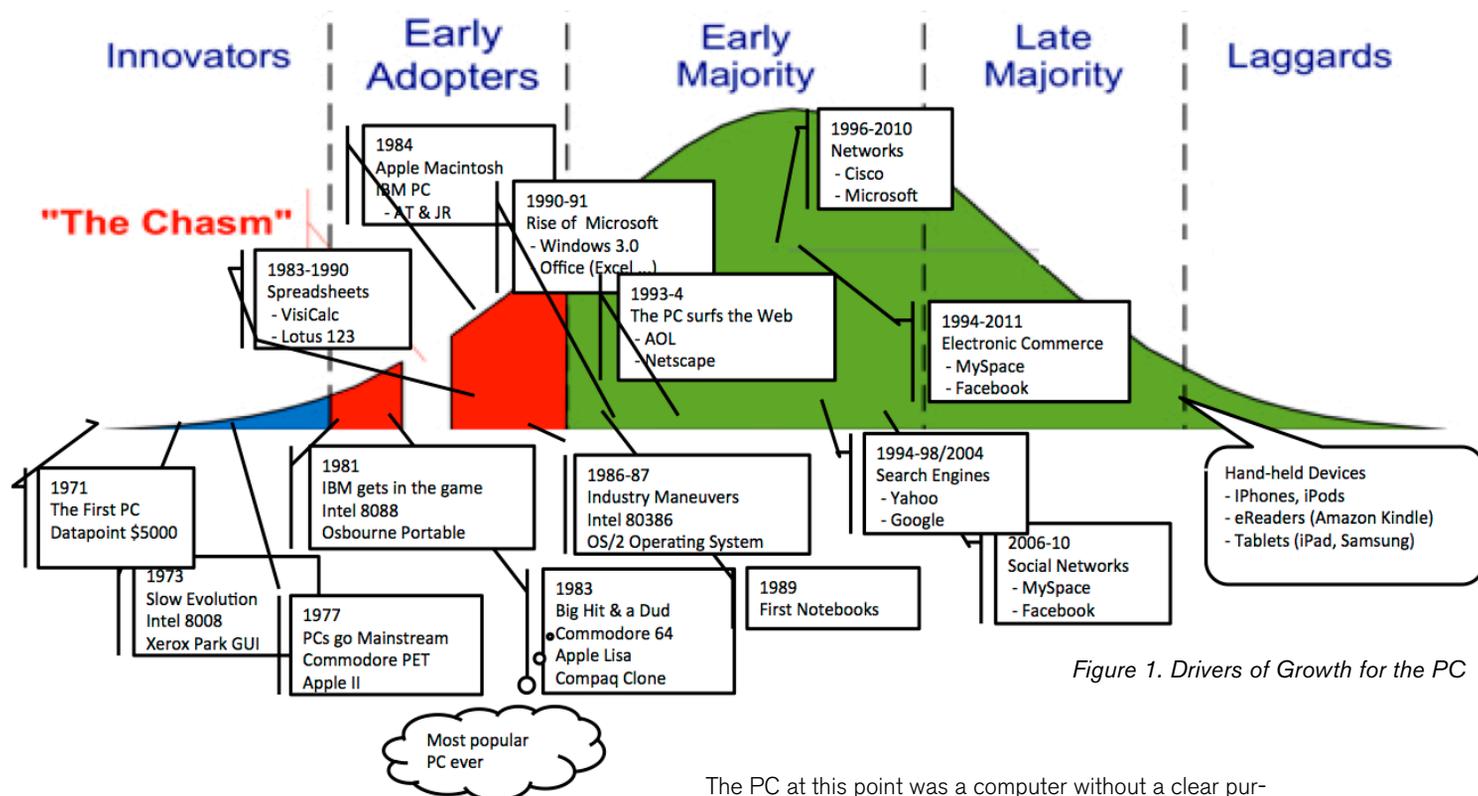
Figure 1. Drivers of Growth for the PC

The figure contains the following labels:

Innovators | Early Adopters | Early Majority | Late Majority | Laggards

"The Chasm"

1984
Apple Macintosh
IBM PC
- AT & JR

1990-91
Rise of Microsoft
- Windows 3.0
Office (Excel ...)

