

# Choosing a Display

A brief talk by William Matheson

# Three Common Technologies



CRT



LCD



Plasma

*(click on images to visit sources)*

# CRT: Cathode Ray Tube

- Cathode rays are streams of electrons observed in vacuum tubes:



Cathode rays casting a shadow on the wall of a Crookes tube

# CRT: Cathode Ray Tube

- To make a display, we need an electron gun and an evacuated picture tube:



# CRT: Cathode Ray Tube

- We need a strong material to hold a vacuum against our atmosphere!



Mauna Kea, Hawaii: Plastic bottle sealed at 14,000 feet (left) taken down to 1,000 feet (right).

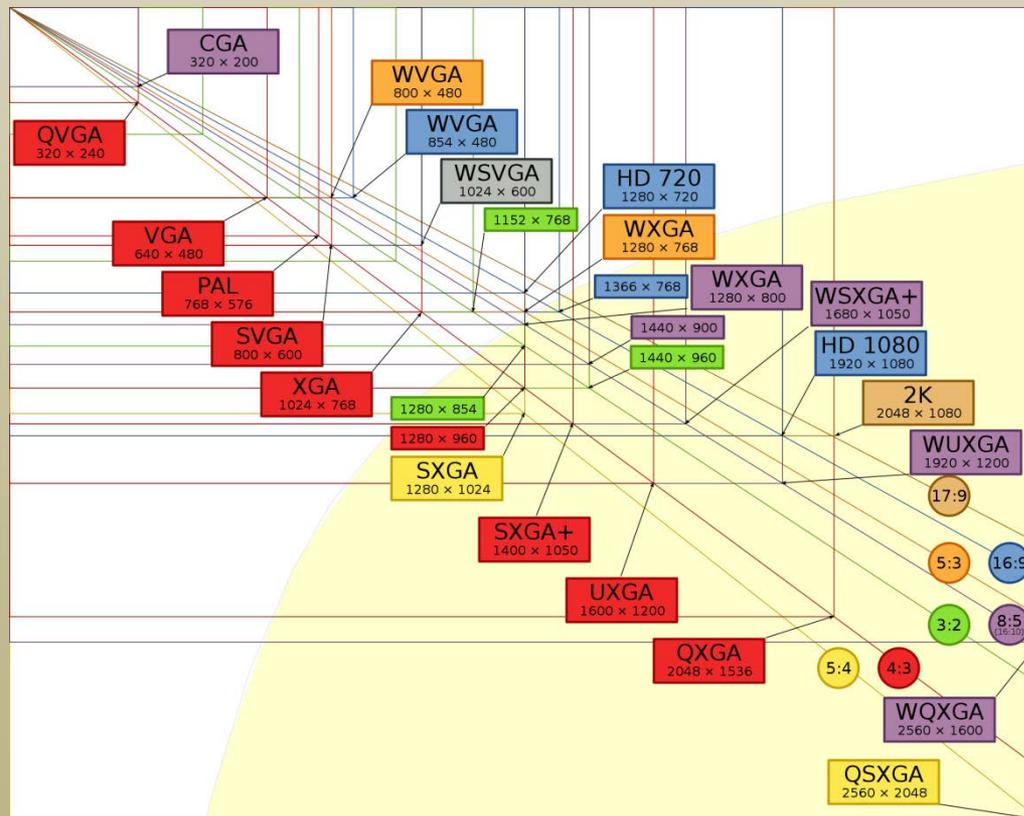
# CRTs: Advantages

- Very wide viewing angle (close to 180°):



# CRTs: Advantages

- Every resolution is optimally displayed.



# CRTs: Advantages

- Ideal for displaying low-resolution content.
- Lowest-possible input lag, fast response time.



