

The background is a dark blue field filled with various sizes of light blue gears. On the left side, there is a vertical strip with a colorful, textured pattern of orange, red, and brown, resembling a close-up of a gear or a printed surface.

Printing

Printer Selection

Printer Developments

Print Head Technology

Printer Problems

How to Select a Printer

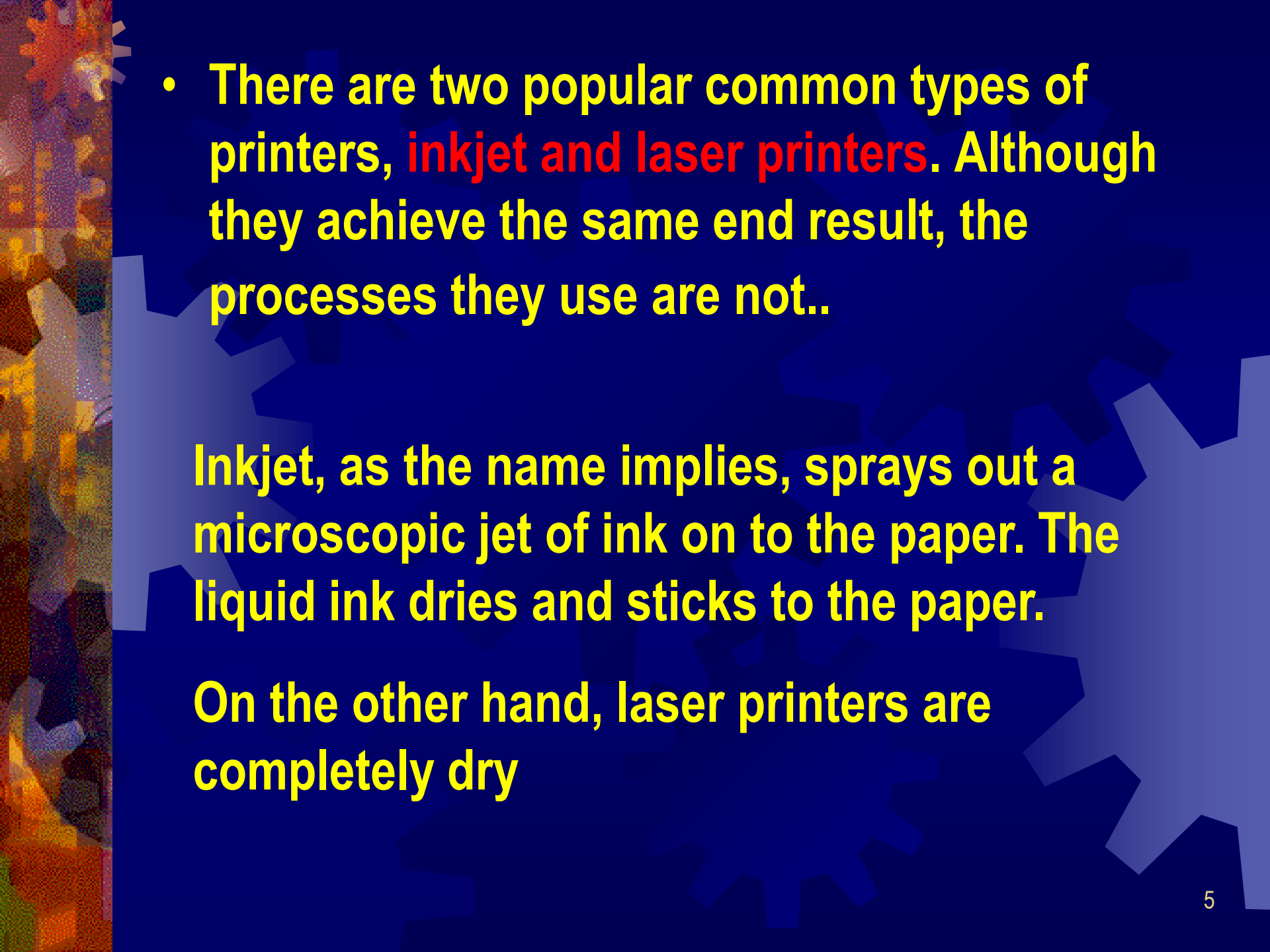
- What is your operating system?
- Will it support the printer?
 - i. e. Lexmark does not support Linux -- Ubuntu ?
- Newer operating systems may not support an older printer -- no printer driver available

How Much Do You Want To Spend ?

- **Duty Cycle or how many pages will you print per week**
- **Low -- 20 pages week -- letters, web pages, simple spread sheets, word documents, e-mail**
- **Medium -- 50 pages per week -- Presentations and high quality photographs -- probably a photo printer**
- **High – over 100 per day – want a faster printer probably a laser is the best choice**
- **Multi function - scanner, copier, fax**
- **Size of Print Out**
- **Comparison Shop**

What Do You Want or Really Need ?

- **Laser or Jet**
- **All In One**
- **Wireless**
- **Networking Capability**
- **Color**
- **Supply Costs**
- **Duplexing**
- **Scanner**
- **Fax**
- **Card Slots**
- **Paper Handling – Card Stock, Envelopes, Non Standard Paper**
- **Speed and Size of Print**
- **Resolution - Resolution should be over 1440 ppi**
- **Photo Printer**
- **Warrantee / Compatibility**

- 
- There are two popular common types of printers, **inkjet and laser printers**. Although they achieve the same end result, the processes they use are not..

Inkjet, as the name implies, sprays out a microscopic jet of ink on to the paper. The liquid ink dries and sticks to the paper.

On the other hand, laser printers are completely dry

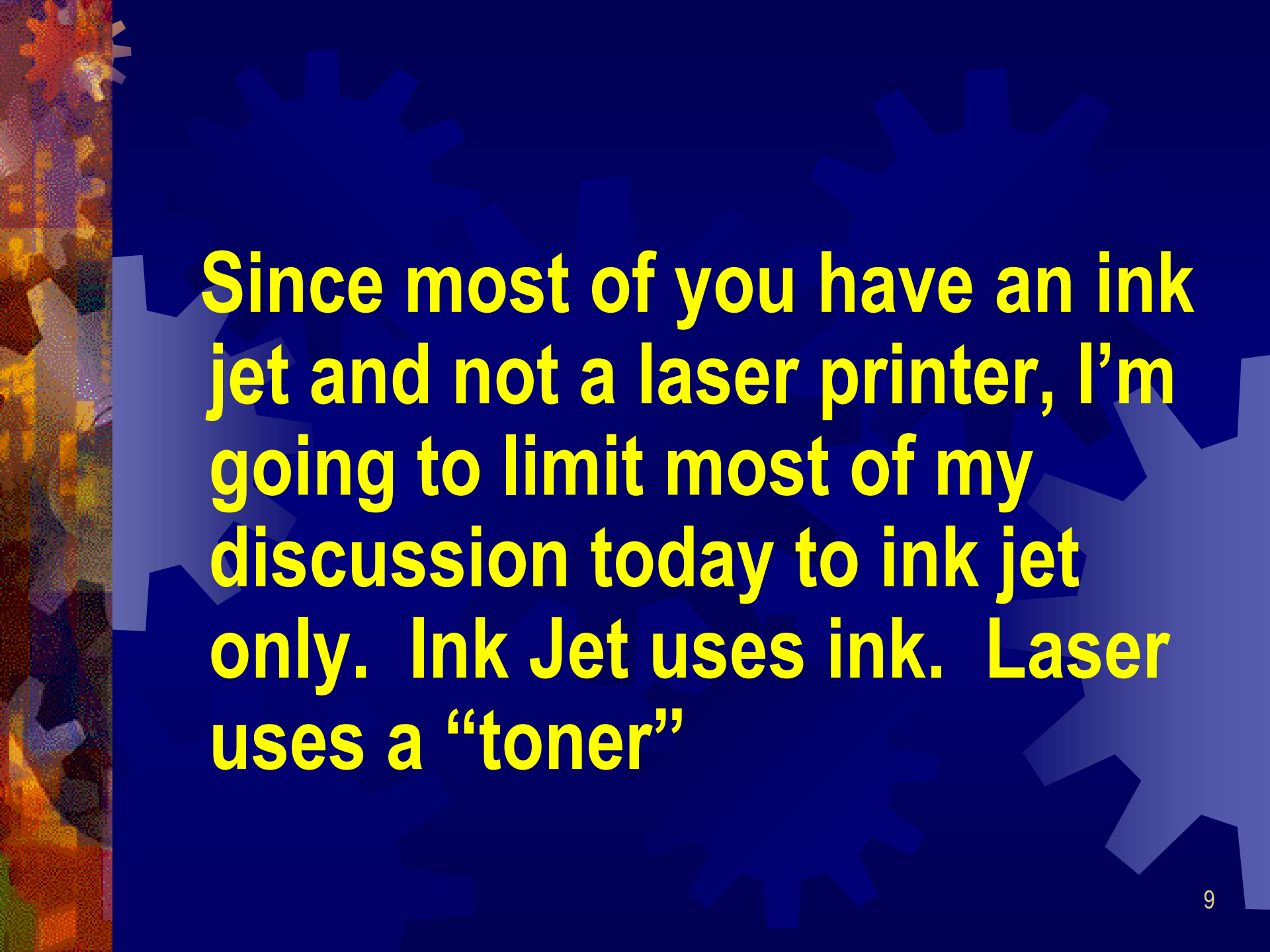
The background is a dark blue field filled with various sizes of semi-transparent gear shapes. On the left side, there is a vertical strip with a colorful, textured pattern of orange, yellow, and brown, resembling a close-up of a gear or a mechanical part.

Each technology has its own strengths and weaknesses. The two types use different approaches and each is appropriate for meeting different printing needs.

Laser Printer

- Laser printers use a xerographic printing process, which uses a cylindrical drum coated with selenium to print an image. A narrow laser beam draws a pattern on a rotating drum, to which toner sticks to. The toner then gets pressed onto paper and baked at high heat, causing it to stick.

- **Since Inkjet Printers spill out tiny droplets of ink to print, the resolution is lower than the laser printers. Laser Printers printer better quality text, as their resolution is higher. High resolution also helps the laser printers create precise fonts without fuzzy edges. However, the cost-effective inkjet printers are usually recommended for inexpensive color printing. These can print high quality text, large photo prints, graphics, banners and greeting cards at less than half the price of a color laser printer.**



Since most of you have an ink jet and not a laser printer, I'm going to limit most of my discussion today to ink jet only. Ink Jet uses ink. Laser uses a "toner"



Mid-South Electrics, Inc.

Manufacturer of Quality Electrical Appliances & Components

Contract Manufacture Supplying



Clairol

Cusinart

IBM

General Electric

KitchenAid

XEROX

Hamilton Beach

Whirlpool

NuTone

Mr. Coffee

Printer Types (early 1990's)

Dot Matrix

Dasey Wheel

Laser

Inkjet ---- Mid-South had bid on the IBM and Xerox printers. Refused to bid on the Xerox printer as un-manufactureable on a sustained production basis. Xerox eventually went to a Japanese firm and a Japanese design.

IBM Ink Jet

Excellent design, Snapped together,
Only two screws in entire assembly,
Highly manufacturable at a low cost.
Cost is a by product of volume and we
believed, as did IBM, the volume could
be attained.

BUT, IBM sold printer business along
with a manufacturing plant in
Lexington, KY to some company called

Lexmark.

Xerox Inkjet Printer





How did we get to where we are today?

**First personal computer developed
by**

Xerox

History

➤ **1972 Xerox decided to produce a personal computing facility that would meet all individual needs, plus be used as a communication device that would allow users to share information. By 1978 it was operational, and Xerox donated 50 “ALTO” machines to Stanford, Carnegie-Mellon, and MIT. Cost @ \$32,000 each. In 1981 Xerox introduced the “Star System” for internal use and was used by Xerox worldwide. Not a commercial success, but idea of a graphical interface was copied by Apple and introduced in the innovative Lisa in 1983, and then in the Apple Macintosh in January 1984**

Printer Control Codes

\ 027 \ 065 \ 024

\ 027 \ 015

**Turn On Double Line Spacing -
Condensed Print -
for Computers Using DOS**

History Microsoft Windows

- **Microsoft development began in September 1981. Used pull down menus based on the “Star System” of Xerox.**
- **Announced Version 1.0 November 1985
Cost \$100.00 – still DOS based (disc operating system – called MS DOS)**

History Microsoft Windows

- Started with DOS – windows 1, 2, 3, 4, 95
- June 25, 1998 Windows 98
- May 5, 1999 98 2nd Edition
- February 17, 2000 – Windows 2000
- June 19, 2000 – Windows ME
- January 2007 – Vista 20 million sold 1st month. Est. 96 Million PC's in 2007
- October 29, 2002 – XP Windows XP 17 million sold in first two months
- October 22, 2009 - Windows 7(support until Jan. 2020)
- January 2010 - Windows 8
- Windows 8.1 - support until January, 2023
- July 2015 - Windows 10 (want to install on 1,000,000,000 machines)



**Windows eliminated the use of
printer control codes**

But

It still looked commercial --i.e.

