Vehicle Displays Specifications & Measurements

Authors:

Robert Donofrio - Display Device Consultants LLC -Ann Arbor , MI
www.displayconsultants.com

Dr. John Troxell - Consultant

Randy Klimek - Midwest Sales Manager of Konica Minolta Sensing

Conents of Talk

1. Historical Vehicle Displays
2. New Vehicle Displays *
3. Touch Screens*
4. LEDs*
5. Measurement Tools- 2D Photometer, Colorimeter

6 Standards - SAE Automotive J1757, and SID ICDM

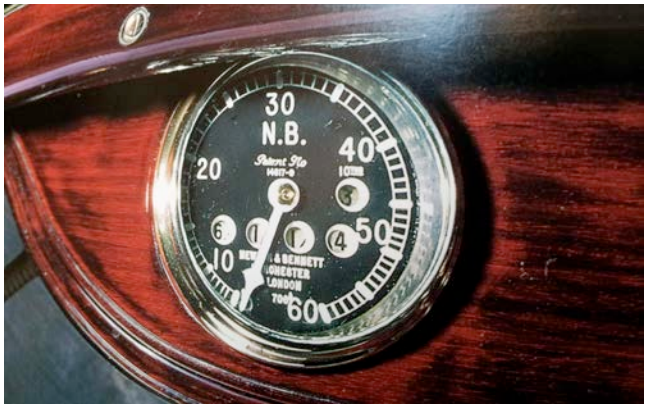
* Info from SID VD Symposia in Detroit Michigan

HISTORY OF VEHICLE DISPLAYS

- Early Displays were Alpha-numerics Inked or painted on plates with mechanical analog or digital movements either front or back lighted with incandescent light bulbs.
- In 1980's Transition to CRT and then VFDs. EL & LEDs and now into AM & PM LCDs
- And when performance improves we may see E-Ink type displays