1996-2010
Networks
- Cisco
- Microsoft

1983-1990
Spreadsheets
- VisiCalc
- Lotus 123

1993-4
The PC surfs the Web
- AOL
- Netscape

1994-2011
Electronic Commerce
- MySpace
- Facebook

1971
The First PC
Datapoint $5000

1981
IBM gets in the game
Intel 8088
Osbourne Portable

1986-87
Industry Maneuvers
Intel 80386
OS/2 Operating System

1994-98/2004
Search Engines
- Yahoo
- Google

Hand-held Devices
- IPhones, iPods
- eReaders (Amazon Kindle)
- Tablets (iPad, Samsung)

1973
Slow Evolution
Intel 8008
Xerox Park GUI

1977
PCs go Mainstream
Commodore PET
Apple II

1983
Big Hit & a Dud
Commodore 64
Apple Lisa
Compaq Clone

1989
First Notebooks

2006-10
Social Networks
- MySpace
- Facebook

Most popular
PC ever

Marketing of the PC

The PC did not magically appear in its current wide-screen, multi-core, viewing form overnight. It took many years to evolve from the IBM PC of 1981 to the high-powered tech gadgets. The original idea of the PC was sound: using off the shelf parts combined with a relatively open, but curated set of standards to avoid reinventing from one version of the PC to the next. There are a number of milestones passed along the way, from the introduction of the IBM PC in August 1981, and moving on to the appearance of the first PC clones in 1982, leading to the "post-PC" tablets of 2010-2011. Microsoft, AMD, and Intel have outplayed and outlasted their rivals. Plus, many of the hundreds of "PC clone makers" have either been left by the wayside, or have been absorbed into larger conglomerates. Apple has been friend, rival, and self-appointed nemesis during this period, and without that competition, it is unlikely that we would see the technology move in the directions it has. There are an abundance of time-lines and papers addressing the evolution and eras of the PC. We have constructed a time-line fitted to the IDT curve—products, and way stations in the journey through PC technology are depicted. Our intention was not to be exhaustive but to cite major events as well as game-changing/legitimizing turning points. The time-line is shown in Figure 1.

The first key event in the PC era was the introduction of the IBM PC. IBM dominated the computer industry during the pre-computer era (machine-accounting); championed the many generations of mainframes (e.g. the 360 – 370); operating systems and most other software applications; extended and expanded the minicomputer industry (System 32, 34, 36, 38…) and then entered into the PC arena on a major scale—setting a standard for operating systems and controlling the overall market in its initial stages. These were the "early adopters"—primarily computer professionals that transitioned from the mainframe to the minicomputer. Many users experienced the computer as a stand-alone, special-purpose desktop (e.g the graphics machines created by HP).

The PC at this point was a computer without a clear purpose—the accompanying event was the spreadsheet—VisiCalc—followed closely by Lotus 123. Abruptly businesses and the general computer population had a tool that legitimized the PC. Simultaneously word processors and database managers were introduced and followed by graphic/presentation software. The speed, storage capacity and communication channels still were lacking. General business users and professionals began to use the PC for individual and departmental applications and analysis —they formed the nucleus of the "early adopters." At this juncture in time problems arose in many businesses and government agencies – the IT administration did not want to relinquish control to the end users.

As hardware enhancements and network connections were introduced the capabilities of the PC made possible the use of the graphical user interface—obsoleting the use of the PC as a terminal to the mainframe. This marked the rise of Microsoft not only as a provider of operating systems but also the visual aspects of Windows 3 and the business acumen of Microsoft Office—the suite of products for the business at the individual and department level. As hardware technology enabled more elaborate software and system use the PC became a standard within most businesses—the "early majority" embraced the PC as their primary desktop tool for basic tasks along all levels of business activity.

