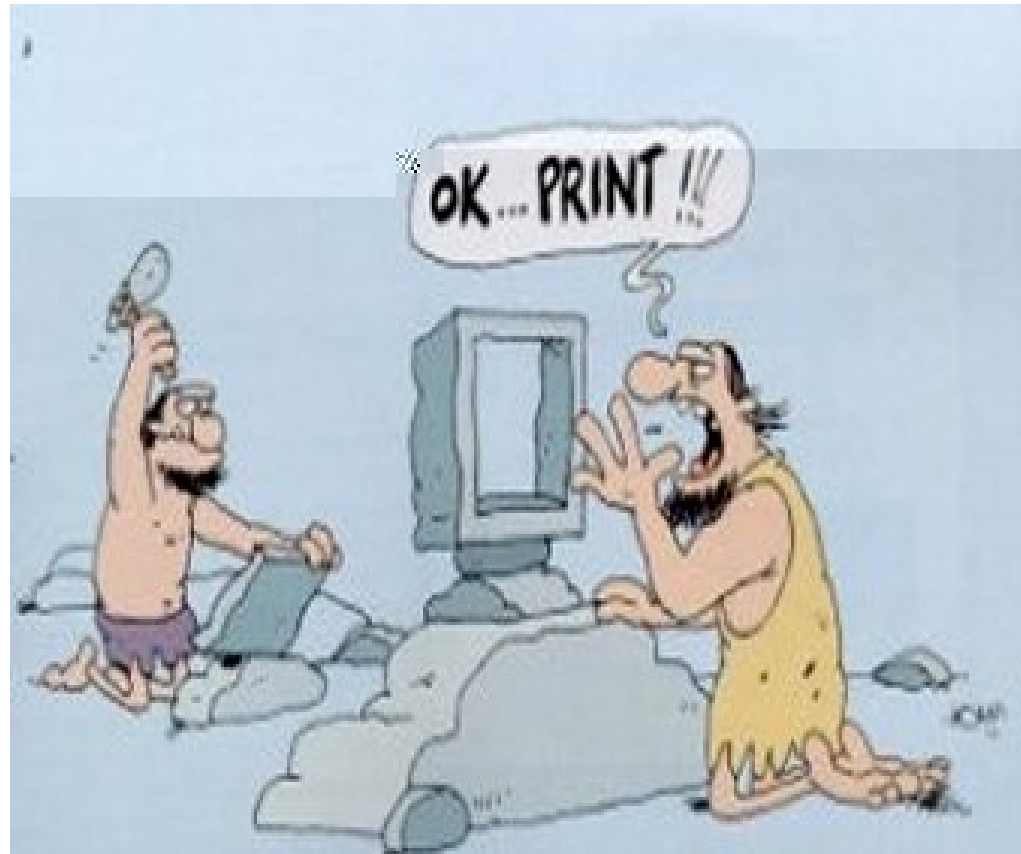




# Printer Command Language (PCL)

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October 11, 2006

# Isn't It Easy?





# The most popular Printer Description Languages (PDLs) are

- Printer Command Language (PCL)
  - PCL 1 was introduced in 1984 on the HP ThinkJet 2225.
    - basic text and graphics printing
    - 150 Dots Per Inch (DPI)
  - 5c color standard 1992
  - 5e monochrome standard 1992
- PCLXL
  - 6 1995
- PostScript (PS)
- Portable Document Format (PDF)
- Coming up...
  - XPS (Microsoft Vista)

