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Developing a good laptop

- Case Lenovo

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DESCRIPTION

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Abstract Accompanying with the industrial revolution, more and more machines are brought into our everyday life. Personal computer is one of the most successful digital products. It has changed our life so much since the first personal computer of IBM 5150 appeared in 1981. And they are used widely today, not any more only at home and work but also on the move. Laptop is a portable personal computer, designed for mobile use and it is small and light enough to sit on one's lap while in use. How to develop a perfect product to customers is very important for PC vendors. This thesis will take one Lenovo case to simply show the main structure of a laptop, and introduce that after development team complete the design, there are still several steps to transfer the product to the market by manufacture and service. DFX (Design for X) is the way to optimize the product. X means everything which could enhance the product value, it is included new technology, assembly method, service, quality, cost, but not limited to those. Besides above X, there is another very important factor for a successful product, which is innovation. And there is a case of a concept laptop or a prototype showed in the thesis. Obviously, developing a good laptop is a continuous process with the improvement of the technology and industry trend.		
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1 INTRODUCTION

1.1 Understanding the main concept of the topic

Accompanying with the industrial revolution, more and more machines are brought into our everyday life. Personal computer is one of the most successful digital products. It has changed our life so much since the first personal computer of IBM 5150 appeared in 1981. And they are used widely today, not any more only at home and work but also on the move.

If you look back to the computer history, you can see how strong impacts computers have had to our professional and private life. At the very beginning, the world's first electronic digital computer was used to do high-speed calculation in academic area. So, it relieved scientists from heavy burden to do calculations by hand.

After decades, programming languages and operating systems developed further. One of the biggest mile stones was Windows operating system. It was another big revolution in computer era. The main contribution of Windows was that it made computers more easy to use by both research institute staffs and household people.

When the Internet rapidly aroused, personal computers brought us to the modern information era. For example, we do not have to wait days to receive a letter but we can get an email almost at the same time when it was written; Instead of meeting people face to face, we can have a video conference between people who are at the opposite corners of this world.

A computer is as one of the most significant invention after the revival of learning. Let us have a quick review about the history of computing:

The first computers were people, predominantly women, whose job was to perform the repetitive calculations to compute such things as navigational tables, tide charts, and planetary positions for astronomical almanacs.[1]

Mechanical computers were invented afterwards. There are a lot of mechanical computers were used in early days, such as abacus, the oldest surviving abacus was used

in 300 B.C., slide rule, and arguably the astrolabe and the Antikythera mechanism (which dates from about 150-100BC).[2]

The first electronic computer of ABC (Atanasoff–Berry Computer) was successfully tested in 1942, and MS-DOS/Windows appeared since 1980s, then it brought us to the high-speed development of computers accordingly.[3]

The fast development was not limited only to the Internet but at the same time the computers themselves have developed extremely fast. I would like to give a brief introduction about its development by two aspects:

From hardware perspective: To save space, we got a desktop computer firstly, which derived from the huge electric computer. Later to make it portable, we get a laptop, net-book, tablet PC, and also Pocket PC soon. Recently to make all portable computers with better performance, we got long battery life batteries and advanced graphics, even mass storage hard disk and so on.

From software perspective: To make systems to simulate human brain, we introduce binary arithmetic and logic formula firstly. Later to make the systems easier to use we got sophisticated operating systems like Microsoft Windows, Mac OS X, Linux, Solaris and FreeBSD. A major development in user friendliness was the introduction of graphical user interfaces (GUIs). They provided more intuitive interface to the users and thus a large number of different kinds of applications was developed to perform more and more useful services to the end users.

Table 1 points out the most important milestones of personal computer development.

Table 1, Development of PC hardware and software

Hardware:	<p>(1) Atanasoff–Berry Computer was the first electronic digital computing device.</p> <p>(2) 1946 ENIAC (Electronic Numerical Integrator And Computer) was designed by two people called John Mauchly and J. Presper Eckert.</p> <p>(3) 1981 IBM, the IBM PC – 5150.</p>
Software	<p>(1) 1981 MS-DOS, short for Microsoft Disk Operating System, is an operating system bought by Microsoft.</p> <p>(2) 1983 Apple Lisa Computer The first home computer with a GUI, graphical user interface.</p> <p>(3) 1984 Apple Macintosh Computer The more affordable home computer with a GUI.</p> <p>(4) 1985 Microsoft Windows Microsoft begins its quick development.</p>

1.2 The aim and structure of the study

The aim of my thesis is to analyse future notebook PC development trends based on hardware and software aspects in more details.

The structure of my study is as follows. In Chapter 2 I give a more detailed review to the computers' history. Chapter 3 introduces a laptop computer and its main components. Chapter 4 gives detailed information about Lenovo Ideapad family. I introduce the mainstream notebook products in 2009 and 2010: Lenovo IdeaPad Y450 and Lenovo IdeaPad Y460. Chapter 5 shows the roadmap of the next Y product by comparing the functions which are inherited and dropped from the old generation. Chapter 6 introduces how to transfer a technology product to manufacture. After products are ready in warehouse, it is the time for service team to involve, so Chapter 7 focus on how do service for a laptop. Chapter 8 is a simple methodology of DFX (Design For X) introduction, which is for product optimizing. In Chapter 9 I show one future product concept with technology limitation and get a conclusion on what is a successful laptop product.

2 COMPUTER HISTORY REVIEW

2.1 The first un-programmable computer-ABC

Atanasoff-Berry Computer was build by Dr.Atanasoff and graduate student Clifford Berry in the basement of the physics building at Iowa State College during 1939-42. The system weighed more than seven hundred pounds (320 kg).and was 800 square feet (74 m²) in all. It contained approximately 1 mile (1.6 km) of wire, 280 dual-triode vacuum tubes, 31 thyratrons, and was about the size of a desk. [3]

ABC was not programmable, being designed only to solve systems of linear equations. And it is the first time to implement three critical ideas that are still part of every modern computer,

1. Using binary digits to represent all numbers and data.
2. Performing all calculations using electronics rather than wheels, ratchets, or mechanical switched.
3. Organizing a system in which computation and memory are separated.

In addition, the system pioneered the use of regenerative capacitor memory, as in the DRAM still widely used today.

2.2 Electronic Numerical Integrator and Computer

ENIAC (Electronic Numerical Integrator and Computer) is unveiled on February 14, 1946 at the University of Pennsylvania, with price of \$500,000. ENIAC has a huge volume. It contained 17,468 vacuum tubes, 7,200 crystal diodes, 1,500 relays, 70,000 resistors, 10,000 capacitors and around 5 million hand-soldered joints. It weighed 30 short tons (27 t), was roughly 8.5 by 3 by 80 feet (2.6 m × 0.9 m × 26 m), took up 680 square feet (63 m²), and consumed 150 kW of power.[4]

During the World War II, United States Army signed the construction contract on June 5, 1943 with the University of Pennsylvania's for the calculations of hydrogen bomb. [4] After 3 years, John Mauchly and J. Presper Eckert with their team efforts, ENIAC was formally accepted by the U.S. Army Ordnance Corps in July 1946. It was shut down on November 9, 1946 for a refurbishment and a memory upgrade, and was transferred to Aberdeen Proving Ground, Maryland in 1947. There, on July 29, 1947,

it was turned on and was in continuous operation until 11:45 p.m. on October 2, 1955. [4]

2.3 First MS-DOS Personal computer

IBM PC-5150 was introduced on August 12, 1981 by a team of engineers and designers under the direction of Don Estridge of the IBM Entry Systems Division in Boca Raton, Florida. Abbreviation MS-DOS stands for Microsoft Disk Operating System, is a single-user, single-tasking computer operating system that uses a command line interface.[5]