Dot matrix printer

Second development

INKJET PRINTER

Inkjet History

1. Became affordable for the average consumer in early 1990's, though big research dollars invested by virtually every major printer manufacturer in 70's and early 80's (mostly unsuccessful) Late 1980's before mastered by Canon and HP.
2. Black & White only – seen as alternative to dot matrix and Xeroxography
3. Color had one cartridge containing CMY (cyan, magenta, yellow)
4. Black was produced by mixing all three which resulted in a composite (sometimes greenish or brown) black

Inkjet History (cont.)

5. Modern printers generally have two cartridges – one black (K) and one with three individual tanks containing CMY. Thus CMYK, which equipped printers with enough color power to produce 16.7 million tones
6. Now have four color tanks, CMYK, with individual color in each tank. Promoted to save ink, but average user probably won't see much savings unless you print one color a lot more often than the others.
7. Recent developments – 6 or 8 cartridges or tanks – CMYK plus “light cyan”, “light magenta” and two “black” for improved color transitions

AMTX

A Advanced

M Micro Fabrication

T Technology

X Xerox (20% ownership - all officers Xerox employees – Xerox later bought 100% when pilot line proved concept viable and production commenced Summer 1993)

Principal product was nozzle for GM fuel injectors



Xerox Inkjet Printer



Maintenance Station Functions

- Seal cartridge when not in use
- Prime cartridge when installed
- Clean cartridge during printing
- Redirect ink to sump during priming or cleaning

Common Configurations of **INK** Cartridges

- 1- color cartridge that makes “black” by combining all colors
- 1- black, 1- color cartridge
- 1- black, 3 color cartridges (CMYK)
- 1- black, 5 color cartridges
- 2 – black, 6 color cartridges
- 1- black, 8 color cartridges

Photographic Colors

Cyan -- Robin's Egg Blue

Magenta -- Pink / Red

Yellow -- Yellow

Black -- Black

Red -- Brown

Blue -- Purple

Green -- Green

From these 3 colors, all others can be formed

CMYK Cartridge

Printing from an iPad or iPhone












- **Air Print Compatible** [Apple Support Website](#)
- **Download Software for your manufacture from Apple or Google Store**

Showing results for "hp eprint"











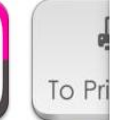
See All >

All
iPad Apps
iPhone Apps
Podcasts

iPad Apps

 HP ePrint Productivity Get	 HP ePrint Enterprise Productivity Get	 HP Designjet ePrint & Share Productivity Get	 HP All-in-One Printer Remote Productivity Get	 ePrint Utilities \$2.99	 HP ePrint Enterprise for... Productivity Get	 HP ePrint Enterprise for... Productivity Get	 Printer Pro - print documents... Productivity \$6.99	 HP SureSupply Utilities Get	 To Print Productivity Get In-App Purchases	 iCan-Print Business Get In-App Purchases
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iPhone Apps

 HP ePrint Productivity Get	 HP ePrint Enterprise Productivity Get	 HP Designjet ePrint & Share Productivity Get	 HP All-in-One Printer Remote Productivity Get	 ePrint Utilities \$2.99	 HP ePrint Enterprise for... Productivity Get	 HP ePrint Enterprise for... Productivity Get	 ePrint Free Utilities Get	 Printer Pro - print documents... Productivity \$6.99	 HP SureSupply Utilities Get	 To Print Productivity Get In-App Purchases
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See All >

Printing from an iPad or iPhone

- What if your printer is wireless but not air compatible ?
- Now you need a Computer and some sort of 3rd Party Software to trick your printer into thinking it is an air compatible printer

O'Print for Apple
Handy Print for MAC

- Cloud

O'Print

- **O'Print - <http://oprintware.com>**
- **System Requirements**
- **- Windows 7, Vista, XP SP3 above, Server 2003, 2008 & 2012**
- **- iPad, iPhone and iPod Touch**
- **- iOS 4.2 or newer**

Before Start

- **Check printer online**
- **Windows computer and ipad/iphone are on the same network or WiFi**

Quick Start

- **Install "O'Print" on Windows computer. Available printers are automatically displayed.**



What is Cloud Printing

- **Basically, cloud printing is a way to connect any web enabled device to any printer, anywhere in the world.**

The Cloud ??

There is NO CLOUD !!!!

Basically an On Line Hard Drive (rented Data centers, informally called “The Cloud”)

Storage is NOT on your Computer

Many Versions :- some popular ones are

Drop Box

Apple I Cloud

Google Drive

One Drive Microsoft

Amazon Cloud drive

So What is Cloud Printing ?

- You are sitting on a lavatory in the Hong Kong branch of McDonalds surfing the net on your smart phone for new images of Mr T. You find a great new one that you've never seen before and immediately know you want to print it out on your home computer.
- But how do you do it?
- Simple, you use cloud printing which connects your smart phone in Hong Kong to your printer at home and hey presto; you've got Mr T on glossy photo paper waiting for you at home. I love it when a plan comes together.

The Cloud

CLOUD FILE STORAGE IS ONE OF THE WONDERS OF THE MODERN WORLD.

BY STORING YOUR FILES IN A CLOUD-BASED DATACENTER, YOU HAVE ACCESS TO THEM ANYTIME AND ANYWHERE--AS LONG AS YOU HAVE AN INTERNET CONNECTION.

AND LETTING SOMEONE ELSE RUN THAT DATACENTER MEANS YOU DON'T HAVE TO WORRY ABOUT THE COST OR COMPLEXITY OF RUNNING YOUR OWN FILE SERVERS WITH REMOTE ACCESS.



Cloud Storage

Is NOT

Cloud Back Up

Dangers of Cloud Storage

- **BUT PUTTING YOUR FILES IN THE CLOUD ALSO MEANS PUTTING YOUR TRUST IN A CLOUD PROVIDER.**
- **THE DOWNSIDE OF CLOUD STORAGE IS THAT IT REPRESENTS YET ANOTHER WAY FOR OUTSIDERS TO ATTACK YOUR INTELLECTUAL ASSETS. IF YOU MANAGE THOSE ASSETS FOR A LAW FIRM, A GOVERNMENT CONTRACTOR, OR A COMPANY IN AN INDUSTRY THAT'S HIGHLY REGULATED (SUCH AS HEALTHCARE OR FINANCIAL SERVICES), YOU HAVE EVERY RIGHT TO BE WORRIED ABOUT CLOUD FILE STORAGE.**

Protection of Cloud Storage

END-TO-END ENCRYPTION PROTECTS YOU FROM BAD GUYS WHO MIGHT TRY TO INTERCEPT FILES IN TRANSIT. BUT THOSE FILES CAN BE AT SIGNIFICANT RISK WHEN THEY'RE SITTING IN THE CLOUD. THOSE "AT REST" FILES ARE VULNERABLE TO THEFT BY A ROGUE EMPLOYEE, SOMEONE WORKING ON BEHALF OF FOREIGN GOVERNMENTS, OR UNSCRUPULOUS COMPETITORS. THEY'RE ALSO AT RISK IF SOMEONE SHOWS UP AT THE CLOUD PROVIDER'S OFFICE WITH A SUBPOENA. THE SOLUTION IS "**ZERO-KNOWLEDGE**" **ENCRYPTION**, WHERE YOU (AND ONLY YOU) HOLD THE ENCRYPTION KEYS. IN THAT CONFIGURATION, THE CLOUD PROVIDER (OR SOMEONE WHO SUCCEEDS IN BREAKING INTO ITS SERVERS) SEES ONLY ENCRYPTED FILES, WITH NO WAY TO DECRYPT THEM.

Top 10 Tips for Making an Ink Cartridge Last Longer

1. Print only what you absolutely need

Before you start printing any particular portion of text or graphics, decide its relevance and usefulness so that you do not unnecessarily spend time in printing things that may not be of much use. In short, you should print only those things that you may actually need to save consumption of considerable amounts of ink. Additionally, these days you can find free programs online such as Cute PDF that will allow you to turn almost anything into a PDF. Once a document is a PDF, then it can be uploaded to an online cloud storage service such as [Dropbox](#), [Box.com](#) (yes, it's different), or [Google Drive](#). All of these have mobile apps, so you will still have access to documents wherever you are.

2. Use Print Preview

Print Preview is a useful function that shows you how the document will look after it has been printed. It can help you adjust spaces and decide which pages to print. Consider turning off the color ink cartridges, selecting only the text you require and only the pages you need - especially that last page with the footer that comes out with each print job. This can significantly reduce your printer ink usage as well as your paper usage.

3. Print text over graphics

If you are printing documents only for later reference, print only the essential text and any related images or graphics that are required. Avoid printing images or colorful graphics if having a hard copy is not essential to the purpose of the document.

4. Print in Draft mode as often as possible

Use draft print quality whenever you can. Go to File - Print to open the box that lists the settings for your printer. Click 'Properties' to bring up the various options available. You'll probably find different choices under the heading 'Paper/Quality' that allow you to select draft quality printing. Your document will print at a lower resolution but that may not matter for reference material that you will likely discard later. You can always switch to a higher resolution for a final version of a document

5. Print text in black ink only

Print documents that are in black and white with a black ink cartridge. Choose black and white printing over color whenever possible. Depending on your printer, you may have the option to select grayscale printing using the black ink cartridge only. If you print black with a color ink cartridge, various colors are mixed to create the black ink. This depletes your color ink cartridge a lot faster than it would deplete a black ink cartridge. If you're not doing presentation quality work, or if you're printing text only, chances are you won't need the other colors.

6. Use color ink only when needed

If you want your refilled ink to run longer, then make use of color printing only when it is required. Otherwise, for general and regular use, it is wiser to use black and white printing that helps in saving your money on buying additional refills. Modern personal printers can produce high quality photographs, particularly if you use specialty photo paper. But printing high quality digital shots can use a lot of ink, so if you print a large number of photos you might want to outsource your photo printing to a local print center. Many services allow you to order your prints online. You can also have your photos printed on calendars, mouse pads or greeting cards if you wish

7. Keep your printer nozzles clean

Perhaps the easiest change you can make to your printing habits is to keep an eye on your printer heads. The printer ink nozzles that dispense the actual ink use a spray function to get the ink onto the paper. As such, these nozzles can experience a build-up of dried ink and become clogged. Clean the nozzle heads every few weeks or more often if you're a heavy printer

8. Use all the ink in the cartridge

Continue to print even when your printer light comes on or you get a warning saying that your ink is low. Check the ink level in the cartridge and if it appears that there is some ink left, keep using it instead of changing the cartridge immediately. There is likely quite a bit of ink left in the cartridge; remember that the ink comes out in a spray so it doesn't take much per page. Use it all and then shake the ink cartridge to break up any ink clogs (especially in humid climates). You may get hundreds of extra pages out of a cartridge by doing this. Keep printing until the ink is almost completely gone (but be careful that you don't run the printer with an empty cartridge).

9. Select "Printer-Friendly" Pages when printing from the Web

You would be surprised how much ink is wasted by printing pages directly as they appear from a website. One Web page can have multiple pictures or graphics...not to mention several pages worth of printing because Web pages are typically much longer than a regular document. Opt for the printer-friendly option if you need to print something from the Web. This eliminates all the unnecessary images, and will save your ink cartridges as well as your printing paper.

10. Use the printer regularly

If you don't print very often, you can stretch the life of your inkjet cartridges by keeping the printer moving. Print a page or two at least once a week using both your color and black ink cartridges. You can print something small (even a printer diagnostic test) to prevent the ink from drying up.

Another ink-saving tip is to power down your printer the right way after each use. Don't merely switch it off or unplug it, but allow your printer to power down slowly and shut itself down. The print heads need to be in the right position while the printer is turned off to prevent the ink from drying up prematurely.