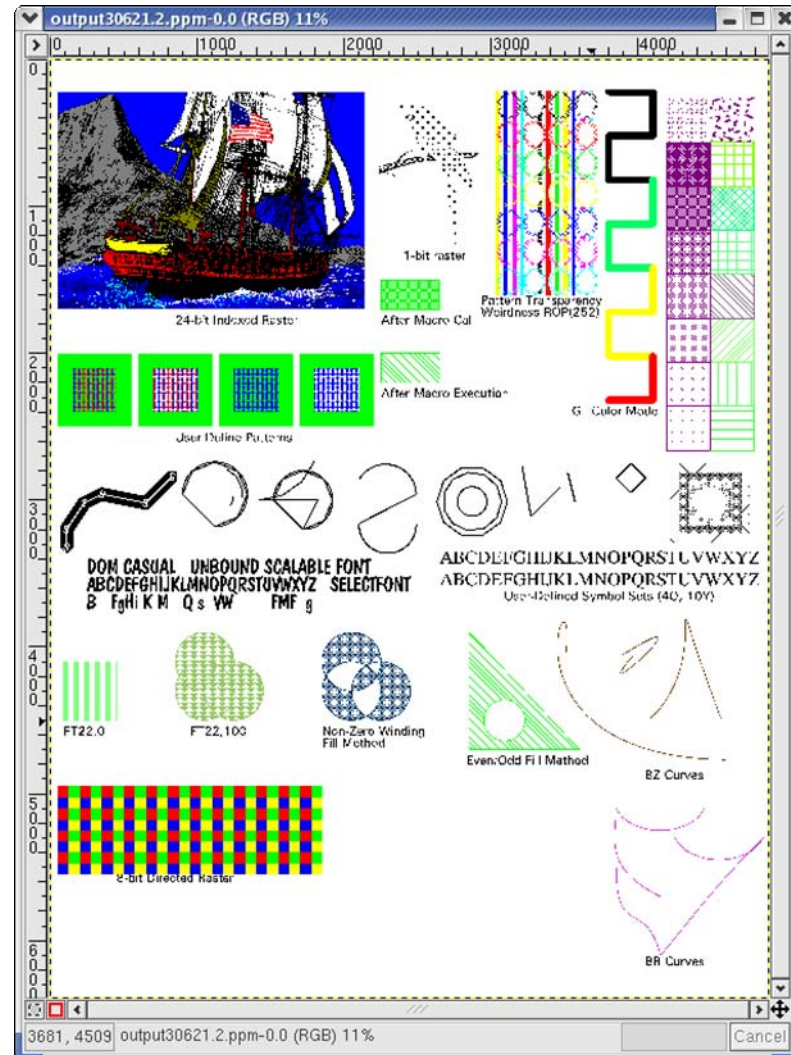


# Why Using These PDLs?

- If we send a raw raster image to a printer:
  - Paper Size: A LETTER is 8.5 x 11 inch
  - Output Resolution: 600 DPI
  - Output Color Model: Cyan, Magenta, Yellow, and Black (CMYK) (4 planes)
  - Intensity Level: 256 (1 Byte)
  - Width x Height x Plane x Intensity Level =  
 $(8.5 \times 600) \times (11 \times 600) \times 4 \times 1 = 5100 \times 6600 \times 4 = 134,640,000$  Bytes = 128.4 MB per page

# Why Using These PDLs? Cont.

- A better way to do it?
  - Assume using PCL, we describe a page and sends the descriptions to the printer that supports the language.