IBM5150 was released on August 12, 1981 and discontinued on April 2, 1987. Its Operating system includes IBM BASIC / PC-DOS 1.0, CP/M-86 and UCSD p-System; Its CPU is Intel 8088 @ 4.77 MHz and its memory covers from 16 kB ~ 256 kB. When IBM PC 5150 appeared in August 1981, it came complete with a 16-bit operating system from Microsoft, MS-DOS 1.0. This was Microsoft's first operating system, and it also became the first widely used operating system. QDOS (Quick and Dirty Operating System) is the MS-DOS 1.0's prototype, a renamed version of which Microsoft bought from a Seattle company in July 1981. QDOS was written by Tim Paterson, a Seattle Computer Products employee, for the new Intel 16-bit 8086 CPU (central processing unit), and the first version was shipped in August, 1980. Although it was completed in a mere six weeks, QDOS was sufficiently different from CP/M to be considered legal. Paterson was later hired by Microsoft. [5]

IBM authorizes a special team, led by Don Estridge, to bypass normal company restrictions and get something to market rapidly. To achieve this goal, Don Estridge with their 12 team members first decided to build the machine with "off-the-shelf" parts from a variety of different OEMs(original equipment manufactures) and countries. They also decided on an open architecture, so that other manufacturers could produce and sell peripheral components and compatible software without purchasing licenses. IBM also sold an IBM PC Technical Reference Manual which included complete circuit schematics, a listing of the ROM BIOS source code, and other engineering and programming information. IBM PC-5150 (see Figure 1) was announced on August 12, 1981. [5]

The most basic MS-DOS system, based on the following files:

- Bootable program of Master Boot Record (MBR). (MBR is located in the first sector of the first hard disk. It contains a small program that is read into memory and executed at boot.)
- Three other files of IO.SYS, MSDOS.SYS and COMMAND.COM.
- Besides, Microsoft also added several standard external programs or external commands in the retail system package.



Figure 1: IBM PC-5150 [6]

2.4 The First GUI Computer

Before GUI was brought to computers, end users had to use logical language to interact with computer because of the limited disk capacity and low performance of CPU and RAM. This kind of interface is called CLI (Command-Line Interface).

Apple Lisa Computer (see Figure 2) was the first home computer with a GUI (Graphical User Interface) and mouse combined. A GUI offers graphical icons, and visual indicators, as opposed to text-based interfaces. GUI greatly enhanced the efficiency and got the ease of use for both end users and programmers.

Today with the upgraded hardware, there is more space to store a large number of application programs, images, and icons. WIMPs (window, icon, menu, pointing device) present the user with numerous widgets that can trigger different kinds of the commands. The most recent development are the 3D user interfaces. Until now, people have used traditional 2 dimension GUIs, but lately there are more and more development in three-dimensional user interfaces.



Figure 2: Apple Lisa Computer [7]

2.5 Modern Operating System computer

When the first graphical user interfaces appeared, a large number of companies started to developed original operating systems. The main aim of this development was to offer for end users a user friendly interface to personal computer, This had a very important role in bringing the PC from institutions to individual users' entertainment. Today there are some very popular operating systems, such as Windows MS, Mac OS, and Linux (the free and open source software)

Accompanying with the development of operating systems, personal computer's hardware also becomes lighter, and thinner. Although the desktop computer is the most popular PC during the 1990's after the year of 2000, laptops become more and more popular. During the last couple of years they have taken an ever increasing role both in the professional and leisure use.

3 LAPTOP MAIN STRUCTURE

3.1 What exactly is a laptop is?

The name 'Laptop' comes from two words: lap and top, which is a portable personal computer, designed for mobile use and small and light enough to sit on one's lap while in use. [8]

A modern typical laptop is usually consisting of a display, a keyboard, a touchpad, speakers, a camera, and a battery. Except above visual common components, there are some other very important components inside: Chipset, CPU, RAM, Hard disk drive, Optical disk drive and many I/O ports for external device: VGA port, USB port, LAN port and so on.

Laptops are usually shaped like a large notebook with thicknesses between 0.7–1.5 inches (18–38 mm) and dimensions ranging from 10x8 inches (27x22cm, 13" display) to 15x11 inches (39x28cm, 17" display) and up. Modern laptops weigh 3 to 12 pounds (1.4 to 5.4 kg). [8] Figure 3 shows an example of a modern laptop computer.



Figure 3: Lenovo IdeaPad Y450 Laptop [9]

3.2 Mainboard and platform

There are four main chipset vendors, INTEL, AMD, nVidia and VIA. They usually first release their products specification and roadmap before it is really launched to market, With new applications and features of their products. They compete with each other to let PC vendors to choose their products as new laptop platform. When a new

laptop product is launched to PC market, chipset vendors will launch their new platform at the same month.

Because Intel has traditionally dominated the chipset market, I will only introduce Intel and the following two products are both Intel Platform.

In 2009 Intel's main platform is Montevina, which is used on LENOVO IdeaPad Y450. And the next generation platform is Calpella in 2010, which is used on LENOVO IdeaPad Y460 products.

The codename Montevina refers to the fifth-generation Centrino platform, now formally named Centrino 2 to avoid confusion with previous Centrino platforms. The codename Calpella refers to the sixth-generation Centrino platform; it will be competing with the AMD Fusion platform. But as of November in 2009, the wireless adapters are still not available, hinting another possible delay for the platform. [10]

Based on the current platforms, I will introduce each components of laptop. Together these components smoothly provide service to end-users.

3.3 Main components introduction

Figure 4 shows the main components of a laptop. Each component will be discussed in more details in the following sections.

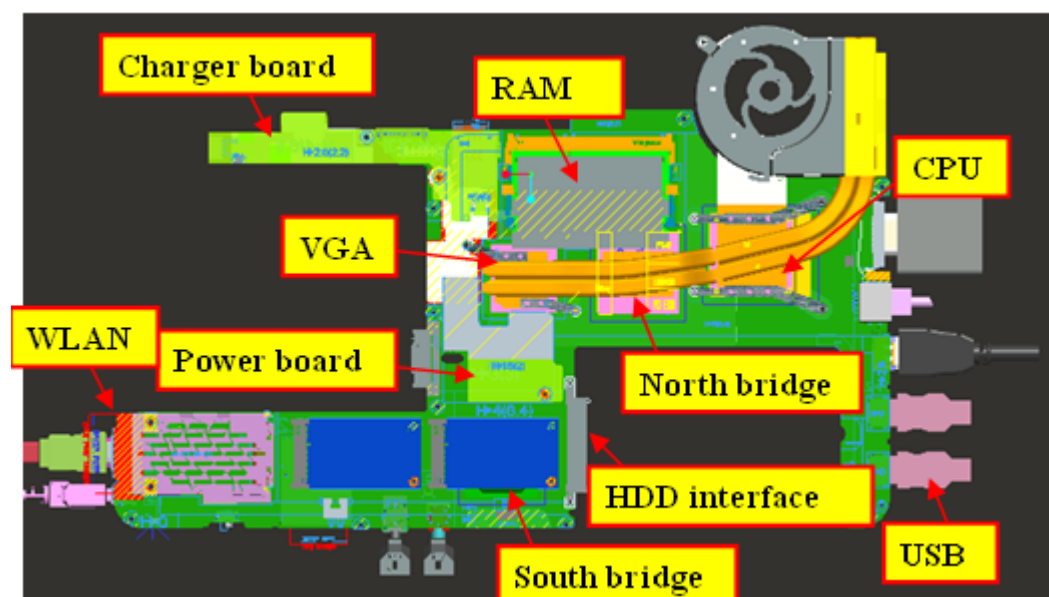


Figure 4: Lenovo IdeaPad Y450 Laptop MB Placement with main components [11]

3.3.1 Processing Chipset (North & South bridge, GPU)

The north-bridge is one of the two chips in the core logic chipset on a PC motherboard, the other is south-bridge. Both of them are connected to different interfaces. North-bridge is usually directly connected to the CPU, so it is also called memory controller hub (MCH) or an integrated memory controller (IMC) in Intel system. The south-bridge is also called as I/O Controller Hub (ICH) in Intel systems, which implements the "slower" capabilities of the motherboard in a north-bridge and south-bridge chipset computer architecture. See Figure 5 for more details. [12] [13]

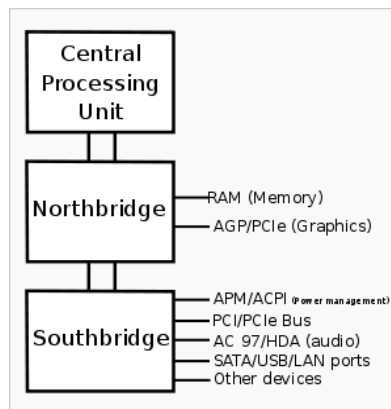


Figure 5: Southbridge and Northbridge [12] [13]

About the GPU, is the Graphics Processing Unit for Video Graphics Array (VGA), which refers specifically to the display hardware. Modern GPUs are very efficient at manipulating computer graphics. In a personal computer, a GPU can be presented on a video card, or it can be on the motherboard. More than 90% of new desktop and notebook computers have integrated GPUs at the beginning of 2000s, which are usually far less powerful than those on a dedicated video card.[14] While now, more and more discrete video card is used on laptop by the graphics technology significant development. Especially more and more 3D games are popular with end users.