Closely following these enhancements was the introduction of the World Wide Web [WWW] browser as an overlay over the Internet. Prior to this introduction the Internet existed for an extended period but did not have wide-spread use except at the business level for file transfers and email-type commerce. Netscape was the killer app that started the paradigm shift—followed by Microsoft's Internet Explorer. In effect, the PC became the vehicle for every man to communicate – no longer just a business-level system. This marked the peak of the PC era and the diffusion of PC use to the general public—"the majority". Not only was the PC the inherent tool in the office but also the home and school.

	New Products	
New Markets/Mission	**Related Technology**	**Unrelated Technology**
	Horizontal Diversification	
Same Type	Barnes & Noble -- Amazon -- Sale of books for eReaders Apple iPad & iPod -- and Android -- sale/use of Books, pdfs, music, video as Aps -- Aps for Business (~ office tools) -- Aps for Games, Personal Use -- Aps for alternative Media (Newspapers,etc)	Google - Samsung - HP Slate --- Intel Ultrabook -- Enter tablet market Barnes & Noble --- Amazon Kindle and Tablet --- Software for PCs & other devices Google - Amazon - HP Cloud Computing -- offer services to existing customers Microsoft Cloud Computing -- Office 365 -- Windows 8
	Vertical Integration	
Firm its own customer	Amazon is able to use its web-based ordering and electronic distribution system without incurring additional costs Microsoft, Google use products internally as development tools for new/revised products	Google's - Commitment to digitize most books in the public domain provides a ready audience for ereading devices and other medium - Use of network infrastructure created for search engine as competitive alternative for -- Online office products -- Social networks (Google +) Publishers can partner with Amazon and Barnes & Noble distribution and other supply chain capabilities

Table 1. Horizontal and Vertical Integration

The culminating event was the rise of the networks—the local area networks in businesses and later in homes—but also the wide area networks for businesses and ultimately the utilization of the complex already in place, the Internet. The operating system and router/switch defined by Cisco became the vehicle for communication worldwide. That combined with the browser enabled access for business and the general public ("the late majority"). Of note the browser became the basic user interface for many businesses and government agencies—the U.S. Navy mandated that Internet Explorer be the standard interface for most contractor software development. Following this accessibility the introduction of the search engine (Yahoo and then Google) made the web a pervasive tool. And lastly the social networks (MySpace and Facebook) involved an extensive array of the population as participants.

At the beginning of the 1990s the stability of the personal computer structure and industry changed. IBM dominance of the PC industry and its role as standard-bearer started to erode in the late 1980s. By the early 1990s the market structure was one in which a number of firms possessed the capability to supply interoperable components. Throughout the 1990s and beyond, thousands of manufacturers built PCs around hardware and software components mainly supplied by Microsoft and Intel. There are two distinct types of supplier to the PC industry. The first type supplies components such as disk drives, RAM, peripherals etc. Products in this category are available from a wide variety of sources at highly competitive prices. The other type of supplier provides products—most notably CPUs and operating systems—available from just a few sources .i.e. Microsoft and Intel.

Most firms outsourced the production of components manufacturing contractors carrying out simple manufacturing operations at high-volume plants in low-cost locations. Eventually, these contractors took on more complex tasks, such as design and testing. By the beginning of this century, large contract manufacturers began to build entire PCs for brand-name companies, designing and assembling basic computers in Asia and shipping them to geographic hubs for production to be completed. These full-line distributors dominated the industry with the broadest customer and product base. Many PC manufacturers aimed to streamline their operations by moving from a build-to-stock to a build-to-order model. Reduced inventory led to reduced costs.

The four main types of PC buyer have remained the same since the early 1990s. Namely: business, home, government, and education. However, the distribution channels have changed. Business buyers now buy direct from vendors or distributors as opposed to full-service dealers. Consumer markets are serviced by web-based retailers that can service all types of demand often at steep discounts.