# CRTs: Disadvantages

- Heavy



# CRTs: Disadvantages

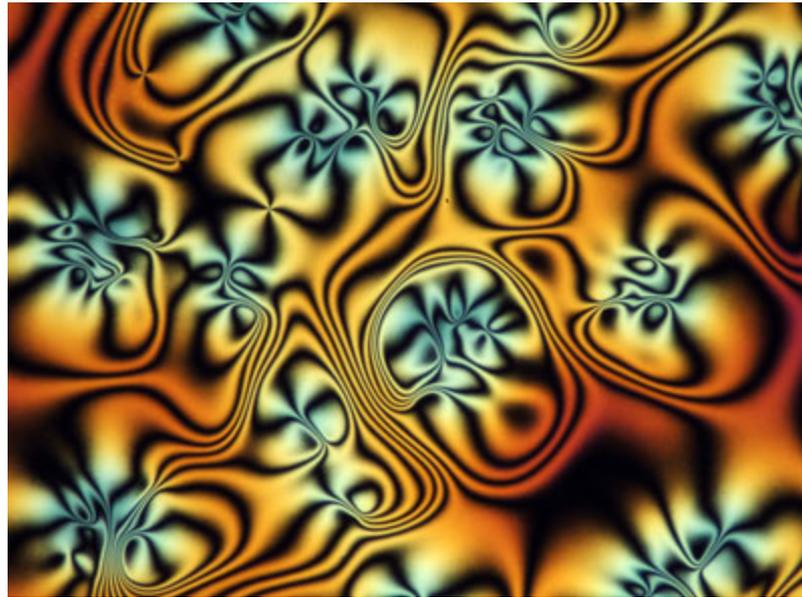
- Expensive



Sony KV-40XBR800:  
40 inches, 304 pounds, 2,999 dollars

# LCD: Liquid Crystal Display

- Use light modulating properties of **liquid crystals** (*being of a state of matter between conventional liquid and solid crystal*)