Inkjet Cartridge Primer

Inkjet Technology

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graph TD; A[Inkjet Technology] --- B[Drop-on-Demand]; A --- C[Continuous Flow]
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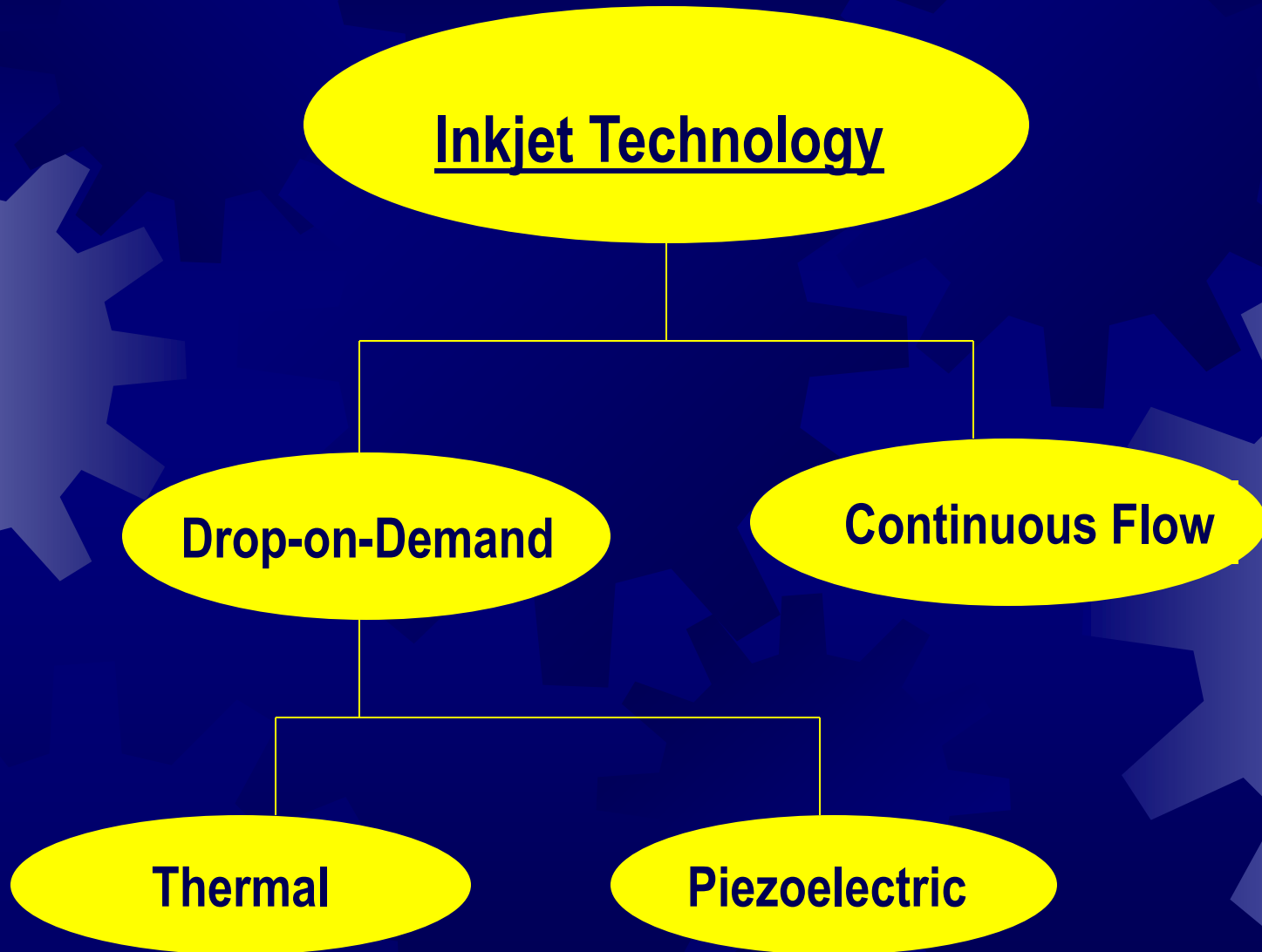
Drop-on-Demand

Continuous Flow

Drop-on Demand

- **Drop-on Demand inkjet printers use print head nozzles that each eject a single drop of ink, but only when activated.**
- **Invented by Siemens in 1977 ?? Some say Cannon accidentally in a lab - (Bubble Jet)**

Inkjet Cartridge Primer



Why Thermal?

- Canon was willing to licensed patents, Epson not as easy to work with
- Xerox used 19 Canon patents on its first inkjet system
- Thermal technology more advance at that time
- Fewer problems with bubbles in the ink transfer process
- Piezo requires vacuum pumps and large ink absorbent pads
- In early 1990's, graphics important, but not digital photography

Print Head Technology

Basically two approaches

Thermal print head – a tiny resistor in each jet warms the ink causing a vapor bubble to form. When this bubble breaks a droplet of ink is forced out of the print head nozzle and placed on a surface to form text or images. As the bubble collapses, it forms a vacuum that pulls in fresh ink. Process is repeated thousands of times per second.

Commonly called “BUBBLE JET” Used by Cannon, Hewlett-Packard, Olivetti, Océ, and Lexmark (formerly IBM)

Xerox Video

The Thermal Inkjet Process



photolithography

6000 times /second or Higher

Print Head Technology

- **Piezoelectricity (from: *pressure electricity*) is a property possessed by certain classes of crystalline materials including natural crystals of Quartz, Rochelle Salt and Tourmaline plus manufactured ceramics such as Barium Titanate and Lead Zirconate Titanates (PZT).**
- **When mechanical pressure is applied to one of these materials, the crystalline structure produces a voltage proportional to the pressure. Conversely, when an electric field is applied, the structure changes shape producing dimensional changes in the material**

Print Head Technology

Piezo-electric – a tiny crystal in the print head works like a pump. When a negative charge is applied to the crystal it bends out from the print chamber and draws in a droplet; While a subsequent positive charge flexes the crystal in, pushing the droplet through the nozzle. Cost and difficulty of producing print heads are the biggest challenge. *Used by Epson and patented for ink jet technology. Very successful for them!*

~~The Thermal Inkjet~~ Process



Crystal

6000 times /second or Higher

Ink

Thermal printers typically use dye based inks, oil or solvent, and must be formulated to retain good print qualities under heat stress. Drops spread out more and do not penetrate the paper as much. Designers have to content with the inks bleeding into each other and thus design accordingly.

Piezo Electric can dismiss heat factors and create smaller and more consistently shaped droplets. The ink drops penetrate the paper and maintain their shape better. Designers have concentrated on drying rates and ink durability.

Printer Resolution & Pixels

Ink Jet Printers transform millions of tiny pixels into dots that form text and images on paper. Tiny nozzles spray droplets onto paper.

Laser printers use a more complicated process, but still use individual dots to create documents.

A dpi (dots per inch) rating specifies printer resolution

Advantages of Inkjet

- Cost Effective – no warm up cycle, no down time
- Easy to use – no special training required, easy cartridge replacement, quiet, clean
- Fast – hundred of nozzles firing at high frequency
- Reliable – less sensitive to air bubbles, no moving parts other than ink ejection
- High Quality – small drop size, high print head operating frequency, highly controlled ink drop placement
- Flexibility – simply snap in the cartridge you want or need
- Integrated Electronics – fewer electrical connections

Print Cartridge Operation

How does the ink get onto the paper? **Nozzles!!!**

Each nozzle requires some sort of separate electrical stimulation, i..e. heater or piezo principal

Early Black and White thermal cartridges had 64 nozzles and 64 heaters

Xerox developed a cartridge with 128 nozzles and 128 heaters (black only)

Today, modern printers have as many as 3072 nozzles – capable of placing placing 74 billion dots per second. Probably more than you will ever need.

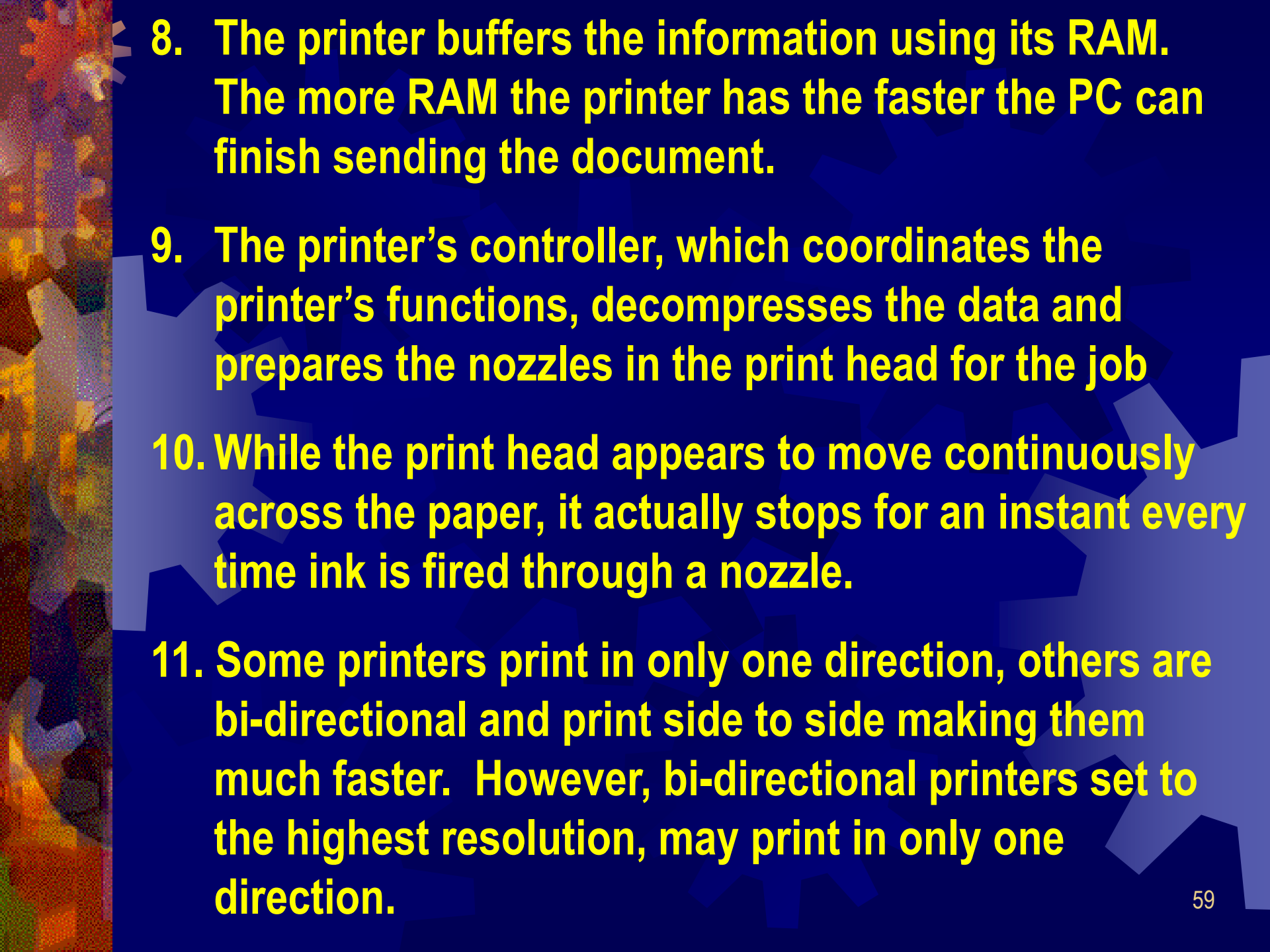
So What Really Happens ?

When we have a image on our monitor, a printer connected with a print cartridge installed, how does the information get from the computer to the printer, and what tells the printer to fire the drops onto the paper?

The Process

1. Software sends data to printer Driver
2. Printer Driver interprets data into something the printer can understand
3. Same data put through a half-toning process. Half-toning involves composing text or images with a series of tiny dots. It also dictates how the printer will create certain color combinations. For instance, half-toning determines that a yellow dot places next to a blue dot, creates the impression of the green color
4. After the elements of half-toning have been completed, the data forms a bit map.

- 5. A bit map is a graphics file that indicates bit by bit, the color of each dot that will be used to print the text or image. Each bit prompts the printer with a command to use a certain color in a specific area of the paper. The darker the image the larger the half-toned dots become, sometimes to the point of overlapping. The regular pattern of the dots creates the illusion of a continuous tone when put to paper.**
- 6. The PC processor compresses the bit map the software created. This minimizes the amount of information that must be sent to the printer.**
- 7. After the driver has translated the data, and insured the printer is online, it routes the information from the PC to the printer**

- 
- 8. The printer buffers the information using its RAM. The more RAM the printer has the faster the PC can finish sending the document.**
 - 9. The printer's controller, which coordinates the printer's functions, decompresses the data and prepares the nozzles in the print head for the job**
 - 10. While the print head appears to move continuously across the paper, it actually stops for an instant every time ink is fired through a nozzle.**
 - 11. Some printers print in only one direction, others are bi-directional and print side to side making them much faster. However, bi-directional printers set to the highest resolution, may print in only one direction.**

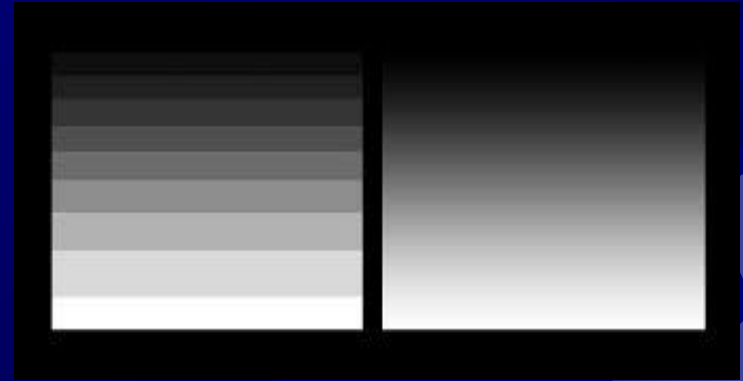
Why Won't It Print ?