By using integrated CPUs or dedicated video card, laptop is distinguished to two main types: UMA and Discrete series.

3.3.2 Central Processing Unit (CPU)

The Central Processing Unit (CPU) is the most important elements carrying out the computing function. It does the high-speed calculating and processing, which is like the heart of the human being. Its standardization trend generally began in the era of discrete transistor mainframes and minicomputers and has rapidly accelerated with the popularization of the integrated circuit (IC). The IC has allowed increasingly complex CPUs to be designed and manufactured to tolerances on the order of nanometers. [15]

3.3.3 Random-access memory (RAM)

The Random-Access Memory is similar to memory capability of brain. Data stored in RAM can be quickly fetched, but its capacity is limited. Today, it takes the form of integrated circuits that allow stored data to be accessed in any order (i.e., at random). "Random" refers to the idea that any piece of data can be returned in a constant time, regardless of its physical location and whether or not it is related to the previous piece of data.[1] Until now, mainstream of laptop RAM is 4G and the maximal value is only 8GB (1GB=1,000MB, 1MB=1,000KB, 1KB=1,000bytes.) [16]

3.3.4 Hard Disk Drive (HDD)

The Hard Disk Drive (HDD) is often called hard disk or disk drive, HDD is used to fix the capacity problem of RAM. HDD can store large amounts of digitally encoded data on rapidly rotating rigid (i.e. hard) platters with magnetic surfaces. Accompanying with the magnetic density on one tape surfaces is greatly enhanced, we get much bigger storage HDD now. Until now, mainstream of laptop HDD is 320GB and the maximal value is 640GB. [17]

3.3.5 Optical Disk Drive (ODD)

The Optical Disk Drive is used to read digital data from a CD or DVD etc. ODD itself does not storage any data. Optical means it uses lenses. The drive uses a light called a laser. The CD or DVD disk is similar to a mirror and the laser light reflects off it. The disk has very small (microscopic) codes written on it. The drive has a very small camera lens beside the laser which can read the codes. Some drives can only read from discs, but recent drives are commonly both readers and recorders. Until now, mainstream of laptop ODD is DVD+RW for rewritable DVDs. [18]

3.3.6 Other main optional ports

There is also Wireless LAN placed in above picture. Wireless technology is very mature and gets very stable environment in many places now, so it has become as one of the mandatory function in a current laptop.

We could see 2 USB ports at the right side of Figure 4. and they connect to the south bridge. The current mainstream standard is USB 2.0 and these ports can be used to connect laptop with a lot of external USB devices. Besides, there is a 6in1 card-reader placed near the south bridge.

Those optional ports are obviously benefits for end users, but they will enhance the cost too. So this kind of functions are originally optional or additional functions. However, when end users needs increases and the technology is mature enough options will become mandatory features on laptop. Adding optional features at the right time offers a PC vendor a possibility to offer value-added features to its customers and thus gain great profit and business success.

4 LENOVO IDEAPAD Y SERIES 2009-20010 PRODUCTS REVIEW

4.1 Lenovo IdeaPad Y series product introduction

Lenovo IdeaPad Y series product is the most important product in all Lenovo consumer products. It is famous for its high performance and reasonable price in market, which provides high quality ID ((Identification) and UE (User Experience) design to enable customers' life& work entertainment.

4.1.1 Target customers of Y series product

Table 2 lists the main characteristics of the Lenovo Ideapad U series targer customers.

Table 2. Target customers of Y series product [Lenovo source]

<p style="text-align: center;">College students from 18-25 years old; Young professionals age from 25-30 years old; Majority male with personal fashion taste; Enjoy online entertainment; Care for quality.</p>
--

This group of people is focused on the needs which could stand for their self-actualization. They have comparatively stable life & work environment and pursue the better entertainment and better life.

4.1.2 Demand of target customers

In this section I will discuss the customer demand from two different perspectives: real and potential demand.

Real demand

It must stand for the latest platform and current technology, which could be clearly represented by the hardware configuration of CPU, graphics, HDD, RAM and software configuration of operation system and application.

Potential demand

It is derived from current product, but it can not be brought to market due to technology is not so mature that it will cost too much on manufacturing and service, but it represents the customers expectation, which will not get big impact if customers do not have this kind of function, but if some of potential demand is come true, it will take the whole industry's change. For example, when MS WINDOWS come to personal computer, it takes the big influence in IT world. So this kind of demand could take big success and opportunity to the computer vendor, but it is so hard to realize.

4.1.3 Solution for Y series product customer demands

After a product is defined by market team, it goes in to development, manufacturing and service phase. There will be a lot of unexpected problems during the product life cycle. Product engineers will focus on all the issues in each phase. The primary issues are: systems could not power on, main components (CPU/HDD/RAM etc.) are broken because of components quality or system mechanical defect, software works abnormally (show error information or no response when customers use it) and so on. To meet the brand reputation, every vendor focuses on how to improve the efficiency of solving problem and prevent it before end user discovers it.

During the product life cycle, customers will publish their ideas after experience the product by forum or other media. They also sometimes send out their good advice to optimize the product, product engineer will study it and try to brought it to the product as additional offer to bit the competitor.

4.2 Lenovo IdeaPad Y450Y460 comperation

In 2009, Lenovo brought the most successful product of IdeaPad Y450 to occupy the big market-share. It is the graphics which makes this miracle happen. I will introduce this product in detail in the following sections.

4.2.1 Lenovo IdeaPad Y450

Hardware

Lenovo IdeaPad Y450 uses the 2009 Intel Montevina-Penryn CPU (35W/25W). It first used the 14.0 inch 16:9 wide screen because of panel industry incision technology change.

Because it use nVidia newest technology earlier than other products, and its target users are game players, it will give end users, especially 3D game players more vivid scenario experience, and it then lead the game player markets.

Details of the hardware configuration are show in Table 3.