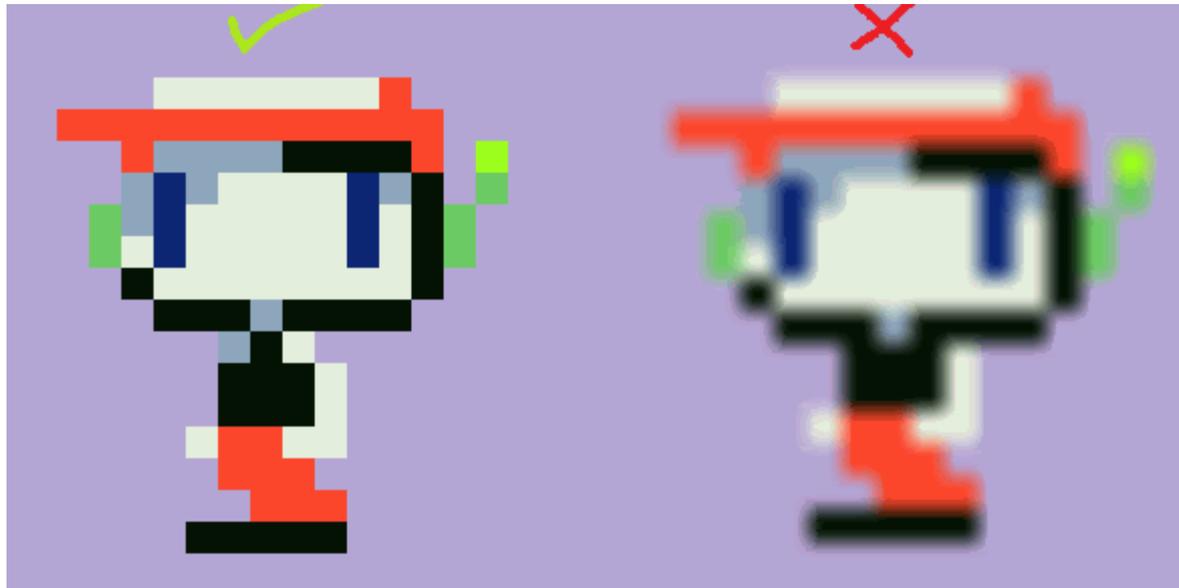
# LCDs: Advantages

- Compact
- Light
- Cheap



# LCDs: Disadvantages

- Only operate well at one (native) resolution



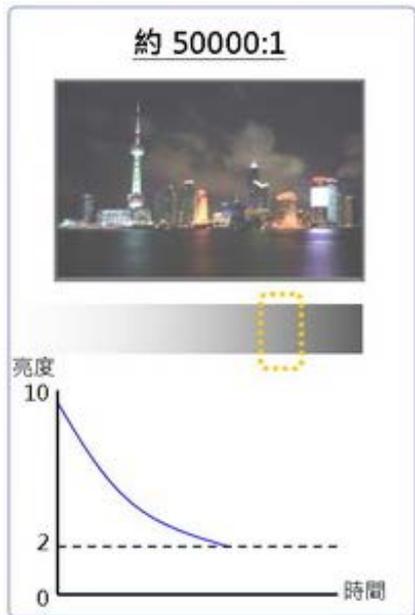
# LCDs: Disadvantages

- Require backlighting

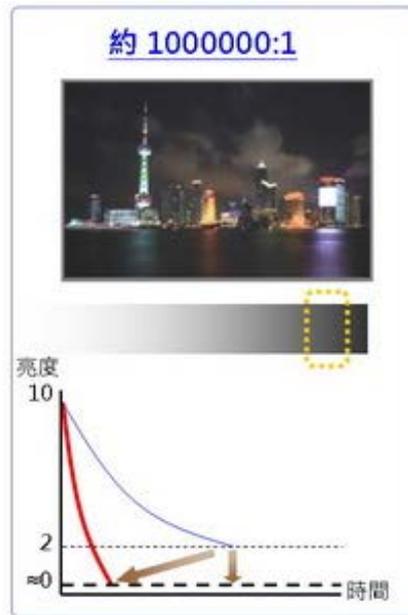


# LED-backlit LCDs

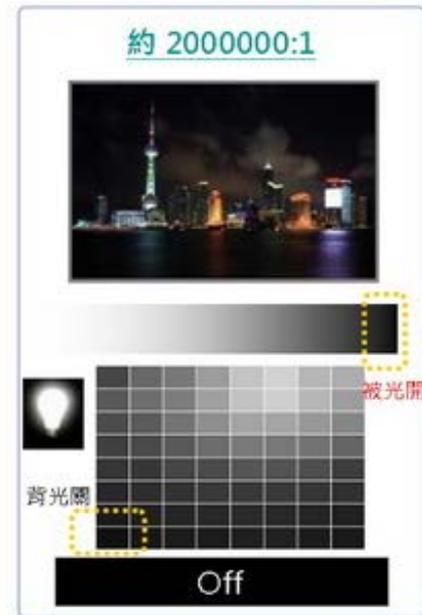
- New LCDs are often backlit by LEDs\*, allowing for finer control of backlighting:



Single rear backlight



Edge-positioned backlights



Array of LED backlights

\* - **L**ight **E**mitting **D**iode. Seen increasingly in things like bus destination signs (the individual LEDs make up a dot matrix) and automotive headlamps (the LEDs replace conventional light bulbs).

# Contrast Ratio

- Difference between brightest and darkest light level the display can show at once (*static*) or ever (*dynamic*)
- The bigger the better
- Static is harder to achieve than dynamic
- Measurement differs among manufacturers, so only use it to compare among a single model line

# LED-backlit LCDs

- Beware: LED-backlit LCDs are often marketed as “LED TVs”:

The screenshot shows the Best Buy website's product page for LED TVs. The page features a navigation bar with categories like PRODUCTS, SERVICES, SPECIALTY STORES, SPECIAL OFFERS, and COMMUNITY. Below the navigation, there's a search bar and a breadcrumb trail: Home > TV & Home Theatre > Televisions > LED TVs. The main content area displays a list of LED TVs with filters on the left and product details on the right.

**Your selections:**

- Category: LED TVs [Undo](#)
- Category: Televisions [Undo](#)
- [Clear all selections](#)

**Narrow your results by:**

- LED TVs**
- 40" - 49" LED TVs (16)
- 21" - 29" LED TVs (8)
- 30" - 39" LED TVs (8)
- 60" & Over LED TVs (7)
- 50" - 59" LED TVs (6)
- 13" - 20" LED TVs (4)
- Other information (5105)
- [See all 5154 items](#)

**Current Offers**

- Best Buy Exclusive (4)
- On Clearance (1)
- On Sale (24)
- Online Only (1)
- Refurbished (2)

**Status**

- Whats New (5)
- New Releases (1)

**1-15 of 49** Page: 1 2 3 4 ▶ Results per page: 15 ▼

**Sort by:** Price: Low to High | Price: High to Low | Title: A-Z | Title: Z-A | Customer Rating

**Product 1:** **New! Insignia 22" 1080p 60Hz LED HDTV (NS-22E450A11) - Black - Refurbished** Model: NS-22E450A11 | Web Code: 10179769 **Our Price: \$149.99** [Add to Cart](#) [Add to Wish List](#) [Add to Price Watch](#)