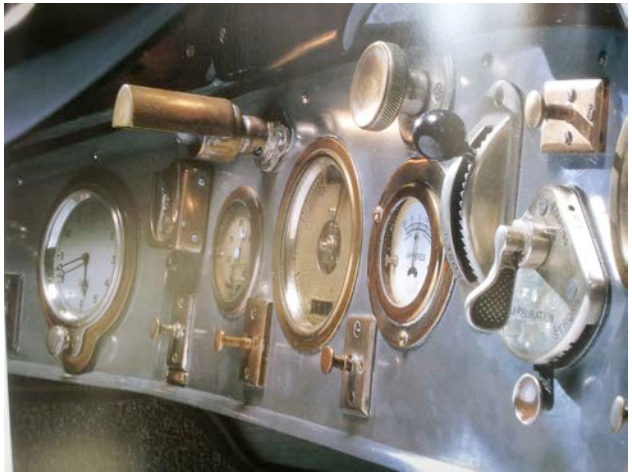
Historic Dashboard Displays/Instruments

1913 Bugatti



1913 Newton-Bennett

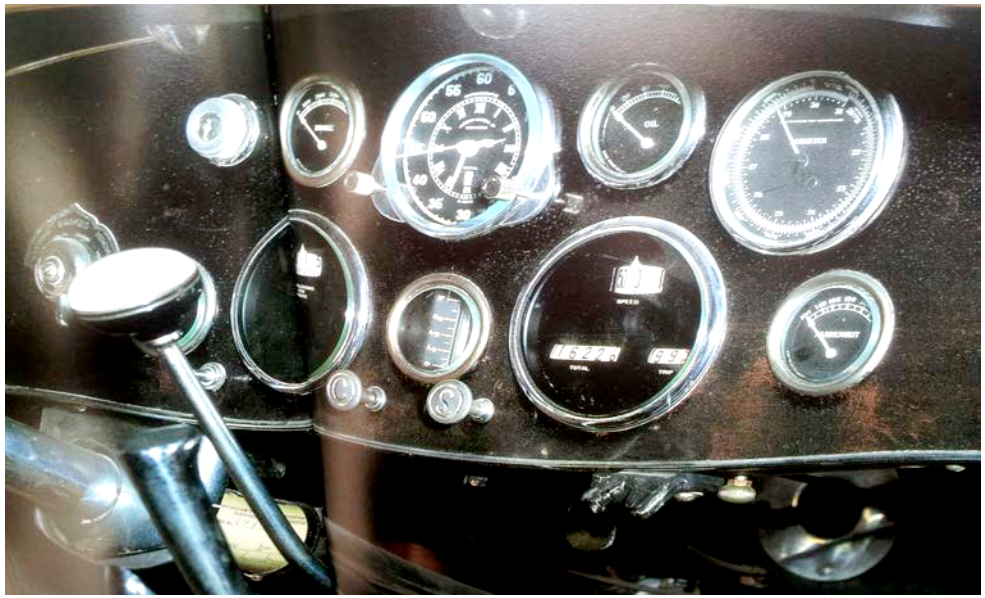
1925 Rolls-Royce



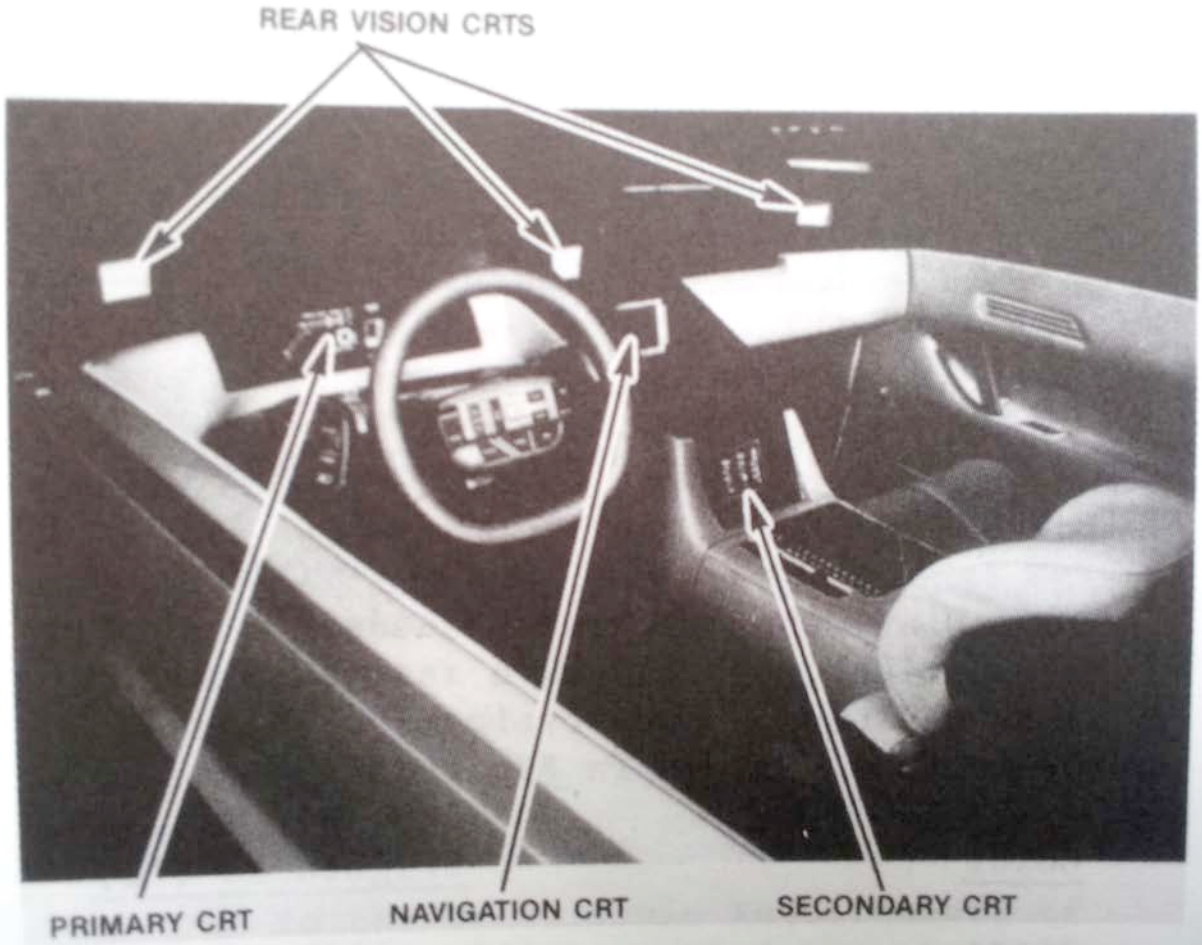
Historic Dashboards Continued

1930 Duesenberg Model SJ
- all Analog

1930 Duesenberg Model J