Table 3. Lenovo IdeaPad Y450 hardware

Platform	14.0 inch 2 spindle
Processor	Intel-Penryn
Chipset	Montevina-Penryn
Display	14.0 inch wide HD/FHD
Graphics	Integrated Intel Graphics Discrete: 55nm NV NB 10M+256MB 55nm NV NB 10P +512MB 40nm NV NB 10P +512MB 40nm NV NB 10M +512MB
Memory	DDR3 1066 to 4GB, 2 DIMM slots/8GB maximum
Storage	2.5" HDD only Main stream: 250, 320G,500G with5400rpm Optimize stream: 320G with 7200rpm
Battery	6 cell 2600mAh Lion battery
Weight(configured)	2.0Kg/6cell for UMA, 2.1kg/6cell for Dis
Dimension	Under 336mm x 228mm x 24~34mm
Material	PC+ABS
A-cover	Painting, IMF,
Camera	1.3M Pixels with LED indicator
Communication	WLAN/WiMAX mini PCIe card 802.11a/b/g Intel and non-Intel,802.11n, MIMO(3x3), WWAN mini PCIe card (GPS/WCDMA,TDSCDMA,CDMA2000), W/SIM card slot 10/100/1000, Giga Ethernet 56K V.92 Fax/Modem

	Bluetooth support
K/B	ISO standard compliant full size 6-row keyboard
Pointing	Touchpad w/Rubber-dome buttons/LED indicator
6-in-1 Card Reader	SD/SD pro/MMC/MS/MS Pro/xD
Speaker	2.0 channel brand speaker with 4 speakers
I/O Ports	1394, 3USB, ESATA, RJ-45, VGA, HDMI, Build-in Array, Microphone, Microphone-in, Headphone-out with S/PDIF, CIR
HDMI	IHDMI 1.3b and HDCP test certification

Software

Lenovo IdeaPad Y450 was launched in April, 2009 with MS Vista operating system. Later in Sep, 2009, Lenovo IdeaPad Y450 introduce Windows 7 OS to enhance end users experience.

Besides OS is keeping with the main stream, IdeaPad Y450 also use unique application with hardware (Slide Bar) which it is called Lenovo Slide.Nav (see Figure 6).



Figure 6: SlideBar in Lenovo IdeaPad Y650 [19]

4.2.2 Lenovo IdeaPad Y460

Hardware:

Lenovo IdeaPad Y460 uses the new Intel chipset of Calpella Arrandale. It uses the 14.0 inch 16:9 wide screen because of panel industry main stream.

To continue to hit end users expectation on graphics, Lenovo IdeaPad Y460 introduced ATI graphics to provide the switchable graphics mode to continually improve end users experience. So except traditional Integrated graphics and discrete graphics, there is another graphics mode: switchable mode. End users can choose a different mode for their needs by easily push the mode change button. It also can help end users to save battery life when they do not need so high performance with graphics.

Lenovo IdeaPad Y460 has another totally new function, SSD (Solid State Drive). It can greatly improve system performance. From Table 4 we can easily see the advantages and disadvantages of using SSD. The main advantages are performance, power, shock, weight, and MTBF (Mean Time Between Failures). The disadvantages of the SSD are cost, and capacity.

Table 4. Compare SSD to HDD

Table 4. Comparing the technologies

1Q 2008	1.8" SSD Native SATA	1.8" 5400 RPM SATA	2.5" 5400 RPM SATA	2.5" 7200 RPM SATA
Capacity	64 GB	80 – 120 GB	80 – 250 GB	100 – 200 GB
Cost	\$700	\$126 - \$162	\$43 - \$91	\$63 - \$121
Performance	110-250%	79%	Ref. (100%)	118%
Vista Boot Time	50%	130%	Ref. (100%)	85%
Average Power	0.08 W	0.6 W	0.9 W	1.0 W
Op. Shock	1500 G	500 G	325 G	350 G
Weight	44 g	62 g	102 g	115 g
MTBF	1.2 MH	300 KH	400 KH	400 KH

For the detail hardware configuration please reference to Table 5. And there is new column to mark with N to represent as new or upgrading from Y450

Table 5. Hardware configuration of Lenovo IdeaPad Y460

Platform	14.0 inch 2 spindle	
Processor	Intel Arrandale	N

Chipset	Calpella Arrandale	N
Display	14" 16:9 wide screen HD, Glossy, LED	
Graphics	Intel Integrated Graphics Discrete: 16W (nVIDIA N11-GE1), 25W (nVIDIA N11P-GS) with 512MB DDR3	
	Switchable: Intel Integrated Graphics with ATI- Pro+1GB	N
Memory	DDR3 1066 to 4GB, 2 DIMM slots/8GB maximum	
Storage	2.5" HDD only Main stream: 320G,500G with7200rpm Optimize stream: 640G,1T with 5400rpm	
	1.8" HDD with SSD (share one full card slot with WWAN)	N
Battery	Li- Cylinder , 6-Cell	
Weight	2.25Kg w/6 cell battery	
Dimension	340*232*19.8 ~38 mm	
Material	PC+ABS	
A-cover	Painting, IMF, IMR	
Camera	1.3M Pixels with LED indicator	
Communication	WLAN/WiMAX mini PCIe card (802.11 a/b/g/n + 802.16e) , MIMO 3x3, WWAN mini PCIe card (GPS/WCDMA,TDSCDMA,CDMA2000), W/SIM card slot	
	10/100/1000 Ethernet, BlueTooth 2.1,	
K/B	ISO standard compliant full size 6-row keyboard	
Pointing	Touchpad w/Rubber-dome buttons/LED indicator	
6-in-1 Card Reader	SD/SD pro/MMC/MS/MS Pro/xD	
Speaker	JBL stereo Speaker 2W*2ch, 10CC/ch ,	
I/O Ports	3 USB, Card reader, DC-in, CRT, HDMI, RJ45, eSATA , Mic IN, CIR, Microphone, Microphone-in, Headphone output jack, Headphone output jack with S/PDIF	
HDMI	IHDMI 1.3b and HDCP test certification	

Software:

Lenovo IdeaPad Y460 was announced with MS Windows 7 in Feb, 2010. At the launch some old applications were also upgraded and some new applications were introduced to enhance end users experience.

IdeaPad Y460 upgraded Lenovo Slide.Nav application based on Slide Bar hardware, especially the zipper function of locking the screen bring users good experiences. When users slide their fingers on the slide bar from the left side to right side, the

screen will show a zipper as on the right picture of Figure 7. If you then click any button on Keyboard, it will no respond. It greatly help users to prevent unexpected operation when they leave they computer. When users come back, they only need slide fingers from the right side to the left side. It will unlock the computer and you can work normally.

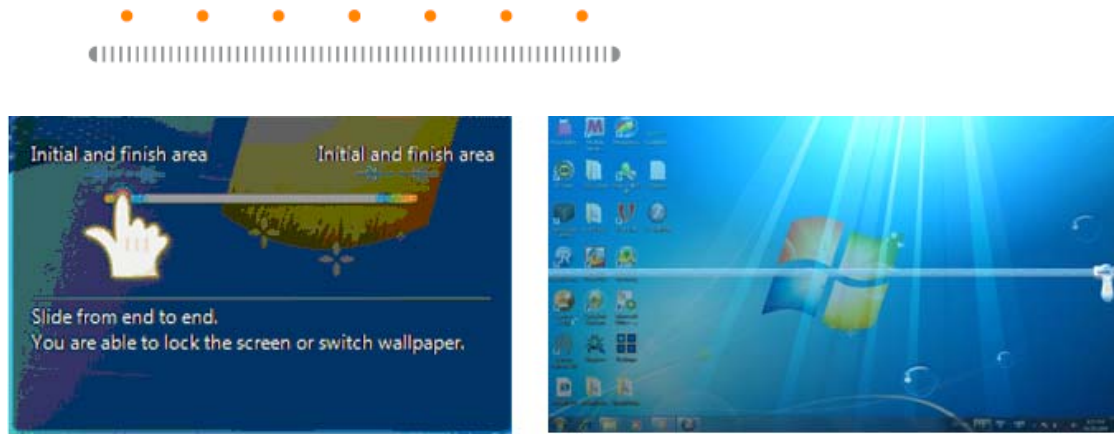


Figure 7: Slide bar in action [20]

5 2011 LENOVO IDEAPAD Y SERIES PRODUCTS EXPECTATIONS

The successful IdeaPad Y450 provides a strong graphic features to end users, and Y460 keeps to improving the graphics experience. The next generation products Lenovo Y4X0 must include new features to attract more and more users.

5.1 Lenovo IdeaPad Y4X0 concept

Lenovo IdeaPad Y4X0 is the new product of 2011. It comes to the design concept phase in the early 2010. As a brand vendor, Lenovo needs to define the basic structure and features when applying it to the product operation phase. As a new product, it must provide better performance than the old generation of IdeaPad Y series. For the business confidentiality reasons, I will only list the main factors or trends but not detail and final parameters of hardware and software.