- **No Ink**
- **Printer Off Line**
- **Print Que**
- **Banding**
- **Print Head / Nozzles Clogged**
- **Miss Directed Jets**
- **Driver Corrupt**

Banding

- Banding:- An artifact of color gradation in computer images where graduated colors break into larger banks of a single color, reducing the smooth look of proper gradation
- Wavy horizontal lines that mar graphics
- Banding is when the transition between colors is not smooth

Banding Examples



Correct Banding or No Printing

- **Clean the nozzles – with our magic fluid**
- **Computer club is selling it for \$30.00 per ounce to anyone attending this meeting**
- **Or you may be able to find it yourself in some specialty store**

The Magic Fluid

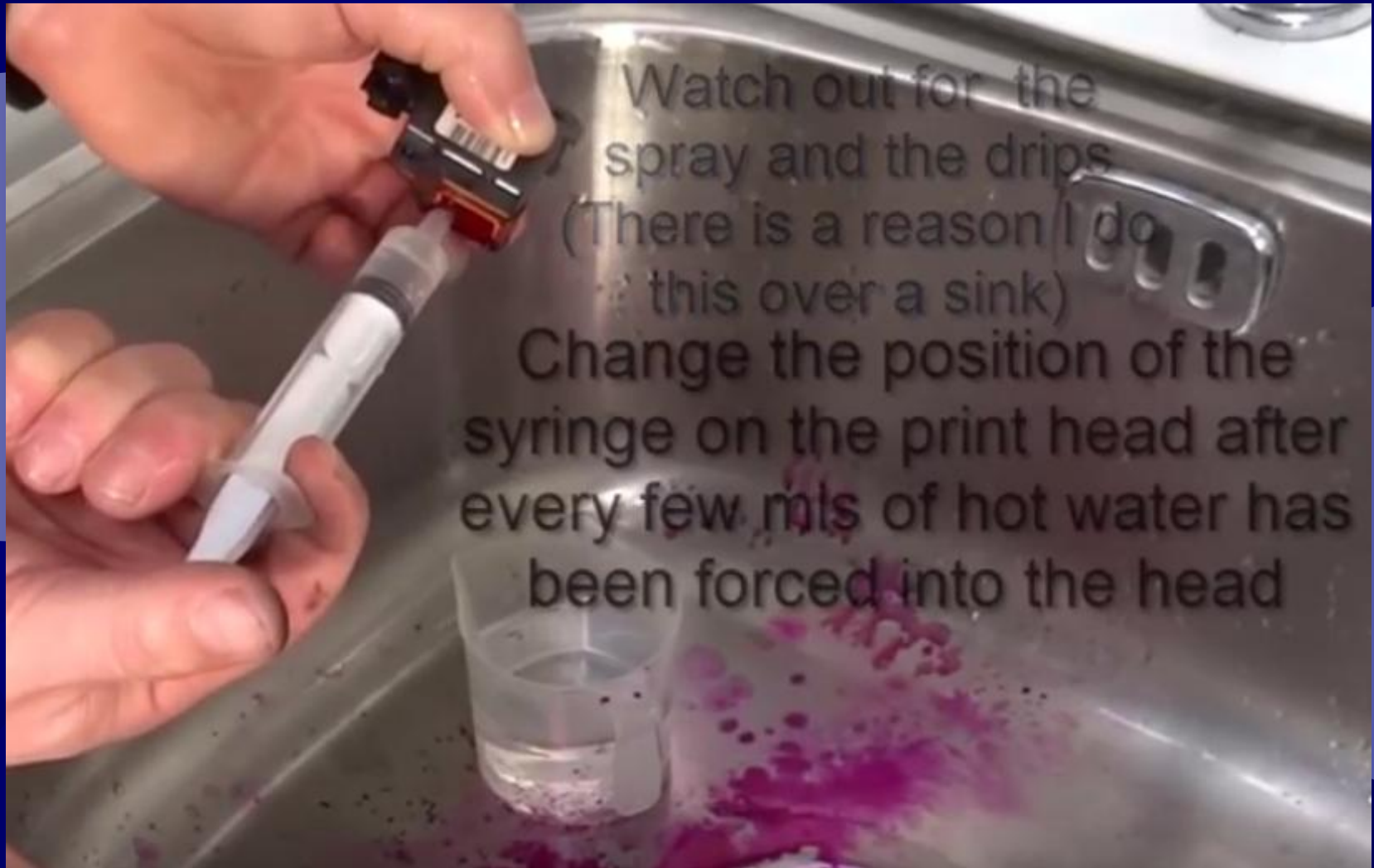
4 Parts
Windex to 1
part alcohol



Print Head in Cartridge



Print Head in Cartridge



Watch out for the spray and the drips (There is a reason I do this over a sink)

Change the position of the syringe on the print head after every few mls of hot water has been forced into the head

Print Head in Machine





Correct Banding

- Clean the nozzles – both manually with our magic fluid and via the printer menu
- Clean the electrical contacts
- Use better paper , not cheap copy paper
- Increase the resolution
- Configure the printer driver for the type paper you are using (changes size, position, and color patterns of ink droplets)
- Use specific driver configured for certain type files, i.e. clip art, photos, text
- New cartridge or print head



Misdirected jets are just that!

**Any particle larger than 5 microns can
clog a jet**

What is 5 microns?

.0002 of an inch

Human hair is about .001 inches

Types of Ink

Die Based :- Solvent or Oil

Epson Uses Solvent, All others Oil Based

Water fast

Pigmented

Archival

High security fluorescent

Ink

Dye based inks start fading the moment they are placed on paper. If placed near sunlight, you can begin to see a marked difference in a relative short period of time. i.e. about a month.

Archival inks are the latest, and Epson claims they will last 80 years before fading

Ink

Ink must be viscous enough to dry quickly and not run or smear on the paper , but thin enough to not clog the nozzles. Viscosity affects velocity. Too slow an exit from the print head nozzle results in misplaced or misdirected drops. Too fast , the ink splatters. Pairing inks properly with the tiny print head nozzles is no simple feat. Patents are closely held. The ink droplets must also interact with the various papers. In the early 90's, I had 10 chemists working full time on ink.

Page Yield -- Black Cartridges

- ✓ Page Yield is based upon coverage. 8 ½ x11 sheet with a normal typed letter in 12 point type (no graphics) has approximately 4% coverage. With this coverage Xerox advertised 1100 pages per cartridge. Coverage of course depends, first and foremost, on the amount of ink originally placed in the cartridge by the manufacturer
- ✓ Most manufacturers today print a 1,500 character document, at the default resolution setting, to determine the advertised number of pages yielded per cartridge.
 - ✓ Color of course depends upon what is printed and the resolution

Ink Sensors

- Dot Count – printer driver analyzes the image before printing and keeps a running total of the number of droplets sprayed.
- Dot Count Plus Optical Sensor – Reservoir inside the sponge in the ink tank has an optical ink sensor. A light inside the printer shines in the reservoir and the sensor determines the ink level. If the reservoir is empty, the printer estimates there is about 20% ink remaining in the sponge below the reservoir and the PC begins using the dot counting method

The Core of Ink Jet Technology

Principal Problem Areas

1. **Viscosity vs. Velocity**
2. **Heat Tolerance**
3. **Drying Rates**
4. **Paper**
5. **Print Head**
6. **Ink**

Ink

Incidentally, if you take the amount of ink in a cartridge, some say are paying about \$10,000 a gallon for ink!! Not True, but companies can sell printers for under \$50.00 and make money on the cartridges

At Xerox we paid a sister plant \$25.60 per gallon for ink or \$0.20 per oz.

Each Cartridge Typically has 50ml of Ink or 1.6907oz.

So at manufacturing cost there is \$0.338 worth of ink in each cartridge

REFILL ??????

1. Hard to use, Messy
2. Can't tell amount of ink to add or at which level to set the needle in the sponge
3. Iffy cost savings
4. Subject to fading and water smears
5. Patents cover OEM inks, no exact Viscosity duplication – subject to misdirection & splatter

But over 5 million kits sold in last 18 months

You be the judge

Ink Cost Truths

- Page yields have gone down
- Cartridges have gotten smaller
- Print heads are being moved from the cartridge to the printer
- Price of the cartridge remains about the same.

Ink Cost Myths

$$\frac{\text{Cost Cartridge } \$ 49.00}{\text{Amt of Ink in Cartridge } 1.6907 \text{ oz}} = \text{Ink Cost } \$ 28.98 / \text{oz}$$

$$128 \text{ oz. / gallon} \times \$ 28.98 / \text{oz.}$$

$$= \$ 3709.70 \text{ per gallon or a mark up of}$$

14,491 %

Paper

- **Coated Photo paper is required because plain paper soaks up ink like a sponge, causing ink to spread unpredictably and paper to buckle from excess ink.**
- **The newer technology uses smaller drops placed more precisely, which visually blend together to create richer colors, smoother graduations, and cleanly defined color boundaries on any kind of paper.**
- **Coated paper still produced the best results.**

Printer Resolution

Measured in DPI or dots per inch

1200 dpi means 1200 dots per linear inch

A 6 inch wide picture therefore has 7200 dots spread across the page

Printer Resolution

Printer resolution is referring to the addressability of the ink dot, not the resolution of the image

Several print head ink dots are required to make one pixel image dot

So 1200 dpi does not actually produce 1200 individual and distinct dots across the page, as some dots overlap

Why

Every RGB phosphor dot on the screen can produce any of the 256 intensity values. It mixes RGB light sources

Inkjets must simulate pixel colors by using combinations of several ink dots. It absorbs white light into the CMY inks and several drops of ink may be required on each pixel.

Printer drivers and control software handle the translation between the two systems

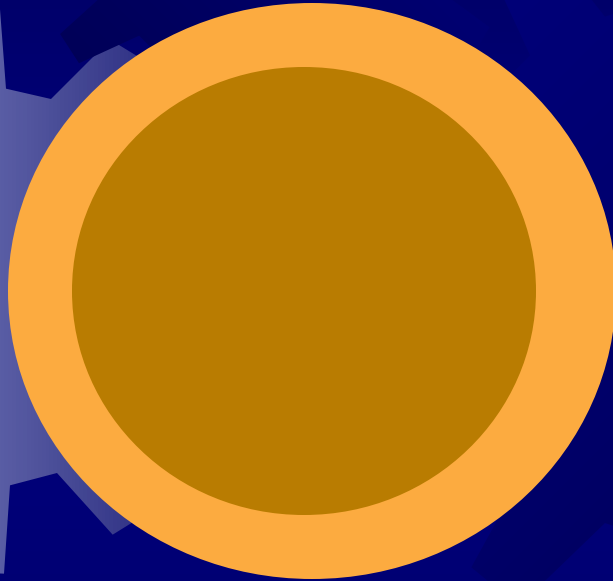
Drop Size – Modern Inkjets

Measured in picoliters, or one trillion of a liter, or one millionth the size of a raindrop.

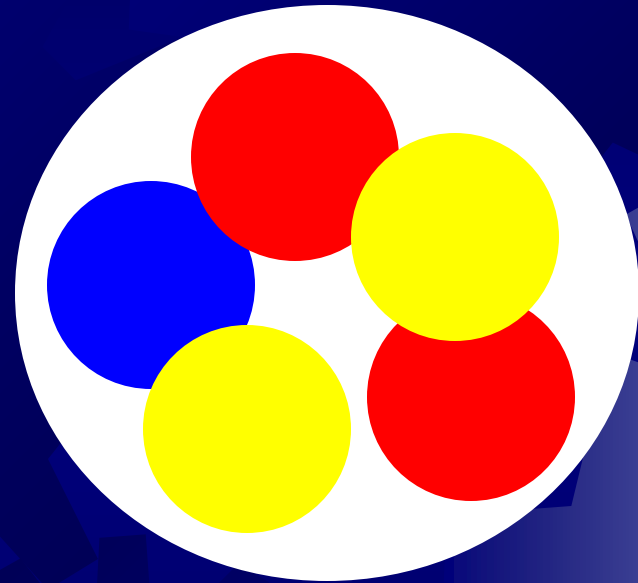
Each drop is 3 to 10 picoliters in size. Once on paper it expands to 50-60 microns. The human eye is limited to 30 microns so the dots are barely perceptible. By comparison, a human hair is about 70 microns in diameter.