In a survey conducted by eWeek, one in five U.S. adults surveyed said they planned to own a tablet by 2014. The survey included application use on tablets, including the iPad and machines/tablets based on Google's Android platform. Some 78% of respondents said they planned to use their tablets to surf the Web. Three-quarters of people said they would use their machines for e-mail. Other uses include electronic reading of books and newspapers, (53%), social networking (50%), consuming TV and other apps (43%). Tablet use is attractive for enterprises as well, with 37% of respondents planning to use their machines for business concerns. The use of the term "laggard" is probably not appropriately used in this presentation of the PC diffusion—another interpretation would be the deployment of the basic technology and ideas rooted in the PC as it evolved from a desktop to a laptop and currently the variety of devices that make use of and expand on the PC platform—the tablets, the smartphones and even the virtual PC.

Diversification–the Diaspora

Diversification is the name given to the growth strategy where a business markets new products in new markets. For a business to adopt a diversification strategy it must have a clear idea about what it expects to gain from the strategy and a clear assessment of the risks. Diversification in new markets concerns the inclusion of activities other than those directly relating to the product or associated services. There are four underlying reasons why companies diversify [12]:

• When their objectives can no longer be met within the product-market scope defined by expansion—even if attractive expansion opportunities are still available and past objectives are being met, a firm may diversify because the retained cash exceeds the total expansion needs. (The pressure may be on the firm to invest money more profitably.)
• When diversification opportunities promise greater profitability than expansion opportunities. This may occur under several conditions.

New Products		
New Markets/Mission	**Similar Types**	**New Types**

Marketing & Technology Related	Amazon eReader has capabilites for reading not offered by any other device
	
	Apple -- iPad
	 - Apple's B2B volume purchasing agreement
	
	Gaming Industry-- companies will be pressed harder and harder to come up with new ideas, which could make for an uphill battle (Caron, 2009)
		A number of new technologies for tablets are being applied and used for business applications
		 - PC manufacturers are designing Hybrid
		   Tablet PCs able to perform heavy duty work
		
		Cloud Services --high cost of power and space is going to force the IT world to look at cloud services, with a shift to computing as a cloud resource (Infoworld,2008)
		
		Consumers can now use smaller gadgets to do many of the same things they once did with PCs, such as surfing the Internet, storing photos and sending e-mail. (Robertson, 2011)
		
		Mobile Workers and related products
		 - Telecommuting -- the home office
		 - Pressure to provide tools and access to
		   corporate system

Marketing Related	Apple -- iPad (Rawson, 2011)
	 - Apple's retail stores
	 - Use by Children
	 - Deployed in Higher Education
		internet and technology companies taking a different approach:
		 -- Introducing a wide range of "smart" devices,
		    from phones to TVs, become the access
		    points to digital information, which resides
		    in the "cloud" (Nutall and Waters, 2011)
		
		For aspirant writers the ereader medium now provides a channel/outlet for private label media publications (Castro, 2007) (Egol, 2009)

Technology Related	Apple -- Google -- Introduce Operating Systems for devices -- Google Android available other systems PC makers are countering the threat is with iPad-style tablets running Android	Advances in network medium will reduce delivery time and cost and provide speed of access Virtualization - Desktop Virtualization (Fogarty, 2010)

Table 2. Concentric Diversification

- When the firm's research and development organization produces outstanding diversification by-products.
- When synergy is not an important consideration and therefore the synergy advantages of expansion over diversification are not important.

Firms may continue to explore diversification when the available information is not reliable enough to permit a conclusive comparison between expansion and diversification.

Ansoff has identified different forms of diversification—these are set out in Tables 1 and 2. Table 1 depicts Horizontal Diversification—consisting of moves within the economic environment of the diversifying firms and is complementary to their existing activities, marketing synergy is strong as they continue to sell through established marketing channels. This has been the lexis for the changes in the supply line, customer relations and expectation management in the PC's competitive environment; and Vertical Integration—referring to the development of activities which involve the preceding or succeeding stages in their production processes and is often more sensitive to instabilities and offers less assurance of flexibility—increases the dependence on a particular segment of economic demand—here most of the main competitors are able to channel some of their related products and distribution channels to provide a competitive edge.