Some Digital



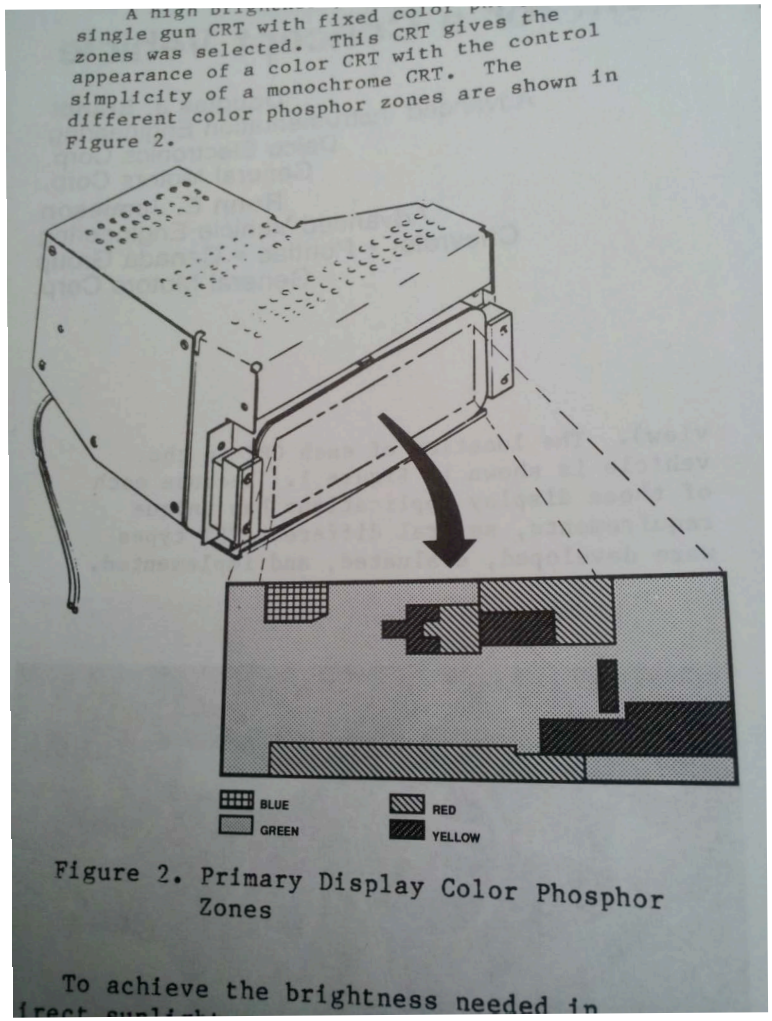
The CRT and Dashboard Displays (from 1989 SAE Pub)



Single Gun Automotive CRT (1985)

Typical Luminance Measurements

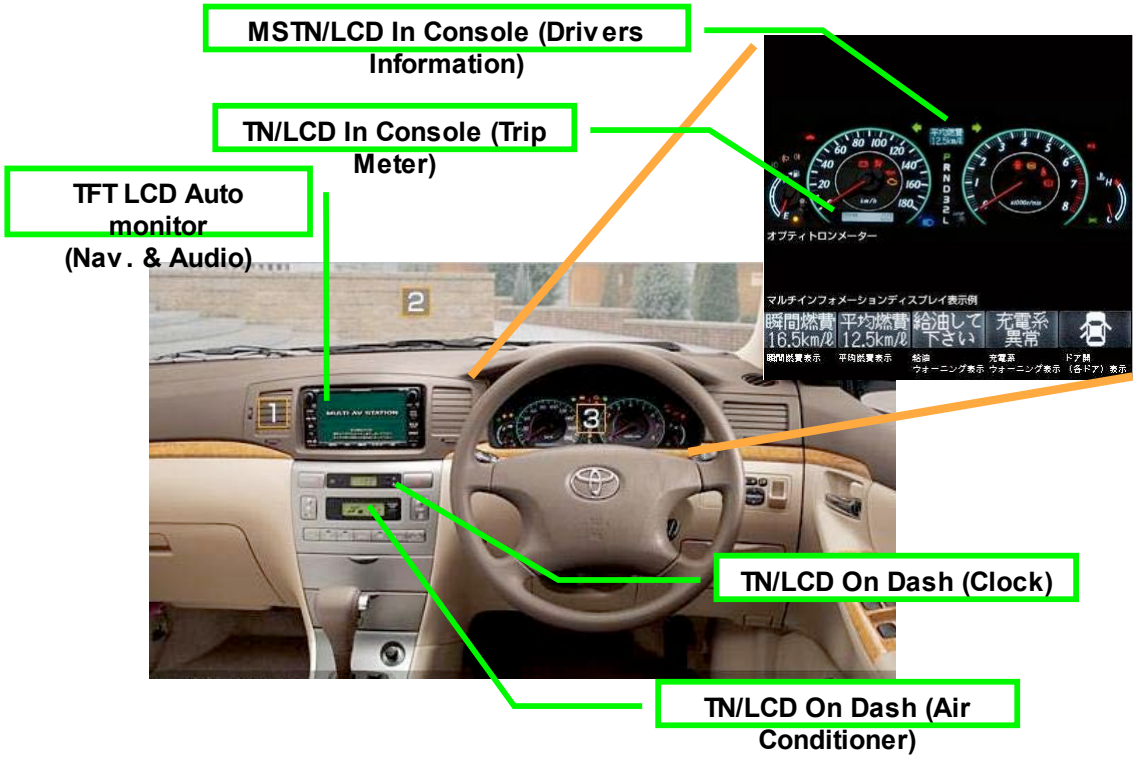
Color	Luminance (fL)
Green (Speedometer)	402
Yellow (Low Fuel)	214
Red (Odometer)	165
Blue (High Beam)	55