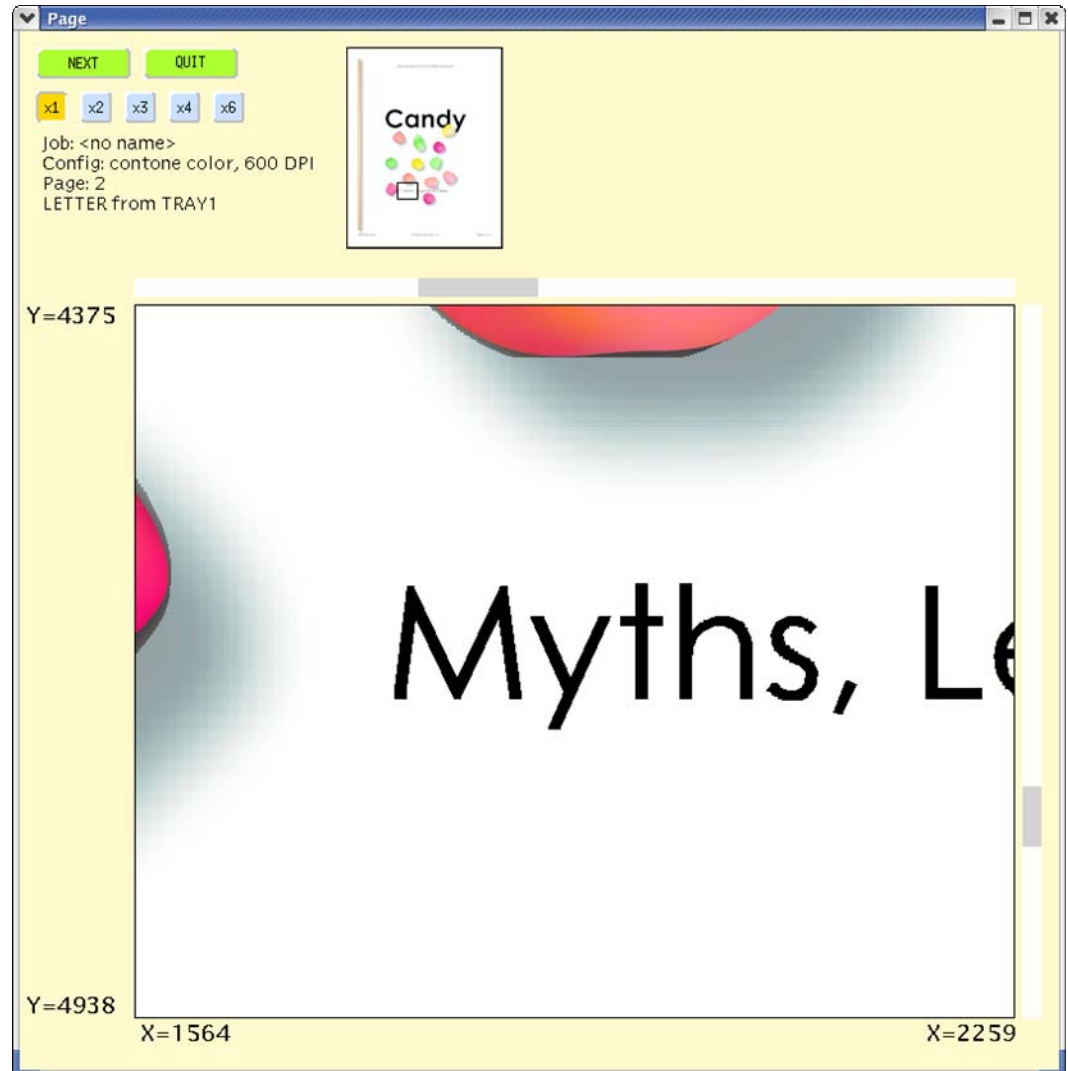


## Why Using These PDLs? Cont.

- While a PDL is more resolution independent, a raster image is the opposite.
  - For example, a font, an arc, ...