Hardware

Hardware features give the most intuitional guidance to end users. From all hardware related features graphics is probably the most important feature for end user. Therefore it is one of the most important features in a new product and thus Lenovo must improve graphic features of its devices all the time.

In addition to graphics other components of the PC must also be developed. For example, the hard drives and RAM memory size have developed as follows: In 2008 HDD main stream was 250G with 5400rpm, 3200G with 5400rpm in 2009, but in 2010, it reached 320G/500G with 7200rpm. RAM main stream was 2 GB in 2008, 2 - 4 GB in 2009, but in 2010, it reached 4 - 8 GB.

A new product must use the new generation of chipset and processor to make sure the system could run smoothly to support the continually growing storage needs of HDD, RAM and 3D or other software.

Table 6 lists the hardware feature of the new Y4X0 concept product. There is the third column in the table to mark with N to represent as new or upgrading from old Y series.

Table 6. Hardware concept of Lenovo IdeaPad Y4X0

Platform	Intel Huron River platform. AMD Sabine platform	N
Processor	<p><u>Intel Platform</u> Support all speeds available for the Intel Huron River Sandy Bridge QC and DC processors and supported off-roadmap processors and Value segment processors on Huron River platform with rPGA CPU socket. Mechanical design must support on-coming higher clock speed in this product program life. New lower power technologies support such C7 state, Intelligent power sharing. Support Intel CPU Turbo and HT.</p> <p><u>AMD Platform</u> Support all speeds available for the AMD Sabine X2/X3/X4 processors and supported off-roadmap processors and Value segment processors on Sabine platform. Mechanical design must support on-coming higher clock speed in this product program life.</p>	N
Chipset	Intel Huron River/AMD Sabine	N
Display	<p>Should support HD and HD+. Aspect ratio is 16:9 for all models. Glossy type is required. Backlight is LED backlight. Interface is LVDS.</p> <p>For 14W Flat type and Wedge type are required for RFQ feedback. (Supplier should consider co-design to max share tooling)</p>	N
Graphics	<p>Integrated Graphics Intel Huron River integrated graphics AMD Sabine integrated graphics</p> <p>Discrete Graphics AMD or NVIDIA external graphics. 25~30W level GPU Optimus/switchable graphics, VRAM: GDDR5 type, x8pcs. Need to compare MXM and on board solution.</p>	N

Software

A good software is a key benefit to end users. For a very long time Microsoft has dominated the operating system markets of the PCs. Since Windows 7 launched in Sep 2009, it successfully took the place of the Vista and got good feedback from customers. In the next Y series generations, it will use Windows 7 to support to market undoubtedly.

Except the operating system, there will be a lot of good applications in Y series products to give the system stronger performance. A traditional application is power management which is developed so that end users can select between different battery modes to save battery life. The most important thing is that software tools needs to developed and provided to Manufacture and Service centre.

5.2 Dropped functions from the old generation

New products do not only increase new features but also some old features can be dropped out. The dropped features are discussed in this section.

Hardware

Because industry design trend prefers much thinner and lighter products, Lenovo must drop some useless functions and less beneficial functions to save more space. From Lenovo IdeaPad Y450 to Lenovo IdeaPad Y460, we dropped the I/O ports of RJ11 (connect to telephone) and modem. Now we plan to drop New Card or Wireless WAN function in the next Y generation to save more space for Power IC to support higher speed processor to enhance system performance.

Software

To save the power on time, we also drop the multimedia effect in BIOS from IdeaPad Y450. It will give end user much better experience, because not only the time is longer, but also there will be a background music, a lot of customers complain it is too loud when they work at office.

5.3 Upgraded and added functions in new generation

Naturally some new features must be added to new products. These features are discussed in this section.

Hardware

A chipset and a processor are the main factors of the new product. However, the development is not limited only to this portion, but all features such as Industry Design or the unique packing must be developed to make a product more competitive.

Industry Design is one of the most attractive features of the product. In 2008, the net-book achieve great success by its extraordinary slim with basic functions. At that time we realized that it is very important to introduce the fashion elements also to laptops. For example, Lenovo IdeaPad Y450 provided a NBA series by print the NBA stars logo on the A-cover during the 2009 NBA season. IMF (IN MOLDING FILM) technology is the contributor for this colorful printing. We may introduce others arts and crafts in new generation to add the modern elements with all effort. It may be metal ID or anodizing but not limited to it.

Software

APS (Active Protection System) is one of very successful software on Lenovo product, which co-works with a shock IC to detect the hard disk status. If a hard disk suffers a sudden force from outside, APS will send command to the hard disk not deal with any data to protect hard disk. This feature is favored by a lot of business man.

Y series is one of the most important Lenovo's consumer products. Therefore it has the responsibility to provide some unique software to meet the consumer potential demands, such as Split-Screen, Slide-Bar.

Split-Screen application will solve the inconvenience problem especially among game players. Currently all 3D games will take the full screen space, so it does not allow players to chat and play the games at the same time. Split screen technology shown in Figure 8 is a very attractive feature for them.



Figure 8: Split screen feature in action [21]

To meet the end users potential demands, we will provide more and more vivid and convenient applications to them.

6 MANUFACTURING LAPTOPS

After a product is defined the concept is ready. RD (Research Development) team will apply all the functions to the whole system, and it will estimate an executable development schedule to define each verification phase for the system before it can be released to the manufacturing phase. Usually there are four verification phases:

- DV (Design Verification),
- FVT (Functional Verification Test),
- SIV (System Integrated Verification),
- SIT (System Integration Test).

6.1 Transfer development phase to manufacturing by engineering work

After the development team complete system verification, NPI (New Product Introduction) team will carry out the following two phase to bring the product to mass producing phase:

- SVT (System Verification Test),
- SOVP (Start of Volume Production).

I will show what will happen during the two phase.

There is a SIT (System Integration Test) stage before SVT. RD team will do a lot of tests to make sure the product quality is good enough before shipping the product to the market. So if a product is ready to SVT, it must meet below criteria:

Firstly, test is completed and all serious issues are closed. Table 6 shows an example of a case in which a driver does not pass Microsoft Windows Hardware Quality Lab test This test is primarily to make sure that the system hardware and hardware driver are stable and compatible with the Windows operating system. WHQL test is mandatory if the computer will be shipped with Microsoft Windows operating system.

Table 6. Lenovo Y460 Software issue data example

Issue ID	Title	Severity	Description	Failure Rate	Category
8812	WIN7:Wireless	3	<u>BIOS</u> :27CN01WW	Frequent	Driver-

Driver have not passed WHQL (2 warning)	Image:Win7 6.1.7600 Build 7600 Wireless Driver :intel 13.0.0.92 SKU:KL2-UMA	(> 10% of time)	Bluetooth/Wireless LAN / Wireless WAN
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Secondly, a product engineer must create the BOM (Bill of Material) for product line to choose the components which are qualified in the development test phase to continually verify if it is really ready for manufacturing.

A whole laptop system consists of a large number of components and component groups and the most important one is the main bone group which is usually called as Shell Group or Bare-bone Group. Every component has its unique part number, only when this component passes all test on this product, it could be added to the MP (Mass Produce) BOM. Then the procurement team will buy these parts from the supplier, and the manufacturing team will produce products based on this chart. Similarly the service team will store information about different key-parts for different projects.

If any component is added into BOM without qualification by mistake of product engineer, it will bring tremendous disaster for the whole company even bankruptcy if this wrong product is already at end users hand and it has safety issue.

So it is very serious to add any component in BOM. I list in Table 7 one of the simplest BOM samples for reference.

Table 7. Lenovo Y460 Shell BOM

Level-1	Part Number	Description	Quantity
	86-001970	Y460 Shell Group	1
10	69-034957	Y460 MotherBoard HM55 Group	1
20	69-034565	NV VRAM group	1
30	69-xxxxxx	2.5' HDD group	1
40	69-xxxxxx	Panel group	1
50

6.2 Improving the products for the manufacturing product line

After SVT is closed, SOVP will be brought to the product line to verify if it could support mass production. Because some defects can only be found when the products amount reach to a certain extent. So SOVP is necessary and mandatory.