Remember, each nozzle is firing at about 6000 times per second.

Color Layering



Single drop
Single dot



Multiple drops
Single dot

What Do I Really See?

A black & white printer can not print gray, only black or nothing. Your eye sees gray because of the pattern in the grid

Color is the same. The color you think you see is really a series of colored dots of the 4 basic colors. Your eye is tricked into seeing the color shade.

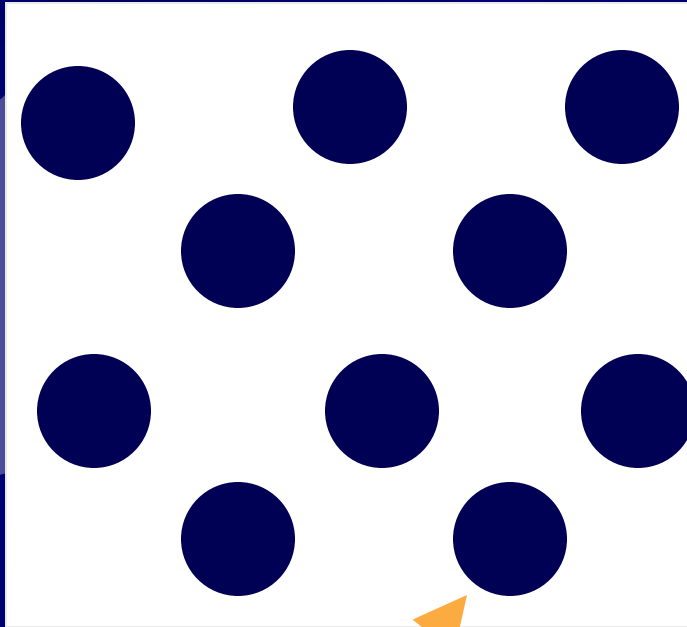
How To Produce Gray Color

Every pixel on the monitor can produce any of the 256 intensity values, but the printer's ink dot can be only absent or present (two values)

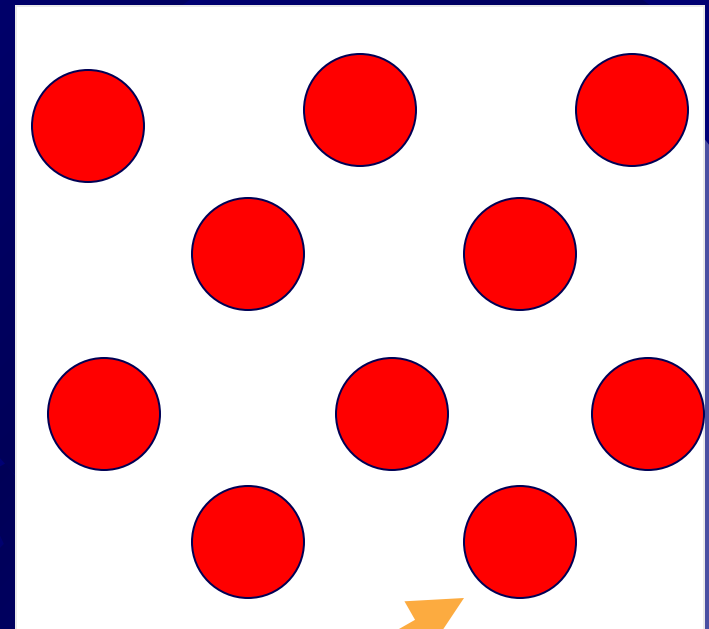
It takes more than one drop to produce a single gray dot. To produce gray the printer prints in something called “half tones”, which are arrays of dots arranged in a grid, to represent each image pixel as a shade of gray. The more black dots the deeper the shade of gray

Array of Dots on Grid

Produces gray



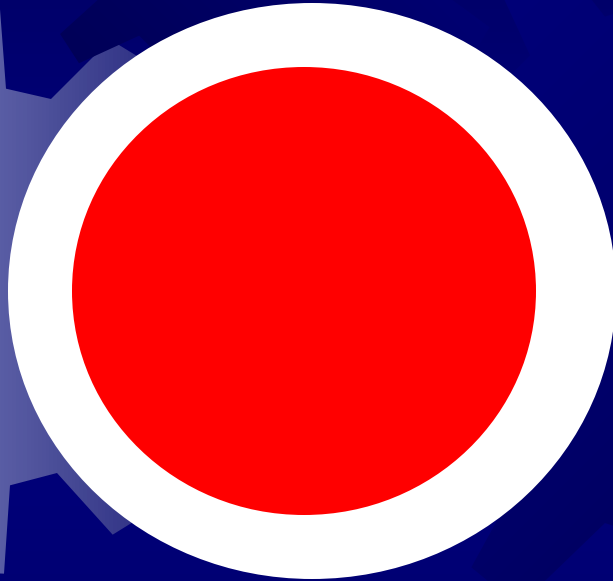
Produces Pink



White is the
Grid or
Image Pixel

Each pixel or dot can
have up to 29 drops

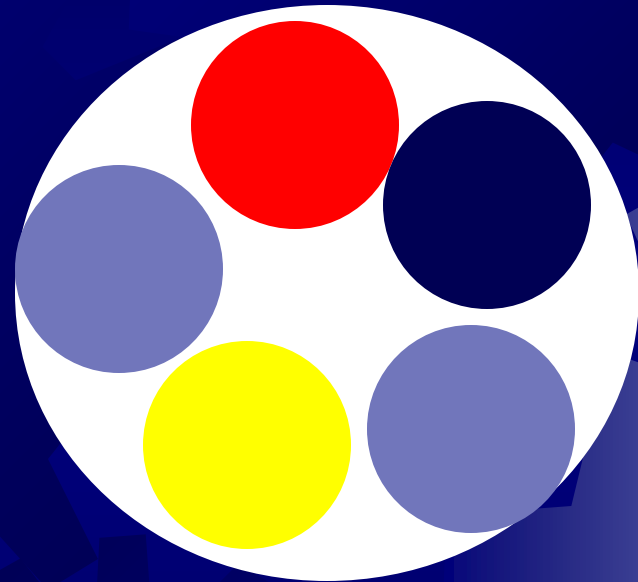
Color Layering



Single drop

**Single dot or
pixel**

**Can only be one
of 4 colors**



Five drops

Single dot or pixel


Half Toning

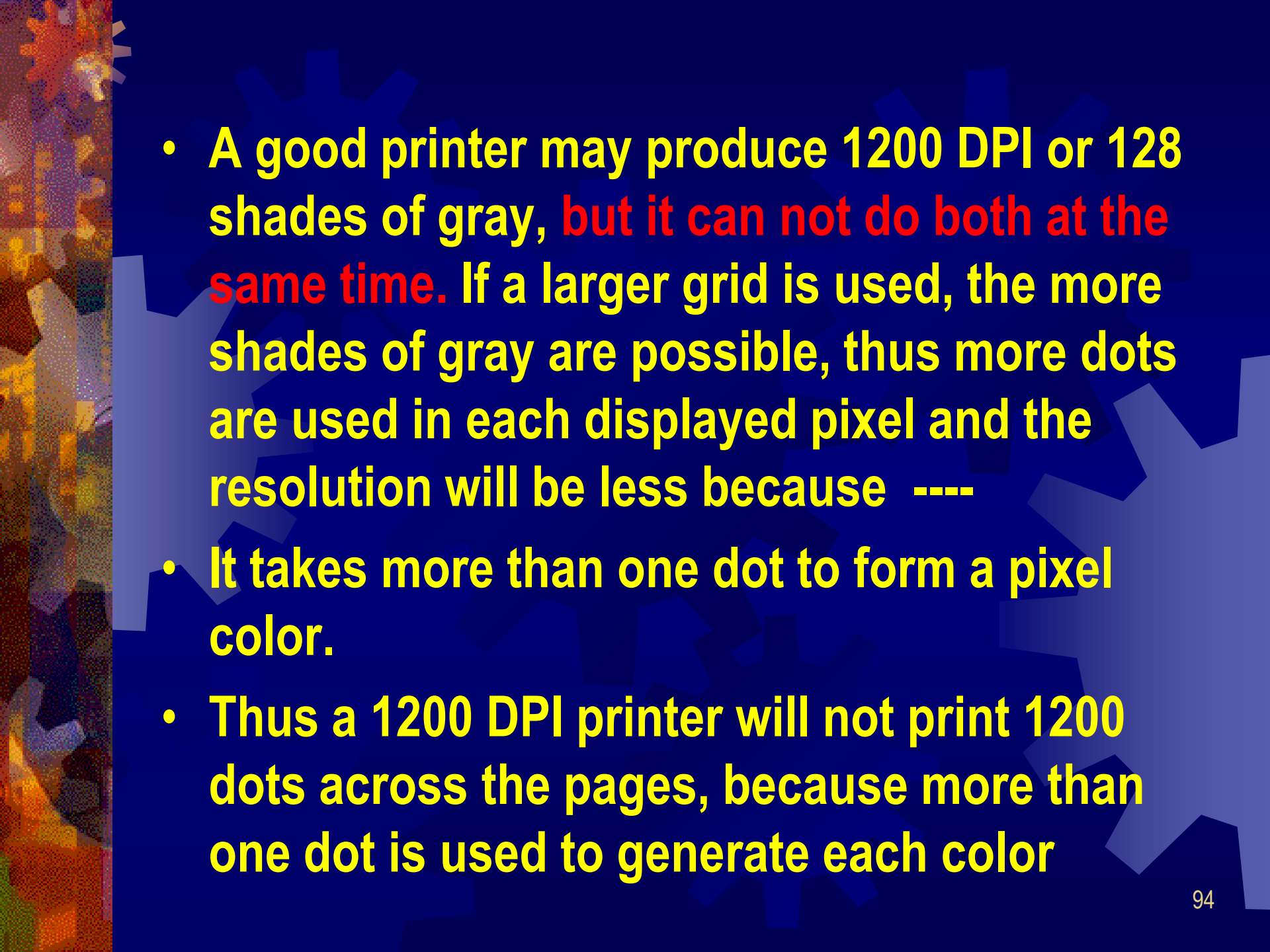
Half toning is a process that creates new color shades by placing color dots close together, so that when viewed from a distance, these dots appear to blend and create a new color. Remember a black & white printer can not print gray, only black or nothing. Your eye sees gray because of the pattern in the grid.

Halftoning

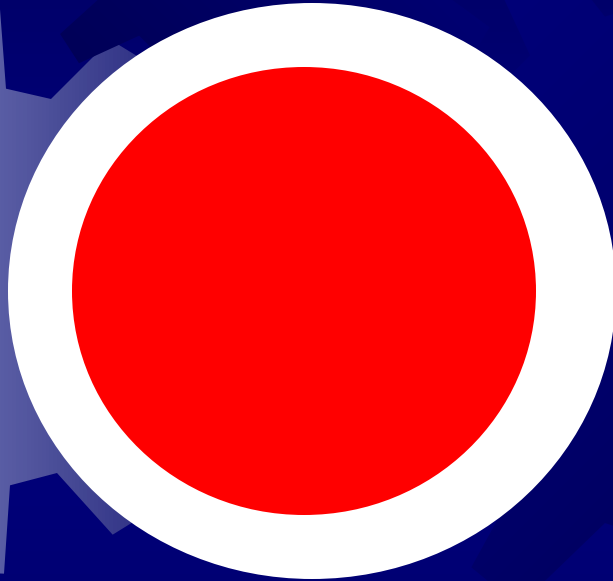
With CMYK printing, halftoning (also called *screening*) allows for less than full saturation of the primary colors; tiny dots of each primary color are printed in a pattern small enough that human beings perceive a solid color. Magenta printed with a 20% halftone, for example, produces a pink color, because the eye perceives the tiny magenta dots on the large white paper as lighter and less saturated than the color of pure magenta ink.

Without halftoning, the three primary process colors could be printed only as solid blocks of color, and therefore could produce only seven colors: the three primaries themselves, plus three secondary colors produced by layering two of the primaries: cyan and yellow produce green, cyan and magenta produce blue, yellow and magenta produce red (these subtractive secondary colors correspond roughly to the additive primary colors) plus layering all three of them resulting in black. With halftoning, a full continuous range of colors can be produced.