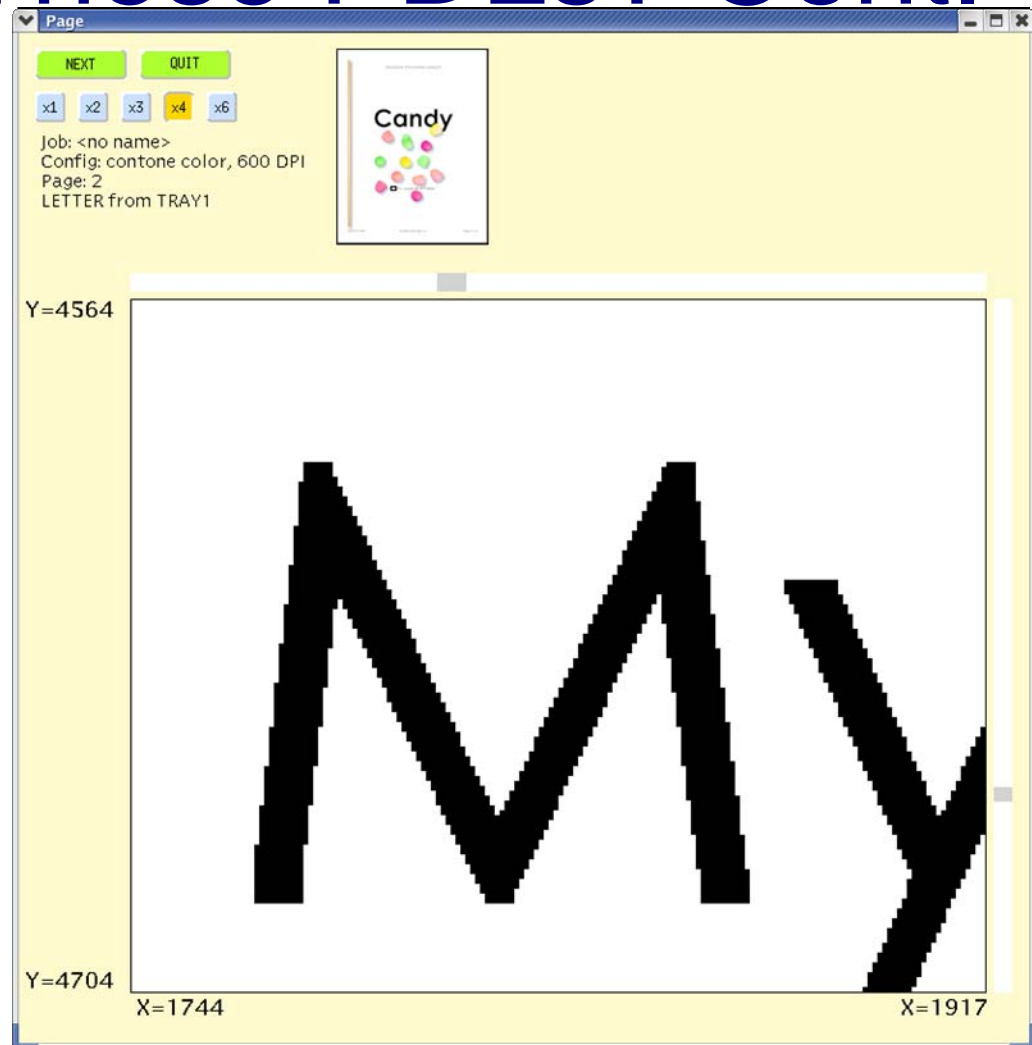
# Why Using These PDLs? Cont.

- The edges of the character “M” looks smooth in this resolution.



# Why Using These PDLs? Cont.

- See the difference in a higher resolution.







## Why Using These PDLs? Cont.

- Industrial view: Raster printers are considered as the low end devices while PDL printers are the high end devices.



# PCL

- What happen after you click PRINT?
  - Application either generates PCL itself (most old applications) or interacts with the Graph Device Interface (Windows GDI) to generate PCL (most new applications)
- PCL commands include
  - Paper size, simplex/duplex, N-up, text, font, image, drawing, palette, transparency, ROPs, and many...