At 22", this Insignia LED LCD HDTV is ideal for your bedroom or dorm room. It features a brilliant F... More Info

[Compare](#)

**Order Online:** In Stock: Usually ships next business day  
**Online Quantity:** 17  
**Local Store Availability:** [Check store availability >](#)

**Product 2:** **New! Insignia 22" 1080p 60Hz LED HDTV (NS-22E455C11) - White - Refurbished** Model: NS-22E455C11 | Web Code: 10179778 **Our Price: \$149.99** [Add to Cart](#) [Add to Wish List](#) [Add to Price Watch](#)

This Insignia 21.6" LED LCD HDTV will fit perfectly into your bedroom, dorm room or limited space li... More Info

[Compare](#)

**Order Online:** In Stock: Usually ships next business day  
**Limited Quantities available.**  
**Local Store Availability:** Information Not Available

**Product 3:** **Sharp AQUOS 70" 1080p 120Hz LED HDTV (LC70LE632U)** Model: LC70LE632U | Web Code: 10181370 **Price: \$2,699.99** **On Sale: \$2,499.99**

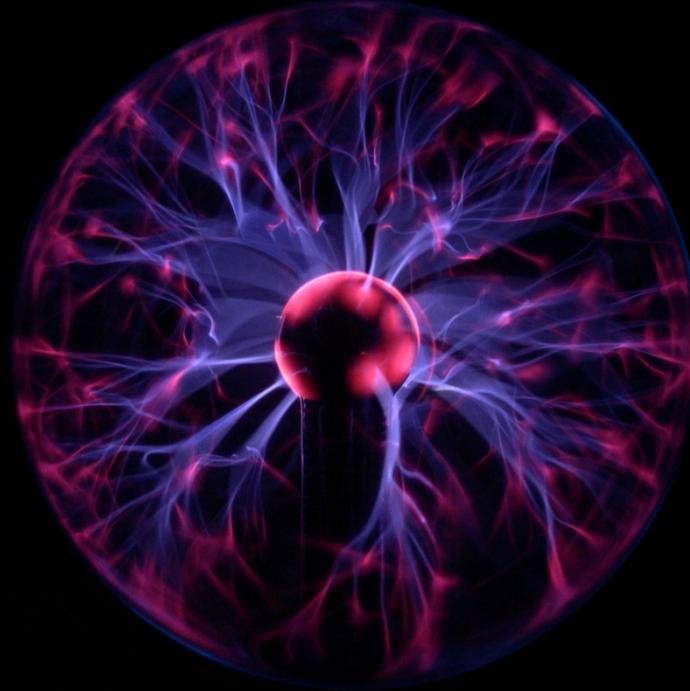
# *An actual* LED TV



Sony XEL-1: 11 inch diagonal, 3 millimeter thickness, 2,499 dollar expense

# Plasma

- Uses cells containing electrically charged ionized gases



# Plasma: Advantages

- Obviates backlighting



This industrious user is working around a broken LCD backlight by mounting the liquid crystal panel onto the case of a disused CRT monitor and installing a fluorescent lightbulb.