SOVP is divided into at least 3 stages.

First stage

The New product introduction team will release the first product order to manufacturing team to run 50~100 pieces systems on the product line.

The product engineer must guarantee that all systems on a laptop can work normally (Power on/Power off/ OS basic function/Led light right etc.). If the system works properly the OOBE (Out of Box Experience) test team will check the accessories, such as:

- additional battery,
- power-cord is right for different country,
- the user manual language and content is right without any printing mistake,
- service flyers are with the right service information,
- the packing carton is right with all certification labels to meet the supported country's safety and customs requirement.

The whole process needs 1.5 days.

Second stage

When the first lot runs smoothly, then the second lot will be produced. The number of produced laptops could reach to 100~250 pieces, and the product engineer still needs to guarantee the whole process. All the operations are carried out here the same way as in the first phase. It needs about 2.5 days.

After the previous 2 phases, there are typically some issues found, which must be clarified before the process can go to the third stage. All the issues can be divided into 3 categories.

The first category is operator workmanship. It means improving the operators operating skill. For example, during the system function check time, some systems may not power on or some panel show garbage information, which may be caused by loosen memory or HDD. Even a panel cable can be destroyed or loosen during the assembly process. These issues are caused by operator workmanship, so the manufacture needs to pay high attention to the weak process and keep monitoring and the following the process. It is also possible that the poor workmanship will cause the OOB test fail because of mixed manuals or accessories in the packing.

The second category is the component issue. As mentioned above, workmanship will cause systems work abnormally, but sometimes, the components connector is so weak that even the most proficient operator cannot assemble a fully functional laptop. This kind of issue will be recognized as component weakness, and Lenovo quality team will request a vendor to improve the component quality. As long as there is no solution to the problem, the quality team will forbid the use of the component with poor quality.

The third category is the reliability issue. It has a fail rate and the problem can not be duplicated easily. For example, when 50 laptops run the auto hibernation/power on/power off automatic test for 4 hours or longer, some systems will get blue screen, black screen or some systems will hang up. Then if the whole lot meets the same issue with the same test program at the very low fail rate, maybe less than 1/‰ or lower, some issue could be regard as at the safe level. But when for example the blue screen appear at very high fail rate, maybe reach to 1%, it will stop the manufacturing process, and let the system to duplicate this issue to get more data by some debug card to check the cause of the problem.

Third stage

Only after the previous two stage completed, the third stage can begin. At this stage, the product line will input 350~500 pieces systems at one time. It will monitor the workmanship and some components improvement solutions and the fail rate status.

After the three stages are completed, it proves that this product can be smoothly assembled and tested by the product line. It is important to prevent any serious issue to stop the product line, because it will cause a huge cost for the whole company.

Now the quality team and the manufacturing team will formally let the new product to go to the mass production phase, and about one thousand systems are already at warehouse. So the project team will announce that it can ship and support the product and the sales team can sign order with customers.

SOVP is the stage before mass product, and which brings qualified systems to the product line with the amount is about one thousand.

When the production increases, new issues will be found and the development team must study them and find also solutions to other issues like:

- to improve the mechanicals structure to save the assembly time,
- to study the more efficient test tools to cover more test program to save the test time,
- to study how to prevent broken components come to the product line as less as possible.

The product line optimization is a continuous work during the product whole life cycle.

7 PROVIDING SERVICES TO THE CUSTOMERS

Before the product is released to mass production, Lenovo service team will do a lot of preparing work. It will publish system BIOS, drivers, digital manuals and some guidance for the new functions of the new products on the website as soon as the project team has announced this product is ready to ship-support as preparation work.

Service team has another high loading work, which is to handle the feedback from end user. Some of the issues are very serious and could impact the normal usage of the system. This kind of issues must be solved in very short time. Other issues are not so serious and they can be related to the fulfilling the customer needs and expectations. This kind of issues will be sent back to the design team for the next generation development phase to continuously optimize the products.

7.1 Handling end user problems

We need to prepare web upload package including drivers, BIOS and other necessary packages to service team, so customers can download them from our web site.

If required, we provide service team machine samples before massive production, and even provide necessary document or face-to-face training to the service team.

When we ship products worldwide, diagnostic software is very helpful to reduce service cost. When a problem happens, before customers call, they can run this diagnostic software to tell service team the error code or other useful information. It can reduce the call time, and eventually saves money. However we do not have this software until now, but it will eventually come true to save cost.

After product is transferred from the manufacturer to the customers, the service team will get a lot of broken components or systems from every service centre. They will firstly check what caused the problem. When it is affirmed as quality problem, Lenovo has the responsibility to replace the components or systems. This kind of issue can be solved easily, but there are some issues can not be solved immediately, such as BIOS/EC/Driver or utility issues. As we discussed in the chapter 6 of SOVP stage, there are some blue-screen/black-screen happened during the product line. When the

users are using the product normally they may meet the same problem for example when they play some 3D games or other applications. Especially when this problem has high fail rate with 3D games, this kind of issue becomes the first priority issue for development team, and the development team must duplicate this failure with the same condition and try to uninstall other application or drivers one by one to check the problem.

When it is confirmed as a driver crash, a driver vendor has to update driver to release patch to fix this issue. However when new driver or patch is ready, development team has to re-test system with whole test items to verify it will not bring other defects. Before the development team can give solutions, the service team has to appease customer emotion and try to ask them to use this function only after the solution is ready. However, some customers still want to return systems to service team, so service team has a great pressure to let customers calm down as they can to save company's business from both cost and reputation.

7.2 Improving the products for a service centre and customers

Although service will not be participated by the development team, they play a very important role in the whole product life cycle.

At the very beginning of the concept phase, the historical data from service team will be useful to gradually improve design. During RFQ timeframe, service will input their requirement for serviceability, so the product design will facilitate service team assembly / disassembly, and reduce service cost. For example, DC IN connector normally is soldered directly to motherboard, and it is easy to crack if customer insert the adapter too hard. If DC IN cracks, the service team has to replace the whole motherboard, and the cost is very high. Therefore the service team might request a designer to separate the DC IN socket and the motherboard, and to connect them by wire. Therefore, DFS (Design for Serviceability) should be noted during the whole product development phase.

Although we do not define FRU (Field Replaceable Unit) and CRU (Customer Replaceable Unit) parts by ourselves, it should be development team's responsibility to tell the service team about the FRU and CRU information. A service manual named as

HMM (Hardware Maintenance Manual) should be prepared by development publication team also, so service team will know necessary information to do field service.

8 HOW TO OPTIMIZE THE PRODUCTS

If we want to send out a perfect product to customers, we have to be concerned the following perspectives, development design phase, manufacturing produce phase and service team maintain phase. In industry, we called a product must start with the assessment of Design for X (DFX). X means everything which could enhance the product value. It includes new technology, assembly method, service, quality, cost, but not limited to those. Besides above X, there is another very important factor for a successful product, which is innovation.

8.1 Design for X

Balance is the most important factor when DFX, I list two example to show how to balance when DFX on a new product.

8.1.1 Market features and procurement cost

The market team always needs new functions and unique features to attract customers, so new technology and new ID (Industry Design) is the key for them. While the procurement team prefers the consistency in products. It will also get good prices for the components from the suppliers. Take one example, Lenovo ThinkPad series is commercial product, it mainly features new product in technology but not ID. So it uses a lot of common mechanical design, such as battery, without shape and painting change. It will get a lot of cost down because it needs no new tools and tests can be reduced a lot. But Lenovo IdeaPad series is consumer product. It focuses on both technology and ID, so it needs a lot of new ID and even painting technology. It always returns to cost. So a classic ID is more important for IdeaPad than ThinkPad. And it is the balance of between market features and procurement cost.