# If you even wonder what PCL looks like?

- ```
← E← )8U← )s1p15v0s3b4101T⌘ ← *p30x50YXIONICS
Color← *p1368x50YMICRO5C FUNCTIONALITY
TEST← )s7V← *p30x3085YTest File: ./micro5c.c      Copyright (C) 1999 by
Xionics Document Technologies, Inc.      compiled on Jul 19 1999 08:57:32
by vun← *p2300x3085Ypage 1⌘ ← *p0x0Y← &a+150h+200V← *r-
3U← &a+0h+144V← (s1p6v0s0b4148T← *v7S← &f0SCMY
text← &f1S← &a+0h+596V← (s1p15v0s0b4101T← *v1SA ← *v2SB ← *v3SC
← *v4SD ← &a-580h+150V← *v5SE ← *v6SF ← *v7SG ← *v8SH ← &a+135h-
895V← *v7S← &a+50h+0V← *r-
3U← &a+0h+144V← (s1p6v0s0b4148T← *v7S← &f0SCMY
opaq← &f1S← &a+40h+736V← *v1S← (s1p60v0s0b4101TA← *v1N← *v2S← (s1p
24v0s0b4101T← *p-165x-100YB← *v3S← (s1p15v0s0b4101T← &a-
100h+0VC← (s1p20v0s0b4101T← *v4SD← &a-
380h+250V← *v5S← (s1p30v0s0b4101TE← *v6S← (s1p24v0s0b4101T← &a-
100h+0VF← *v7S← (s1p35v0s0b4101TG← *v8S← (s1p25v0s0b4101T← *p-
100x+0YH← &a+290h-890V← *v7S← *v0N← &a+50h+0V← *r-
3U← &a+0h+144V← (s1p6v0s0b4148T← *v7S← &f0SCMY
over← &f1S← &a+40h+736V← *v1S← (s1p60v0s0b4101TA← *v2S← (s1p24v0s0
b4101T← *p-165x-100YB← *v3S← (s1p15v0s0b4101T← &a-
```



# Don't Worry! We have tools.

- RESET;
- SYMBOLSET2("8U");
- FONT2(1,15,0,3,4101);
- TEXT("\016");
- POSP(30,50);
- TEXT("XIONICS Color");
- POSP(1368,50);
- TEXT("MICRO5C FUNCTIONALITY TEST");
- HEIGHT2(7);
- POSP(30,3085);
- TEXT("Test File: ./micro5c.c Copyright (C) 1999 by Xionics Document Technologies,  
Inc. compiled on Jul 19 1999 08:57:32 by vun");
- POSP(2300,3085);
- TEXT("page 1\017");
- POSP(0,0);
- MOVE\_D(150,200);
- CMY\_PALETTE;
- MOVE\_D(0,144);
- FONT(1,6,0,0,4148);
- SELECT\_COLOR(7);



# Three Major Objects

- Text

- Resident fonts and downloaded fonts

- Vector Drawing

- Line, arc, circle, rectangle, ...

- Raster Graphics

- compression methods

- 1 – Run-Length Encoding

- 2 – Tagged Image File Format (TIFF) rev 4.0

- 3 – Delta row

- 4 – Adaptive compression



# Run-Length Encoding

- Interprets raster data in **pairs of bytes**
- [(Repetition count byte 0-255)(pattern byte)].[.][[]]
- Ex:
  - If source looks like “UUUUATT”
  - The Run-Length Encoding is
    - <ESC>b1m6W3U0A1T
      - 1m means method 1 compression
      - 6W means 6 bytes follows



# Tagged Image File Format (TIFF)

## rev 4.0

- A negative number (-1 to -127) indicates a repeated byte.
- A positive number plus 1 indicates that the number of the following literal bytes.
- EX:
  - The same source “UUUUATT”
  - TIFF 4.0 looks like <ESC>b2m6W(-3)U(0)A(-1)T or <ESC>b2m6W(-3)U(2)ATT where (-3)U comes from the twos complement.
    - The complement of  $0000\ 0011_2$  is  $1111\ 1100_2$
    - Plus one is twos complement  $1111\ 1101_2$ . Or,  $256 - 3 = 253$  which is  $1111\ 1101_2$  as well.