# Plasma: Advantages

- Fast response time, less motion blur



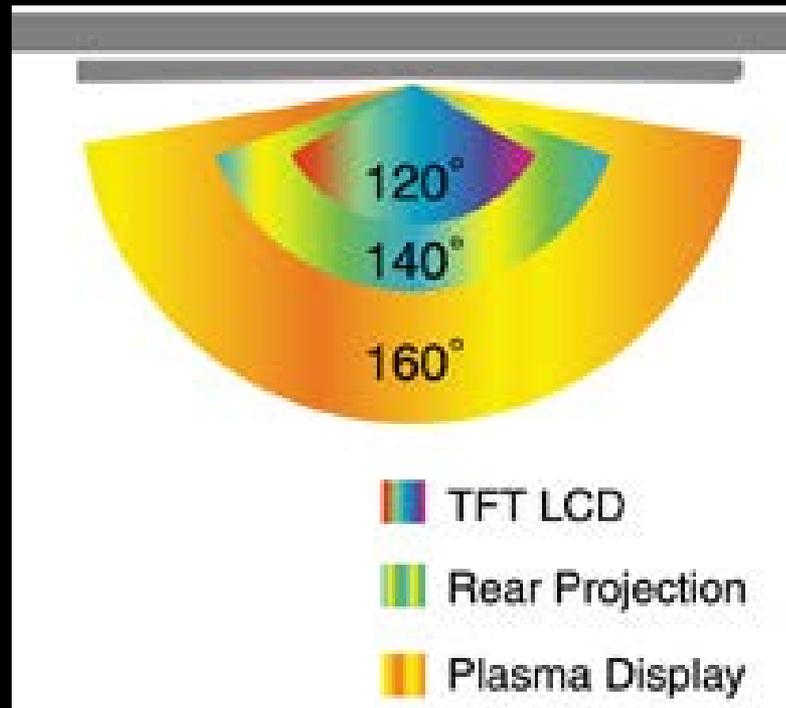
Sharper



Blurrier-er

# Plasma: Advantages

- Wide viewing angle:



# Plasma: Disadvantages

- Expensive; seldom offered in sizes smaller than 37 inches



- ... but the initial outlay for the technology scales well: At very large sizes, plasmas are cheaper than comparatively sized LED-backlit LCDs (but still more expensive than conventional LCDs).