- 
- **Our vision is incapable of discriminating detail below a certain level. This varies from individual to individual, but more or less this point is at about 200 dots per inch. When an image is composed of dots smaller than this they appear to the eye as continuous tone. This has been relied upon by the printing trade for a couple of hundred years.**
 - **Every photograph and every image that you see in every book, magazine, calendar and art reproduction is comprised of dots of ink, at resolutions typically ranging from 70 to 300+ dots per inch.**

- 
- A good printer may produce 1200 DPI or 128 shades of gray, **but it can not do both at the same time.** If a larger grid is used, the more shades of gray are possible, thus more dots are used in each displayed pixel and the resolution will be less because ----
 - It takes more than one dot to form a pixel color.
 - Thus a 1200 DPI printer will not print 1200 dots across the pages, because more than one dot is used to generate each color

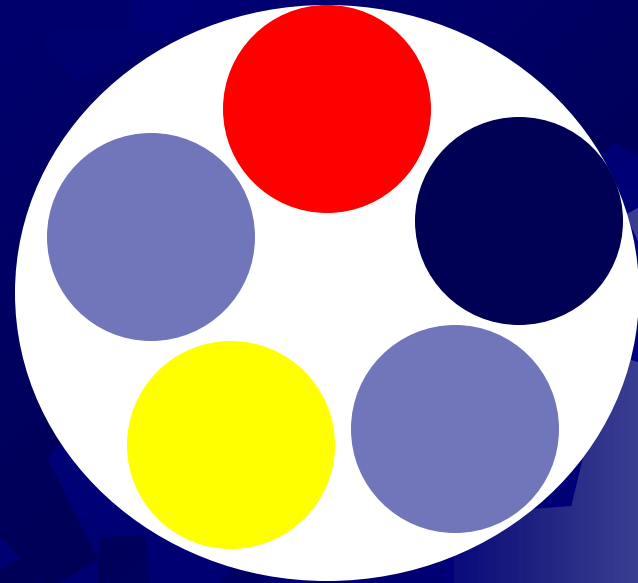
Color Layering



Single drop

Single dot

**Can only be one
of 4 colors**



Multiple drops

Single dot

DPI & Video Images

- In our world of digital images, dpi is for printing images on paper, or for scanning images from paper or film
- DPI means “dots per inch and it implies inches on paper or film, or someplace where inches exist

DPI & Video Images (cont)

- Paper is dimensioned in inches, but video screens are in pixels
- Any dpi value is always ignored on the screen, regardless of what value it is
- *There is no concept of dpi in the video system*

Fact Check

- An Image on the monitor has no fixed size. It only has a fixed number of pixels.
- *Size is determined by how we arrange the pixels*
- Color is form by illuminating phosphors dots – equal illumination produces white
- Printers produce dots of a single color. We can not mix colors or control the intensity of a single dot - and we have only 4 colors

Standard Printer dpi

INK JET

2400 x 1200

LASER

600 x 600

COLOR LASER

1200 x 1200

2400 X 1200 means a printer can spray 2400 horizontal and 1200 vertical droplets *per inch*, which is more than most of us will ever need.

That's 2,880,000 dots per inch !!!!!

Photo Quality

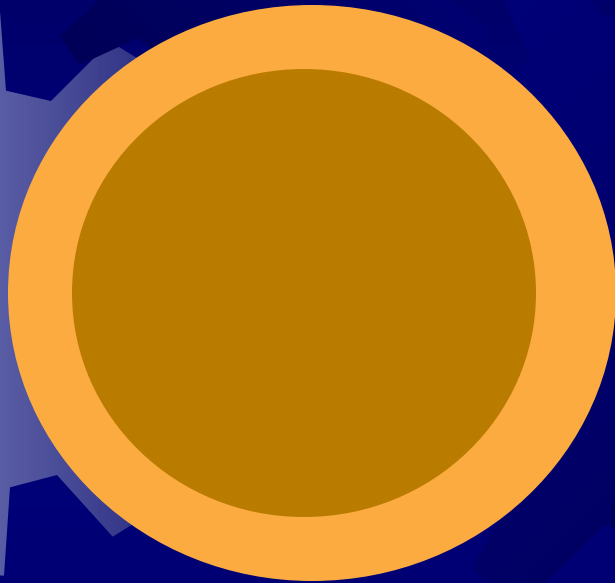
Two ways to obtain photo quality

(1.) Increase dots per inch or (2.) increase the levels of color

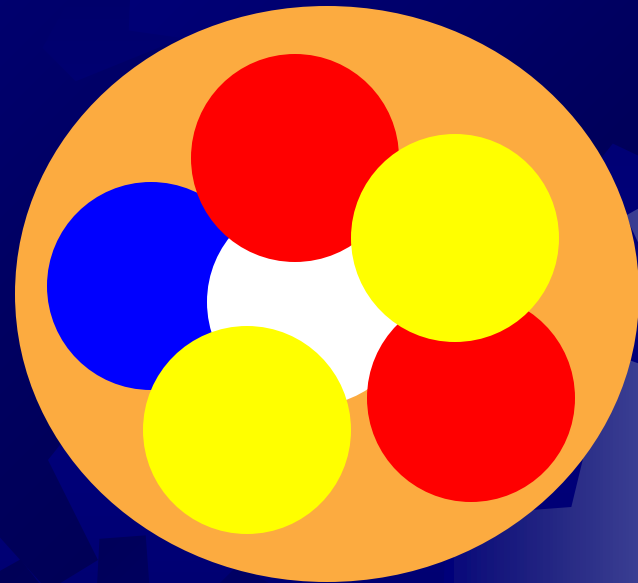
Old color printers used to place two drops of ink per dot. Using the four basic colors and two drops per dot, the typical inkjet printer today produces up to 8 different colors per dot. **Half toning** creates more color shades.

Technology developed in 1994 and refined in 2000 allow as many as 29 drops of ink on a single pixel. This is accomplished by making the drop size smaller.

Color Layering



Single drop
Single dot



Multiple drops
Single dot

Possible Future Programs

- Resolution
- Cartridge Manufacturing
- How to Set Up Your New Printer
- How to Up Grade from XP to Windows 7
- System Restore
- Power Point
- Word
- Basic Excel
- Excel Without any Math



That's All Folks!



Printer Cartridge Manufacture

As was done by Xerox

Inkjet Cartridge Primer

Inkjet Technology

Drop-on-Demand

Continuous Flow

Thermal

Piezoelectric

Xerox Choice

Why Thermal?

- Canon was willing to licensed patents, Epson not as easy to work with
- Xerox used 19 Canon patents on its first inkjet system
- Thermal technology more advance at that time
- Fewer problems with bubbles in the ink transfer process
- Piezo requires vacuum pumps and large ink absorbent pads
- In early 1990's, graphics important, but not digital photography

Disclaimer !!



It isn't magic, but a highly complex, sophisticated science!!

Nothing I've said throughout this discussion is original. It is all gleaned from the efforts of others, via discussions with them, through their papers, or from the internet. I was just the one responsible for the manufacturing program, not the technical expert.

The manufacturing process is for black cartridges only.

Definitions

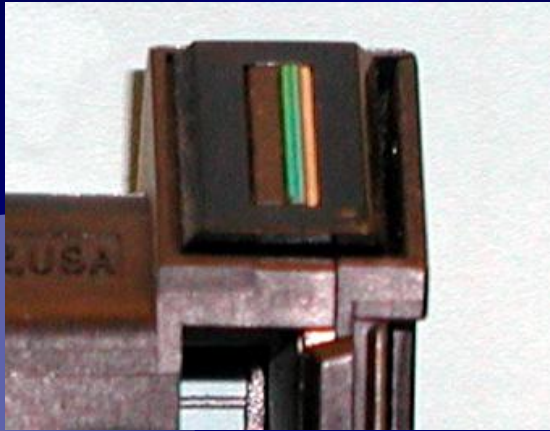
Angstrom is an old metric unit used to measure sizes of atoms and molecules and wavelengths of radiation. One angstrom equals 1/10 nanometer, or 1/10,000,000 millimeter (1/254,000,000 inch). The angstrom is not a part of the modern metric system (SI).

Micron = Micro-meter is .000001 meter or 1/25,400 inch. Lets use .000040 of an inch. Therefore 5 micron = .0002 inches

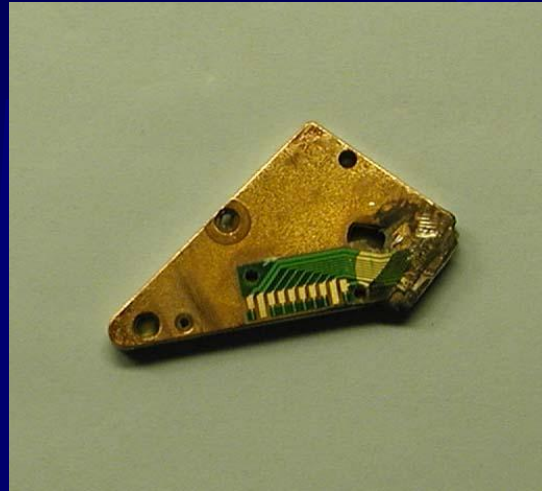
Xerox Components

- ✓ Die (Channel & Heater)
 - ✓ Heat Sink
 - ✓ PC Board
 - ✓ Wire Bonding - 16
 - ✓ Housing Reservoir
 - ✓ Seal
 - ✓ Face Plate
 - ✓ 1 Filter & 3 Wicks (Sometimes called Sponge)
 - ✓ 2 Covers (Top & Bottom)
 - ✓ Ink & Key (47 ml minimum : 53 ml typical)
- Print Engine**