These two diversification strategies offer limited potential for objectives; they make a limited contribution to flexibility and stability and will contribute to the other objectives only if the present economic environment of the firm is healthy and growing. This inflection point is just as dramatic as when the PC came on the scene and cut the cord between the mainframes and minis and made the personal computing local. Another way to think of this is that we are moving into a phase in which people want a PC on their desktop and in their pocket [13].

Table 2 depicts Concentric Diversification—having a degree of common thread with those firms that possess marketing and/or technology capabilities. A concentric strategy is generally flexible and usually more profitable and less risky because of synergy. For the PC industry sector the major players can bring to bear resources established from their other product lines to enhance their competitive position.

PCs are being replaced at the center of computing not by another type of device—but by new ideas about the role that computing can play in progress. According to Burt [14], "it is becoming clear that innovation flourishes best, not on devices but in the social spaces between them, where people and ideas meet and interact. It is there that computing can have the most powerful impact on economy, society and people's lives." Software and technology-based companies need to understand where computing is headed and to embrace "that which is technologically inevitable"—a future of varied devices connected to the cloud. The days of the PC-centric environment, which helped fuel Microsoft's success, are declining as the use of mobile devices and cloud computing rises, implied Ozzie, a Microsoft's chief software architect [14].

At the unveiling of the iPad 2 in March, 2011, then Apple CEO Steve Jobs affirmed that the post-PC world would be dominated by such devices as smartphones and tablets. Some

other vendors view tablets as something new in the PC market, but that, "is not the right approach to this," Jobs said. "These are post-PC devices that need to be easier to use than a PC, more intuitive. The hardware and software need to intertwine more than they do on a PC."

Given the diaspora it is well to note that the smartphones and tablets are hybrids— variations of not just the PC but other technologies. A smartphone is a mobile phone that combines the functions of a personal digital assistant and a mobile phone— also serving as portable media players and cameras with high-resolution touchscreens, web browsers and mobile broadband access. A tablet PC is just that—a tablet-sized computer that has the key features of a full-size personal computer. With the introduction of the iPad and later the Samsung tablet, these devices have taken on many of the features of the smartphone and iPod-like devices.

Two other related directives altering the PC are virtualization and the cloud. These concepts are somewhat intertwined. Cloud computing delivers applications via the Internet and the web browser—the business software and/or user data are stored at remote location. Virtualization is the creation of a virtual (rather than actual) version of something, such as a hardware platform, operating system, a storage device or network resources. It can be viewed as part of an overall trend in enterprise IT that in which the IT environment will be able to manage itself based on perceived activity, and utility computing, in which computer processing power is seen as a utility that clients can pay for only as needed. These innovations extend the PC by enabling any web-enabled device to serve as a conduit to an organization's applications and data. For the consumer we already see this trend with Google's Gmail and apps being stored on Google servers— these are just the tip of the data and application iceberg.

PC sales are decelerating in the U.S. because the same technological advances that fueled the PC industry's rise—faster processors and lower costs—are now benefiting the devices that are usurping it. Consumers can now use smaller gadgets to do many of the same things they once did with PCs, such as surfing the Internet, storing photos, and sending e-mail. Apple even boasts that users can edit home movies on an iPad [15].

In summary, just as with the PC evolution the diaspora is marked by several significant diversifications. The PC itself has mutated into many products ranging from laptops to mini and micro PC-laptops to Tablet-PCs. Accompanying this mutation is the software that supports this array of devices—much of it can be found on other hand-held devices such as the BlackBerry and the smartphones. The promotion and progression of the array of Apple products ranging from the iPhone to the IPod to the iPad has created and fostered not only a market niche but moreover an extension into a worldwide set of devices—engendering other software and hardware companies to follow suit. The iPad has come to be a multi-use product—serving as an access point or portal to the web, a gaming device, a communication medium, and perhaps a substitute for media devices such as the burgeoning eReader market—going directly against the Amazon Kindle. The way that firms now do business is changing. This also has fallout to the consumer that can now use a hand-held device to access a plethora of data anywhere, anytime, and anyplace. The PC is in some sense becoming a virtual machine. ◈

ABOUT THE AUTHOR

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