# Delta Row Compression

- Identifies a section of bytes in a row that is different from the preceding (seed) row, then transmits only the different data.
  - If a row is completely different, a entire row needs to be sent as the delta (inefficient)
- [(Command byte)(1 to 8 Replacement bytes)]
  - Command byte looks like

|   |                                  |   |                                          |   |
|---|----------------------------------|---|------------------------------------------|---|
| □ | Command Byte                     |   |                                          |   |
| □ | 7                                | 5 | 4                                        | 0 |
|   | Number of bytes to replace (1-8) |   | Relative offset from last untreated byte |   |

Continue.



# Delta Row Compression Cont.

| Command Byte                     |   |                                          |   |
|----------------------------------|---|------------------------------------------|---|
| 7                                | 5 | 4                                        | 0 |
| Number of bytes to replace (1-8) |   | Relative offset from last untreated byte |   |

## ■ Command Byte:

- 0<sup>th</sup> – 4<sup>th</sup> bit: **relative offset** 0 to 31 ( $2^5 = 32$  values), and 31 is reserved for an additional offset byte. Then, if the second offset byte is 255, an additional offset byte follows.
- 5<sup>th</sup> – 7<sup>th</sup> bit: **the number of replacement (delta) bytes** ( $2^3 = 8$  values)
- Therefore, we can replace up to 8 bytes at a time/per command in any length offset.

## ■ Example:

- `<ESC>*b3m4W(000111112) (111111112) (100000002) (100101112)`
- Method 3 (3m), 4 bytes follow (4w), at offset  $((11111)_2 + (11111111)_2 + (10000000)_2)$  replace 1 (000) byte with value (10010111)

# Delta Row Compression Cont.

| Byte Number | 0        | 1        | 2        | 3        | 4        |
|-------------|----------|----------|----------|----------|----------|
| BZERO       | 00000000 | 00000000 | 00000000 | 00000000 | 00000000 |

<ESC>\*b3m2W(00000001<sub>2</sub>)(11111111<sub>2</sub>)

|       |          |          |          |          |          |
|-------|----------|----------|----------|----------|----------|
| Row 1 | 00000000 | 11111111 | 00000000 | 00000000 | 00000000 |
|-------|----------|----------|----------|----------|----------|

<ESC>\*b2W(00000010<sub>2</sub>)(11110000<sub>2</sub>)

|       |          |          |          |          |          |
|-------|----------|----------|----------|----------|----------|
| Row 2 | 00000000 | 11111111 | 11110000 | 00000000 | 00000000 |
|-------|----------|----------|----------|----------|----------|

<ESC>\*b5W(00000000<sub>2</sub>)(00001111<sub>2</sub>) (00100010<sub>2</sub>)(10101010<sub>2</sub>) (01010101<sub>2</sub>)

|       |          |          |          |          |          |
|-------|----------|----------|----------|----------|----------|
| Row 3 | 00001111 | 11111111 | 11110000 | 10101010 | 01010101 |
|-------|----------|----------|----------|----------|----------|



# Adaptive Compression

- Interprets a raster image as a block of raster data rather than as individual rows.
  - Up to 32,767 compressed bytes
- Uses
  - 0 – Unencoded
  - 1 – Run-Length Encoding
  - 2 – TIFF
  - 3 – Delta row
  - 4 – Empty row
  - 5 – Duplicate row



## Summary: PCL Minimizes The Data Translation

- PCL minimizes the low-level compression effort by describing the semantic of a page rather than in the page's output context
  - Although the final product before print engine puts out color is always an engine ready raster image.



# References

- Printer Command Language, [www.wikipedia.org, http://en.wikipedia.org/wiki/PCL\\_6](http://en.wikipedia.org/wiki/PCL_6), retrieved on Sep. 25, 2006
- PCL 5 Printer Language Technical Reference Manual, Hewlett-Packard CO., 1992
- PCL 5 Color Technical Reference Manual, Hewlett-Packard CO., 1996



Questions?