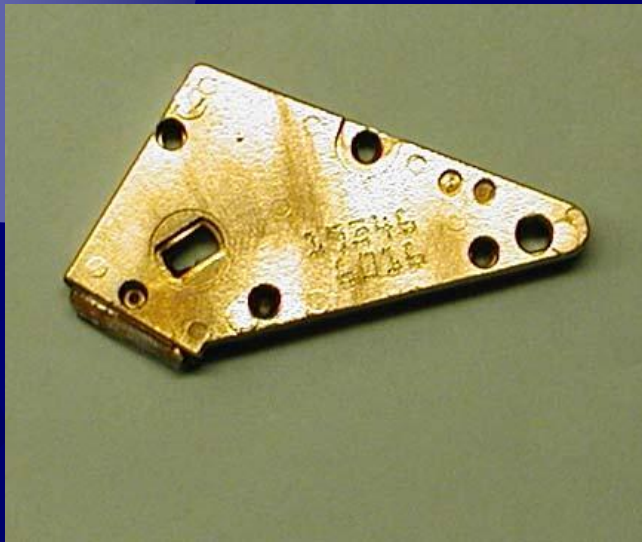
Components



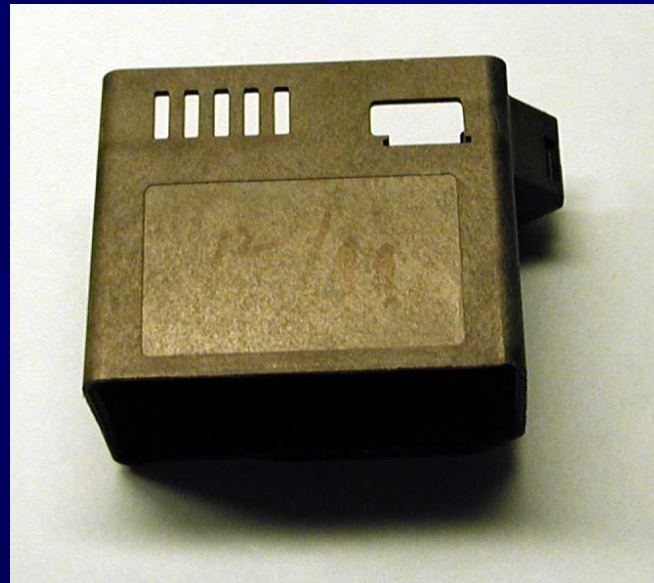
Die



PC Board

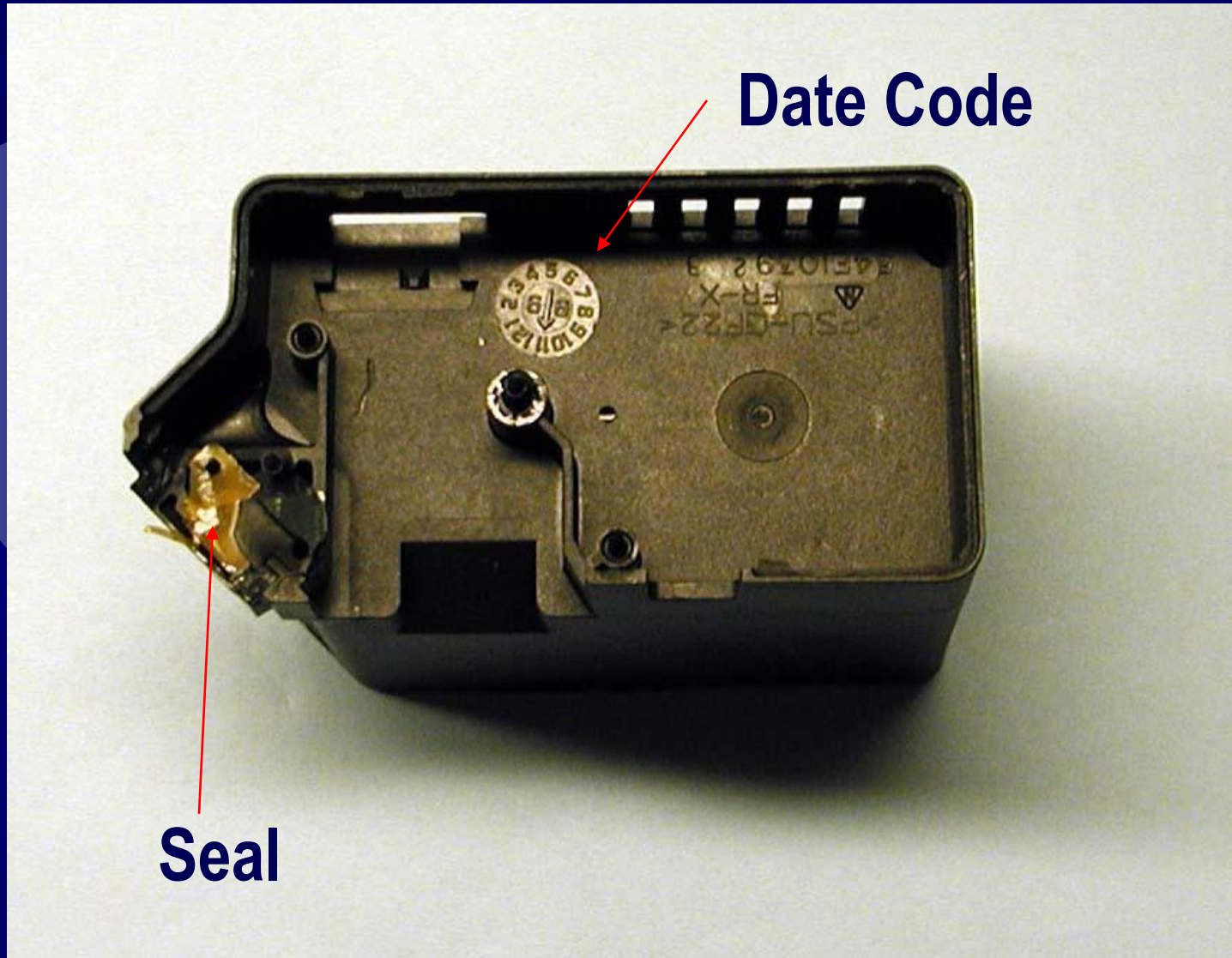


Heat Sink



**Housing
Reservoir**

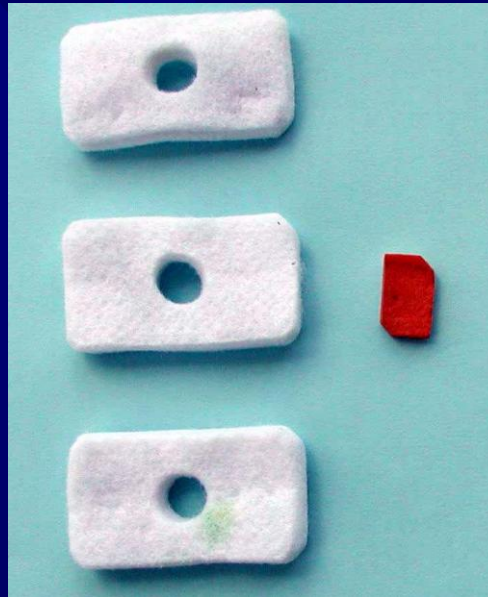
Date Coding



More Components



Face Plate



Wicks & Filter



Covers

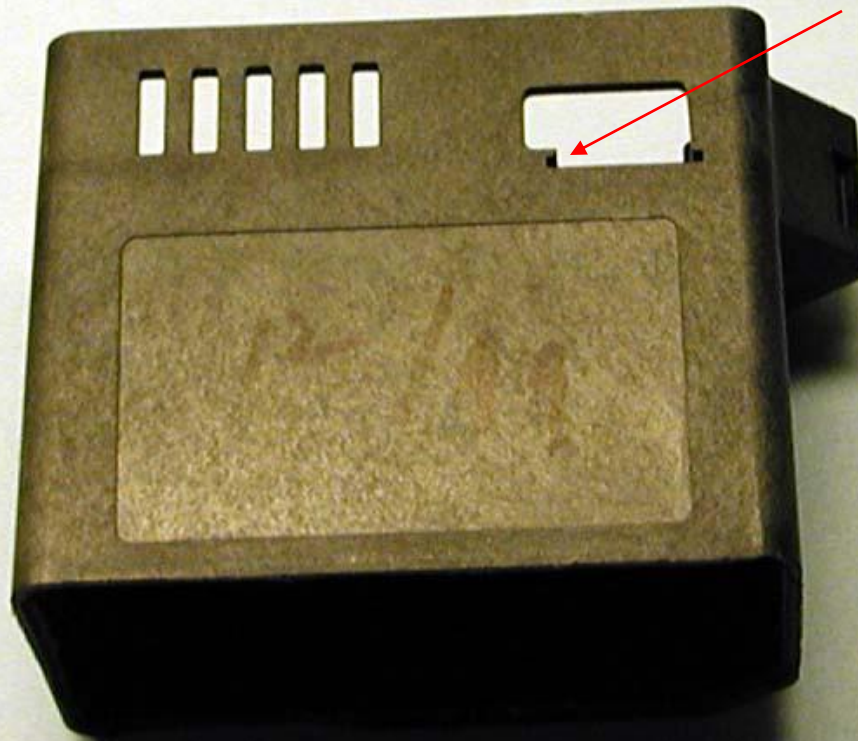


Key



Private Labeling

Dovetail



Key



Finished Cartridge



Die Module

The die module consists of two basic functional elements: a heater element and a channel element.

(1) the heater element which consists of 128 individual heaters that generated the bubble to expel the ink droplets (2) a channel element which contains 128 individual channels that define the ink path for each heater. Both elements are fabricated on 4 inch diameter silicon wafers containing 196 potential elements. A completed die module assembly consists of a heated element with 128 heaters aligned and bonded to a channel element containing 128 fluid paths. The ability to make electrical connections to the die module is also provided by removing the rear section of the channel element to expose the electrical bonding pads.

Channel Wafer Manufacture

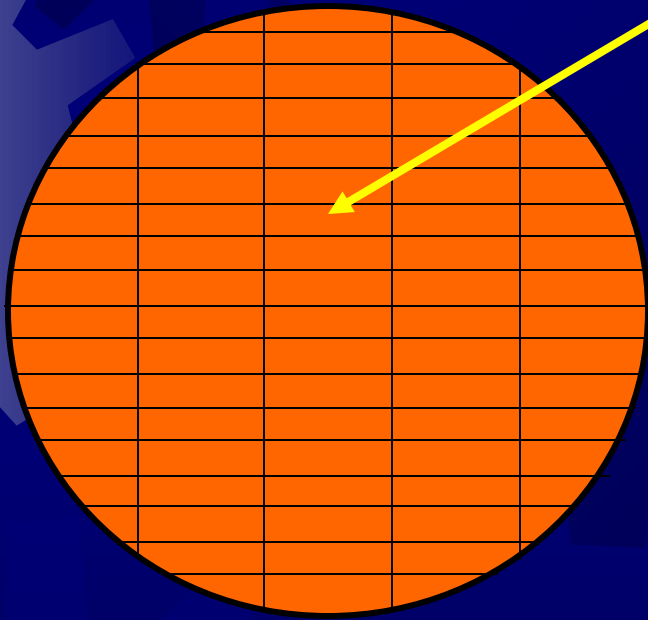
1. Silicon cylinder 4" in diameter is sliced into thin wafers
2. Wafer polisher to a mirror finish
3. Exposure to intense heat and gasses causes a thin layer of silicon dioxide to grow on the surface of the wafer -- like rust
4. Thin layer of photo resist applied

Channel Wafer Manufacture

5. Stencil or mask with desired pattern of channels or circuits is applied and a UV light turns the unmasked areas of the photo resist into a jelly like substance
6. Jelled photo resist is washed away leaving silicon dioxide exposed
7. Exposed silicon dioxide etched away with chemicals laying bare the silicon wafer. Remaining photo resist washed away leaving the pattern we want

Channel Wafer

196 potential die on
each wafer



Each die has 128 ports
or nozzles and measures
overall about $\frac{1}{2}$ inch
long by $\frac{1}{4}$ inch high by
 $\frac{1}{16}$ inch thick

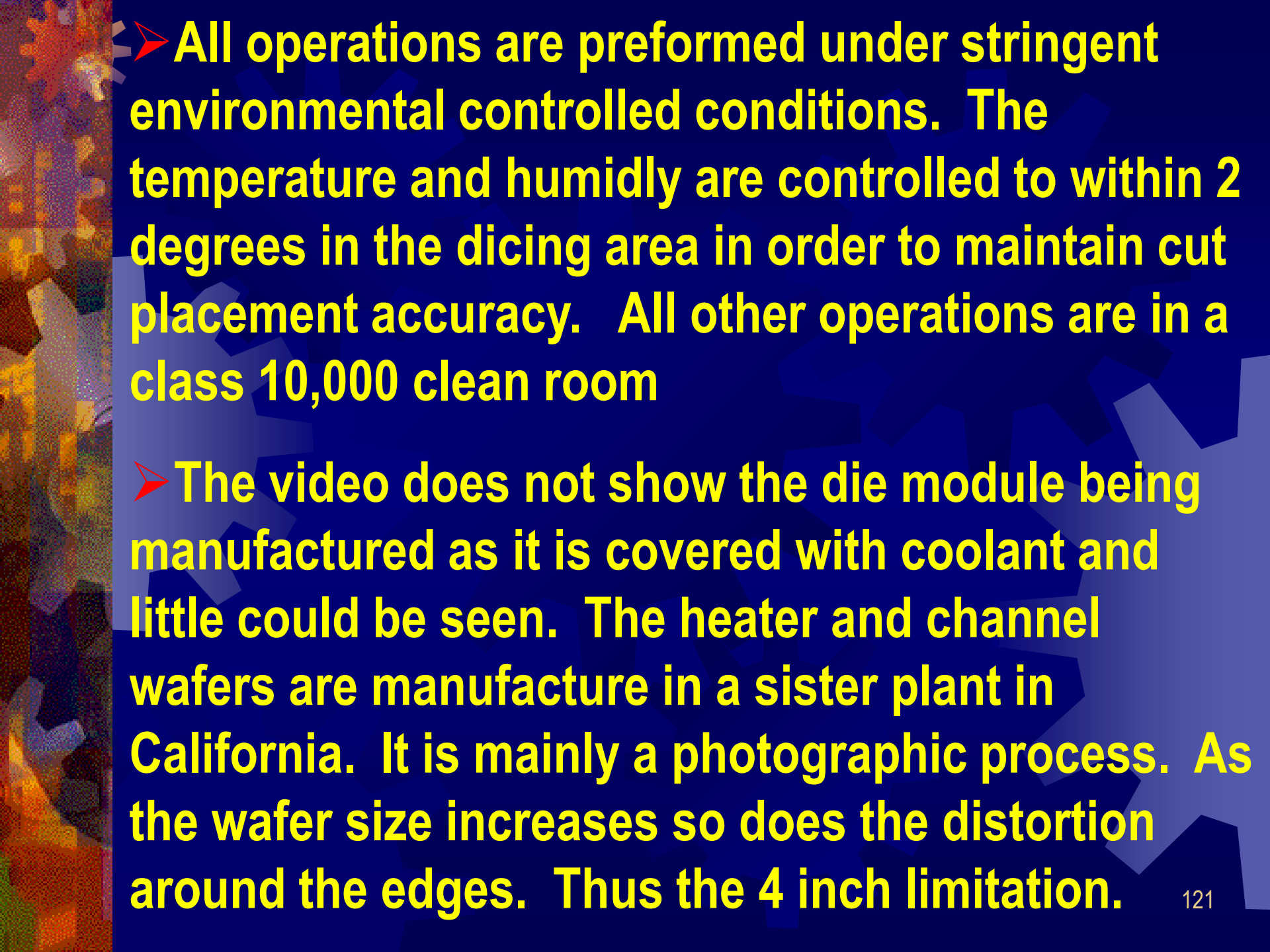
Die Module Assembly

There are 4 primary functions in the die module assembly.