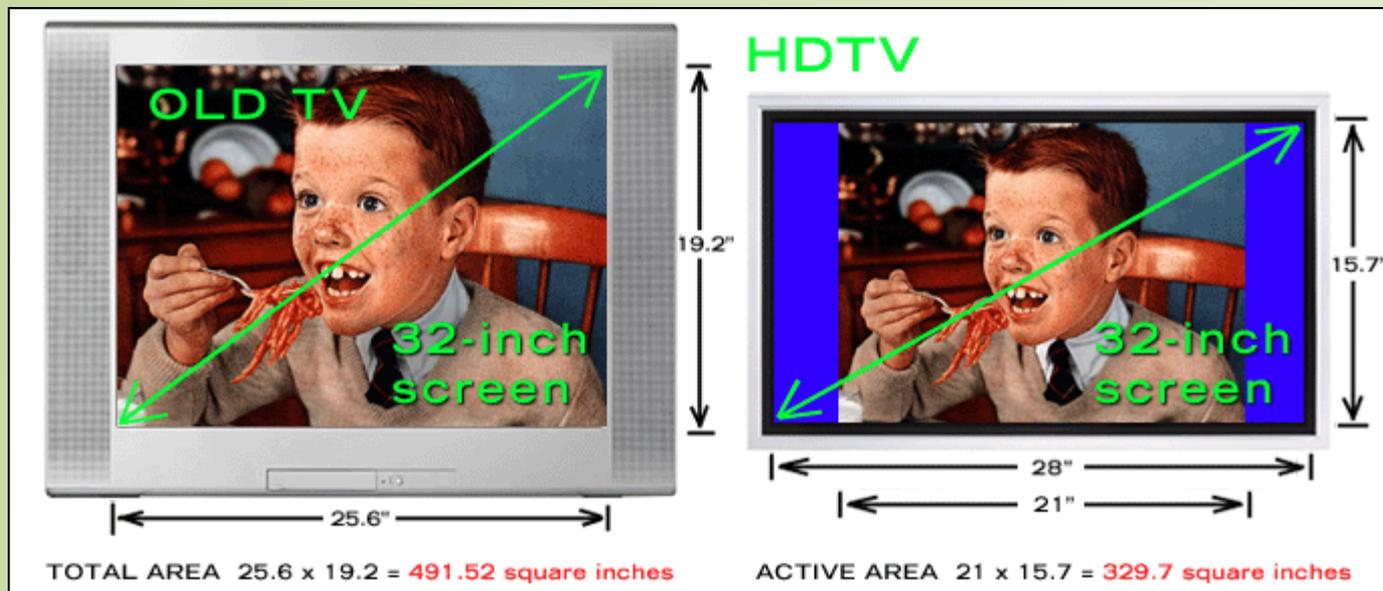
# Plasma: Disadvantages

- Doesn't work well at high altitudes because of the pressure differential

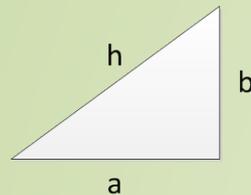
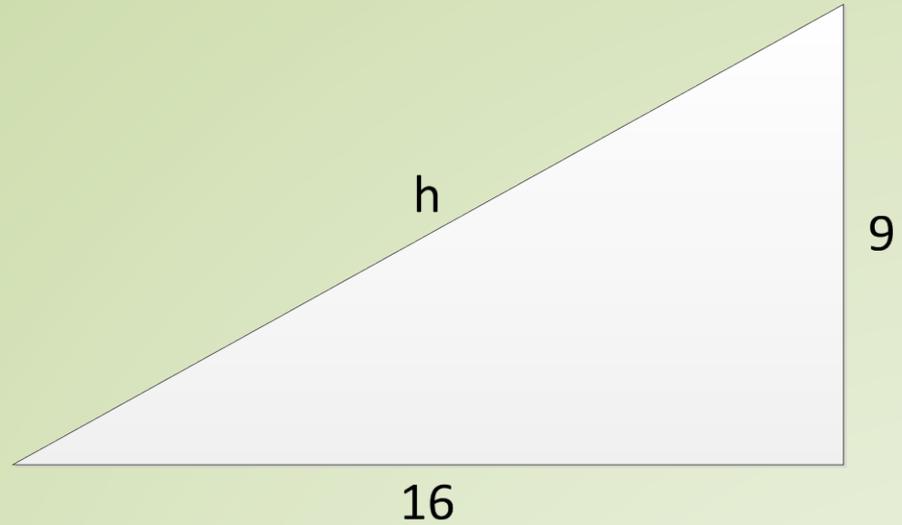
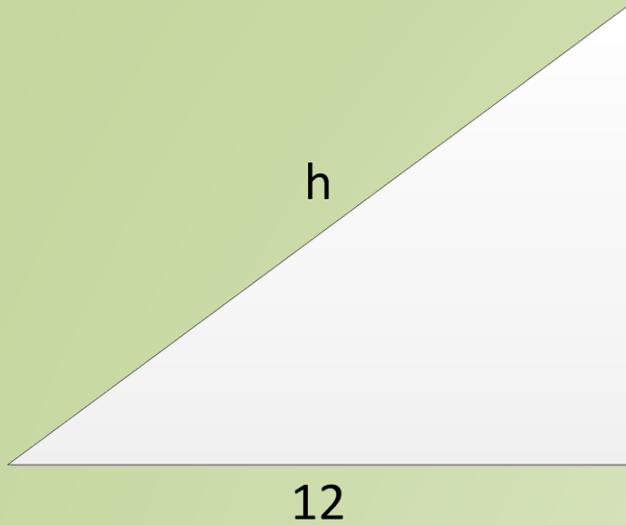


# Screen Size

- Displays are typically sold by their diagonal
- When changing the ratio of the display, the relative length of the diagonal also changes:



# Screen Size



$$a^2 + b^2 = h^2$$

# Screen Size

$$9^2 + 12^2 = h_{12:9}^2 = 225$$

$$h_{12:9} = \sqrt{225} = 15$$

$$9^2 + 16^2 = h_{16:9}^2 = 337$$

$$h_{16:9} = \sqrt{337}$$

$$\frac{h_{16:9}}{h_{12:9}} = \frac{\sqrt{337}}{15} \approx 1.2238\dots$$

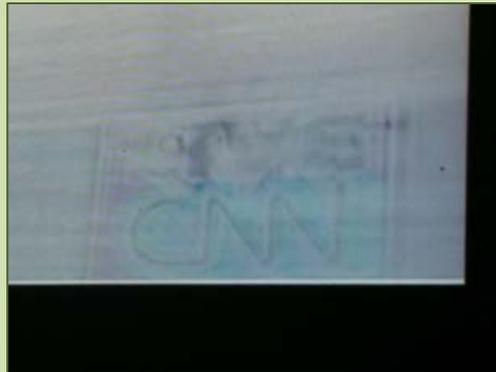
- To find the diagonal of the appropriate 16:9 replacement for a 4:3 display, multiply the diagonal of the 4:3 display by **1.22**.

# Screen Burn-in

- Though the mechanics differ among them, this anomaly affects all display types:



CRT



LCD



Plasma

# Screen Burn-in

- To avoid burn-in, avoid long-persisting pixels (prompts, sign-in screens, watermarks, channel indicators, etc..)



At Saint Mary's in the middle of the last decade, this login screen was persistent enough that it burned itself into many of the workstation LCDs.

# Thank You