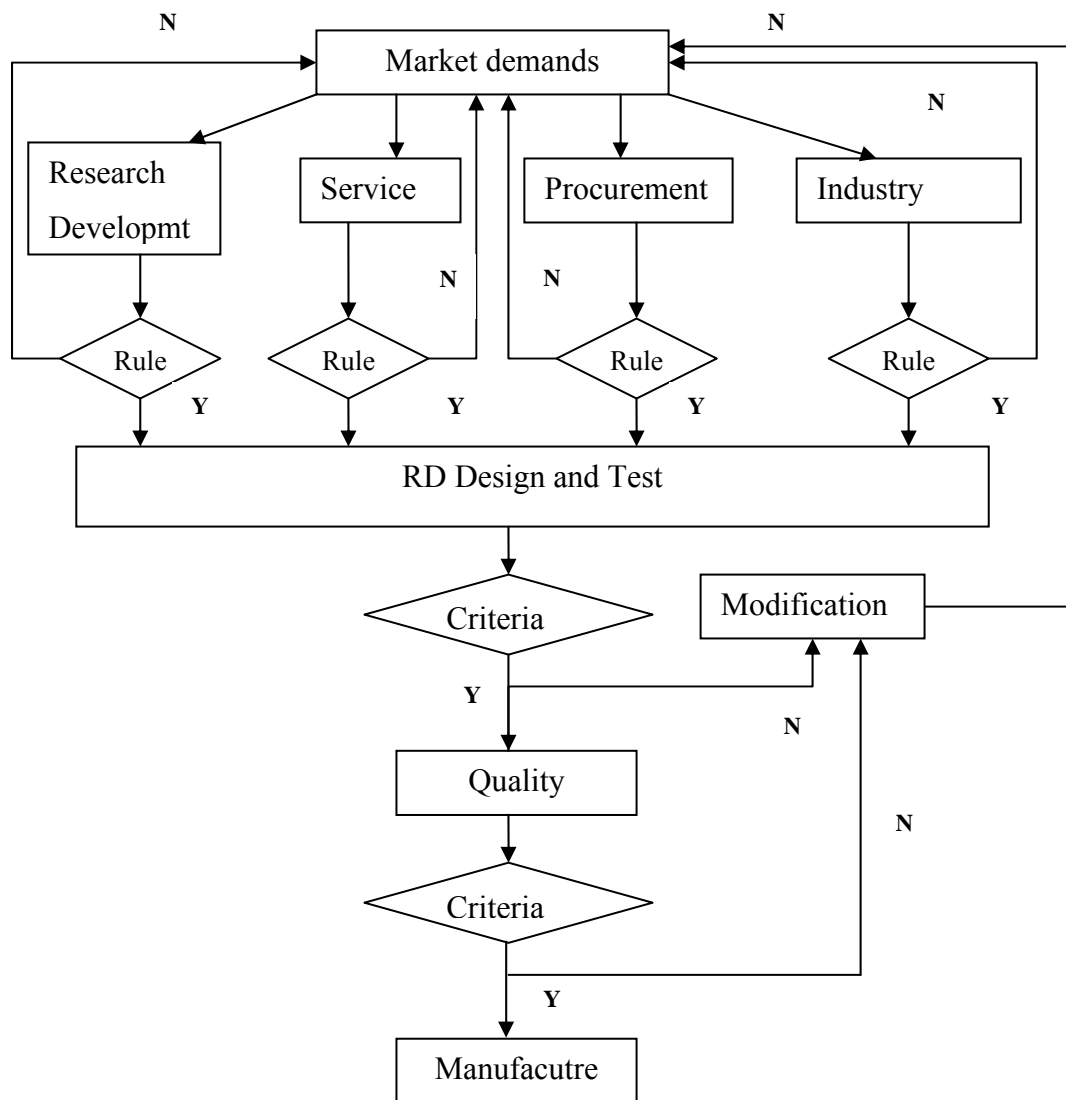
8.1.2 Manufacturing and service

The manufacturing team is focused on the assembly time for their KPI (Key Performance Index). So it needs as many as possible key parts mounted to the motherboard, and as less as possible screws to connect the components. But for the service team, it hopes that the key parts such as CPU, HDD, RAM are replaceable units which can be

easily replaced.. Because the components are common parts for most of projects, but the motherboard is a unique part for each project, it will easily bring the unique parts storage or shortage issue. And also more Replaceable Unit will let users have a better experience to improve their systems as easily as possible.

Besides above aspects, there are other teams concerns need to be considered, please see a simple flow chart about how to optimize product by DFX.

Table 8. Design for X on a laptop



8.2 Innovation

Innovation is a never ending process to develop a product, It is partly based on the current requirements to reflect the potential demands of customers. Usually customers hand up clear requirement, and the customer research team will check and analyse them with the market team and request the RD team to work out proposals. Finally the whole development team will work out to find the best solution. The research team not only needs to analyse the current data but it needs also to research the potential development possibilities for the development team. So innovation is not only to solve customer problems but to send out a total new method or function to the products. Please see the innovation phase in Figure 9.

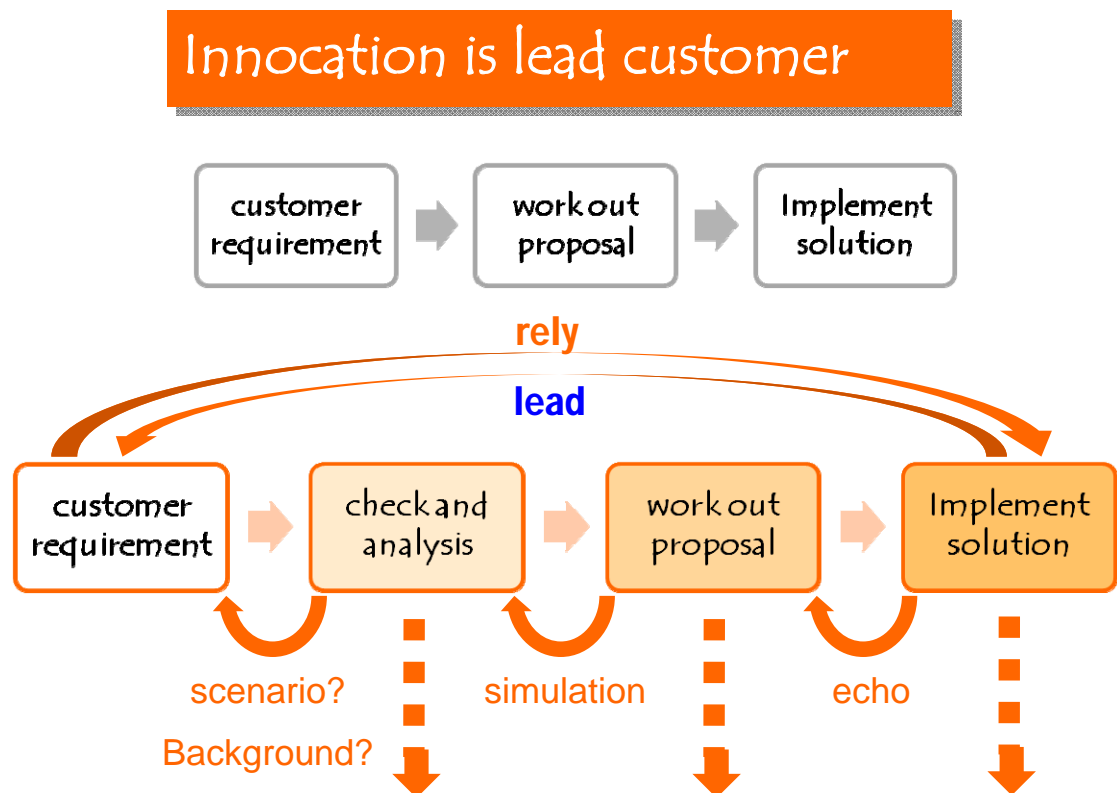


Figure 9: How do innovation [22]

9 FUTURE OF LAPTOPS

From IdeaPad Y450, we can easily see that there must be some leading features in every product before it can get great success. I also believe that technology is always the most powerful portion of a product and this holds true especially on notebook markets. In this chapter I introduce a new kind of laptop prototype. This prototype highlights one of the possible developments of laptops in the future.