- 1. Align and bond the 4" channel wafer to the 4" heater wafer so that the individual fluid paths align to the individual heaters to within 6 microns**
- 2. Cut out the individual die elements and expose the electrical bonding pads with precision dicing saws capable of maintaining 15 micron cut placement tolerances**

Die Module Assembly (cont)

3. Apply a thin 2,000 angstrom (.000006") Teflon-like coating to the nozzle face to prevent the ink from wetting the nozzle face.
4. 100% inspect the nozzle face for defects that could cause print quality problems. This is done under a microscope at 100 power. Check electrically

- 
- **All operations are preformed under stringent environmental controlled conditions. The temperature and humidity are controlled to within 2 degrees in the dicing area in order to maintain cut placement accuracy. All other operations are in a class 10,000 clean room**
 - **The video does not show the die module being manufactured as it is covered with coolant and little could be seen. The heater and channel wafers are manufacture in a sister plant in California. It is mainly a photographic process. As the wafer size increases so does the distortion around the edges. Thus the 4 inch limitation.**

Final Assembly

Die Module and 14 other components are assembled to complete the Korbek Thermal Ink Jet Cartridge. This is in a class 10,000 clean room. A particle size as small as 5 microns (.0002 inches) could cause a jet to become clogged or misdirected. Pilot line started in August 1993 with the first production month being September. There are 28 sequential manufacturing operations, which maintain tolerances of 38 microns.

Epson in their explanation of Piezo technology in their print head states, "45 microns, 2 times smaller than the diameter of a human hair and close to the limit of resolution for the human eye"

Packaging & Private Label

- **Packaging, not shown on the video, is in a separate department where private labeling take place. Customers in 1992 were Seikosha, Texas Instrument, Tokyo Electric Company, and Xerox.**
- **Stocked as a generic unit and customized at packaging with company name. Key inserted so one company's cartridge could only be used in their printer and not in another company's printer printer.**

Video

1. Pilot Line ONLY
2. One color - Black Ink Only
3. Made for two reasons - top management education and to minimize cost of visitors
4. Cost to produce video – Xerox quote \$20,000 –script and photography by AMTX engineers, but with professional narration \$2,800

Comparison

Pilot Line

Production Line

Rate	20,000/month @ 200,000/yr.	21,600/day @6,000,000/yr.
Time	40 seconds	4 seconds
People	25/shift, 3 shifts, 5 days	5/shift, 7 day continuous operation
Cost	\$5,000,000	\$20,000,000

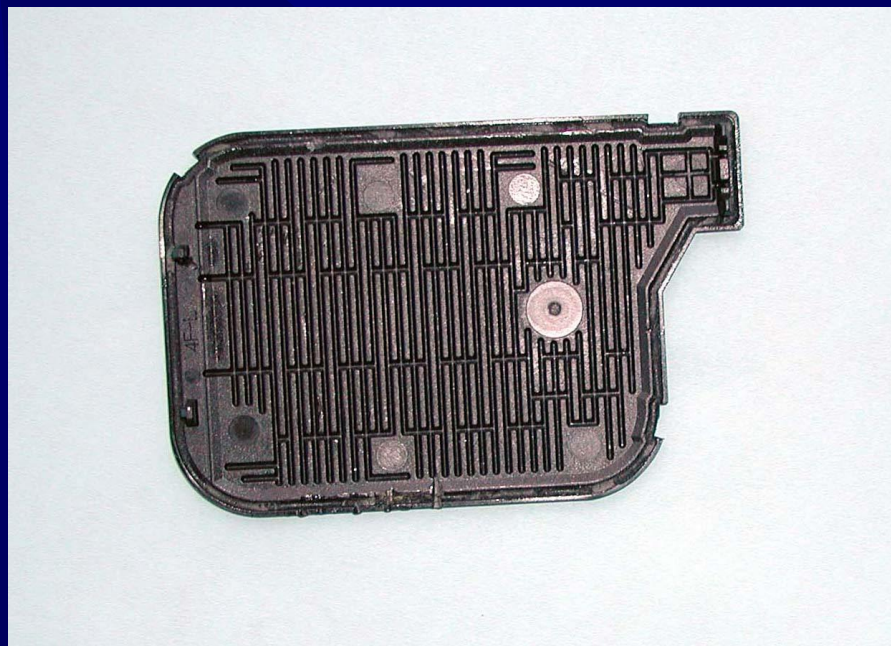
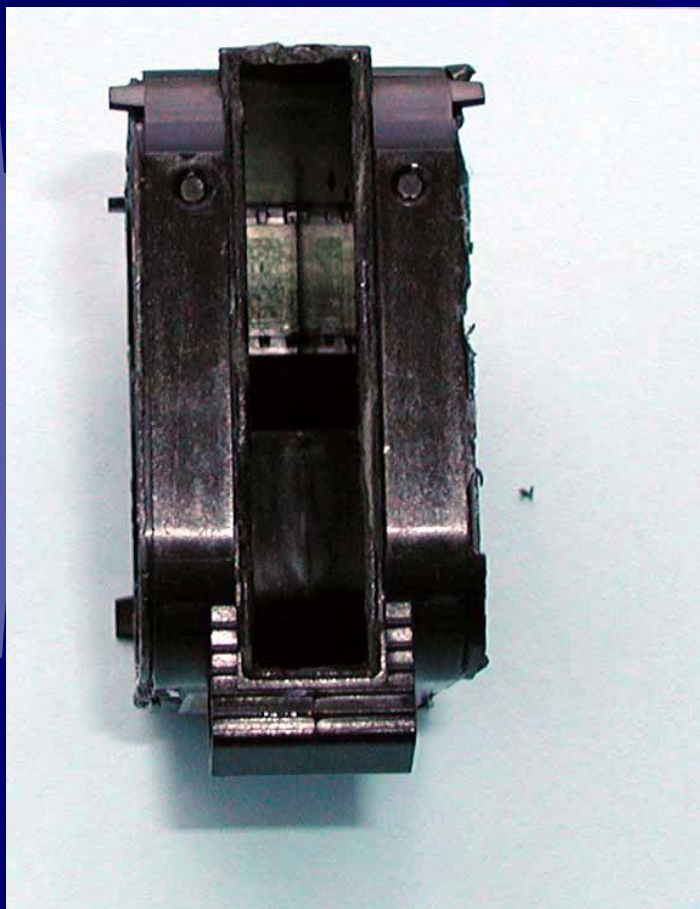
Manufacturing Cost = \$15.00

Selling Price to Consumer = \$49.00

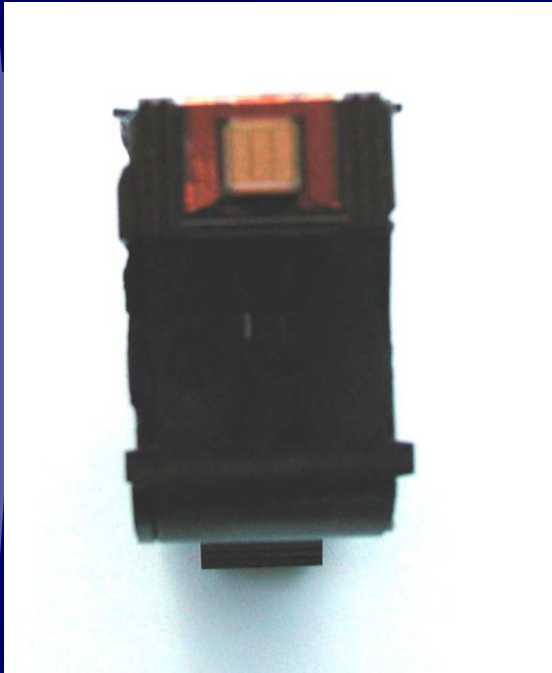
Sold as Xerox and through Private Label



Hewitt Packard Color 950



Hp 950 Series



Die



PC Board



**Shown Two
Chambers
& 1 Filter**

The Video

Runs about 10 minutes

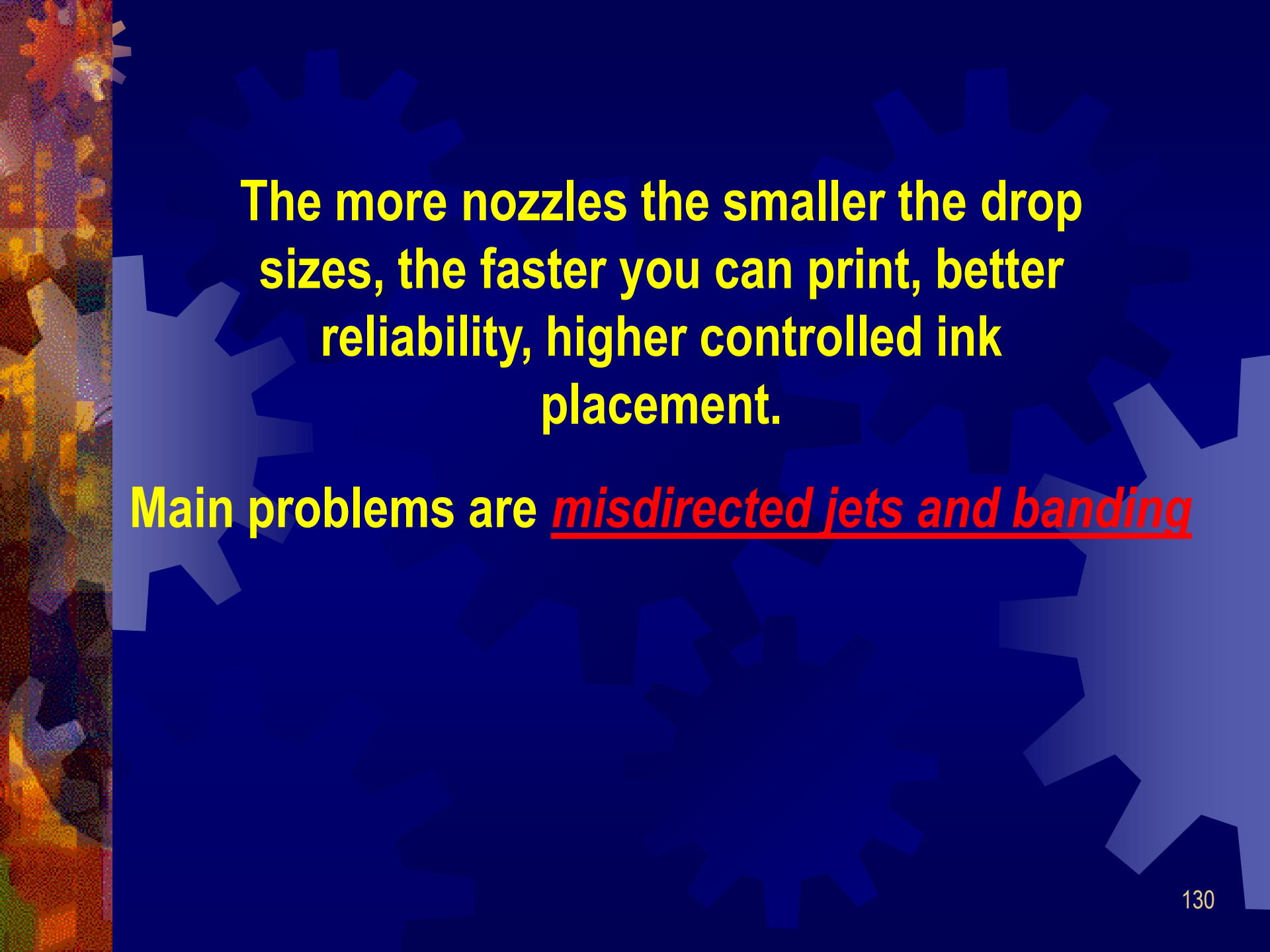
Not much time for a nap!!

**Three basis differences between pilot line
and production line**

**(1)Very few people - all robots, (2)machine
operations broken down into several
stations, (3)testing automation**



Questions?



The more nozzles the smaller the drop sizes, the faster you can print, better reliability, higher controlled ink placement.

Main problems are *misdirected jets and banding*

Printer Resolution & Pixels

Ink Jet Printers transform millions of tiny pixels into dots that form text and images on paper. Tiny nozzles spray droplets onto paper.

Laser printers use a more complicated process, but still use individual dots to create documents.

A dpi (dots per inch) rating specifies printer resolution