9.1 Product concept

Because portability is one of the most significant features of a laptop they must be small and light. Therefore we can imagine totally remove some of the common components from it. For example, we can consider a laptop without a keyboard just like iPhone has realized it with a touch panel. Similarly we can easily get another idea of dropping the panel or screen by adding one little projector bulb to project the screen on a plastic cover. It will bring at least 2 advantages to end users.

First of all the system would be more portable and convenient. A projector can project the screen with different sizes by adjusting the focus of the zoom. Even without a plastic cover, our little palm maybe used as the display screen. Laptop will be lighter too.

Because a plastic cover is only as mechanical cover, so there is no electric antenna or other electrical components in it. Thus it can be designed as easy to remove and some simple mechanism such as a little hook could connect it on laptop. This kind of cover can be design a fashionable way for example we could print colorful pictures on it. Users can also fine tune their laptops by selecting their favourite images and colours just like we can do today with some mobile phones.

Figure 10 below demonstrates the idea of a plastic cover. In this set up we have a plastic board instead of monitor panel. A little projector can be found at the bottom of the keyboard and the inside interface of the plastic board is the screen. On the outside of the plastic cover we can print colorful pictures like mentioned above. And this cover could be easily replaced by the end users.

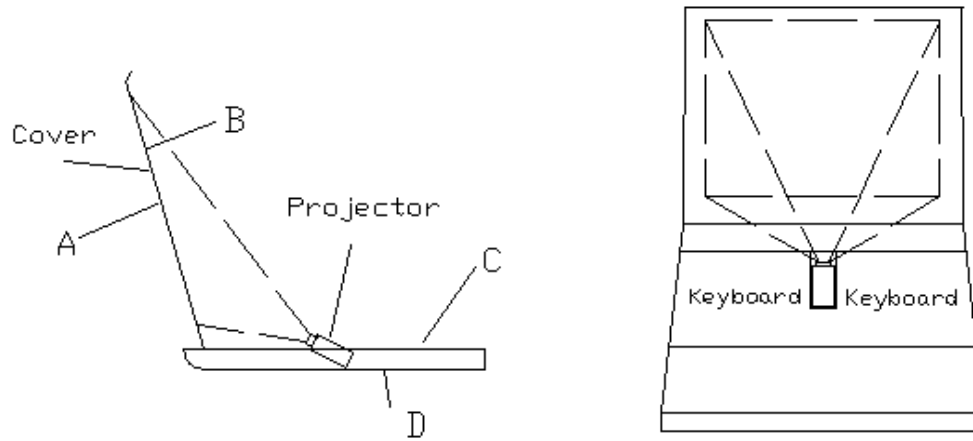


Figure 10: Demonstration of a new kind of monitor panel [23]

Because the panel can move around with the hinge, and during the turning, the displaying pictures is not to be impacted to distort, so when we use the mechanical cover to replace the panel, it should have the same functionality and user experience they are used to. Otherwise the customers will not accept this product. So we must make a function to define the logic and arithmetic between the turning angle(α) of the cover and the project angle(β), $f(\alpha)=f(\beta)$. This arithmetic is used to make sure the screen looks normal and there is no distortion in the pictures. The idea is shown in Figure 11.

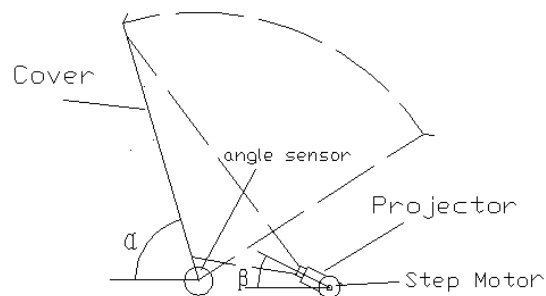


Figure 11: Securing the right kind of image [24]

When the cover is closed to the angle shown in Figure 12 it is impossible for the end users to see the screen, there should be a sensor to detect the angle and feedback to the IC to let system to shut down the projector to save power and avoid the thermal problem.

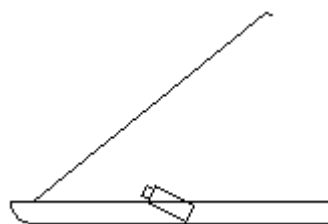


Figure 12: An example of an angle when the project is shut down [25]

When end users close the cover totally, the projector control system will move the projector to the same level with the keyboard as shown in Figure 13. Then we can close the system similarly as with a normal laptop and make sure the cover is tightly closed.

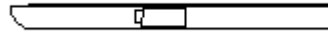


Figure 13: Projector position when the cover is closed [26]

9.2 Technology limitation

Naturally there are many technological limitations to this kind of new concept, I have listed some of them below.

Because the HDMI needs a high quality panel, this solution is more reasonable to be applied on Net-book or Tablet-PC products. Because it is impossible for end users to play vivid 3D games or see the high definition movies by this mechanical cover. A more advanced technology is needed to support the high quality pictures and videos.

Until now, all projectors emit a lot of heat. Therefore it is impossible to let the projector to be at the bottom of the keyboard. This can cause the system to hang-up due to heat produce in so short time and there is not a strong thermal module to absorb or output the heat from the system.

The battery needs to support the high power consumption of the projector. This is a problem because customers expect long battery life. So if the new structure means shorter battery time the users are not satisfied with it.

9.3 Conclusion for the prototype

I believe that young people may prefer this kind of low cost and fashionable product. If we want to have a successful product it must offer something new and it should lead industry and not only focus on current and existing components and their small scale

improvement,. So DFX is the development method for the new product and innovation is the spirit.

10 CONCLUSION

I firstly introduced the history of the digital computer and how e it has changed our daily lives. Later I discussed the basic structure of a laptop and compared several Lenovo Y series productions by listing their configuration and functions. In addition to the development phase for the product, there are manufacturing and service phase along with the products life cycle. So development of a good laptop does not depend only on the development phase. When a company wants to develop a good laptop it must pay attention to all aspects mentioned above.

With my thesis a reader can learn a lot about computers, especially about laptops. Firstly we know that computers have taken the heavy calculation burden from the people. Secondly the weight of a modern computer is much lower and the dimensions are a lot smaller than during the early days of computing. The main reason is the integrated circuit (IC) development. Thirdly the Windows operating system and similar kind of software replaced the Command Line Interface (CLI) with the Graphics User Interface (GUI). This development has dramatically increased the popularity of personal computers finally as well as the most importantly the reader learns how to optimizing the laptop by different aspects to get more benefits for customers and gain the business success.

A good laptop is a product that needs to be affirmed by customers. So developing a good laptop must focus on two aspects: Solving the problems in current products to make sure the systems is stable and reliable and offering something new to change the traditional user habits and lead a new industry trend. Solutions for both above requirements need to be verified by delivery of product.

The future laptop development must follow the process: knowing the customers' requirements, sending out the proposals for current demands and potential demands, DFX reviews, applying and testing the proposals to the design phase, taking it into manufacturing phase and collecting service feedback to the product concept phase.

Because of information time is coming, so the future laptop will not only focus on the amount of the data storage which impacts the components like HDD, RAM, ODD

media but also on the mobile use which impacts the WLAN, WWAN, Bluetooth, long battery life and the slim shape. The fashion elements are brought to all kinds of products and a laptop is no exception. Therefore unique and colorful appearance is the trend, which impacts the mechanical parts such as the covers of the laptop. Because new features and components do not fit nicely with other highly valued characteristics of laptops like slim structure and long battery life, there is a long way for balancing the functions on one product. However some examples such as iPhone have proved that it is possible to offer new kind of solutions for the users. I believe that also on laptop business we can expect new innovations in the near future.

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