The 1980's and CRT Displays in Autos & Military

- 1983 Buick Riviera 5" Green Monochrome CRT
- 1885-86 Toyota Soarer 6" CRT
- 1986 Toyota CRT - for Navigation and Diagnostics with IR Touch Screen
- 1988 Toyota "Crown" Electro Multivision CRT in Center Stack with Navigation, TV, CD player and Vehicle information and Maintenance guide.
- 1992 Sumitpmo CRT Touch Screen 320x240 pixels
- 1992 CRT Oldsmobile Trofeo as Trav Tek vehicle GPS Sony System
- 2013 CRTs used in Bradley Fighting Vehicle and the Abrams M1A1 Tank

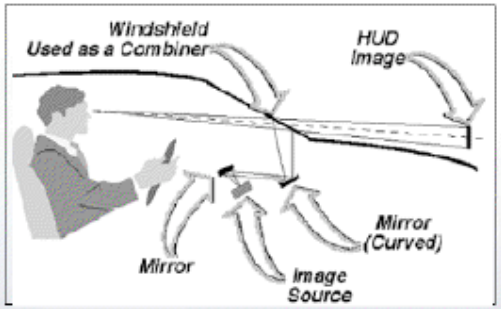
New Developments in Vehicle Displays & VD Standards

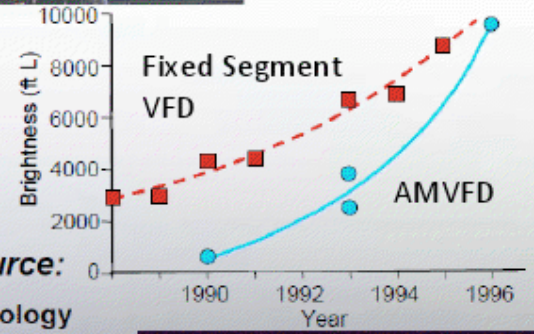


2006

How HUDs (VFDs) Operate (Troxell 2004 SPIE)

Reconfigurable Head Up Display (HUD)





Very high brightness reconfigurable image source:

Automotive-proven vacuum fluorescent display technology

Image source brightness; 9600 ftL

80 x 40 pixel array, 0.36 mm pixel pitch, 6.4 x 2.8 cm package

Complete HUD system power consumption; 12W

OEM and dealer-installed HUD configurations

34

DELPHI

VFD Design (Troxell 2009)

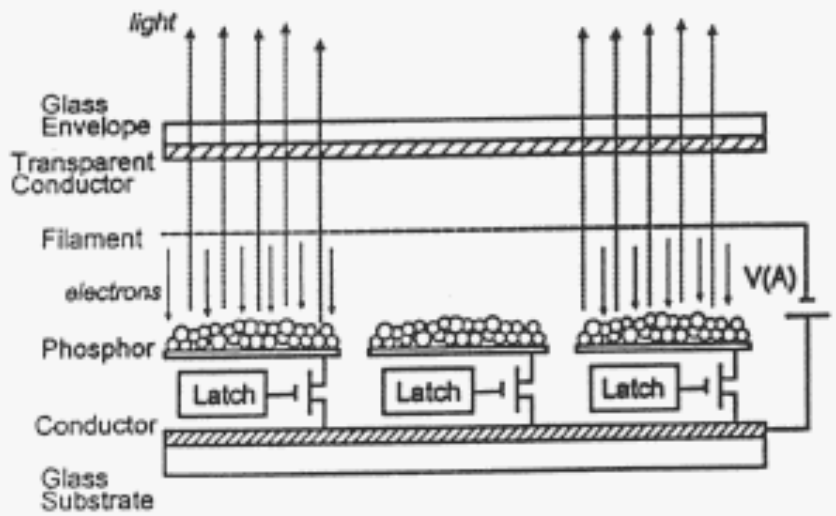


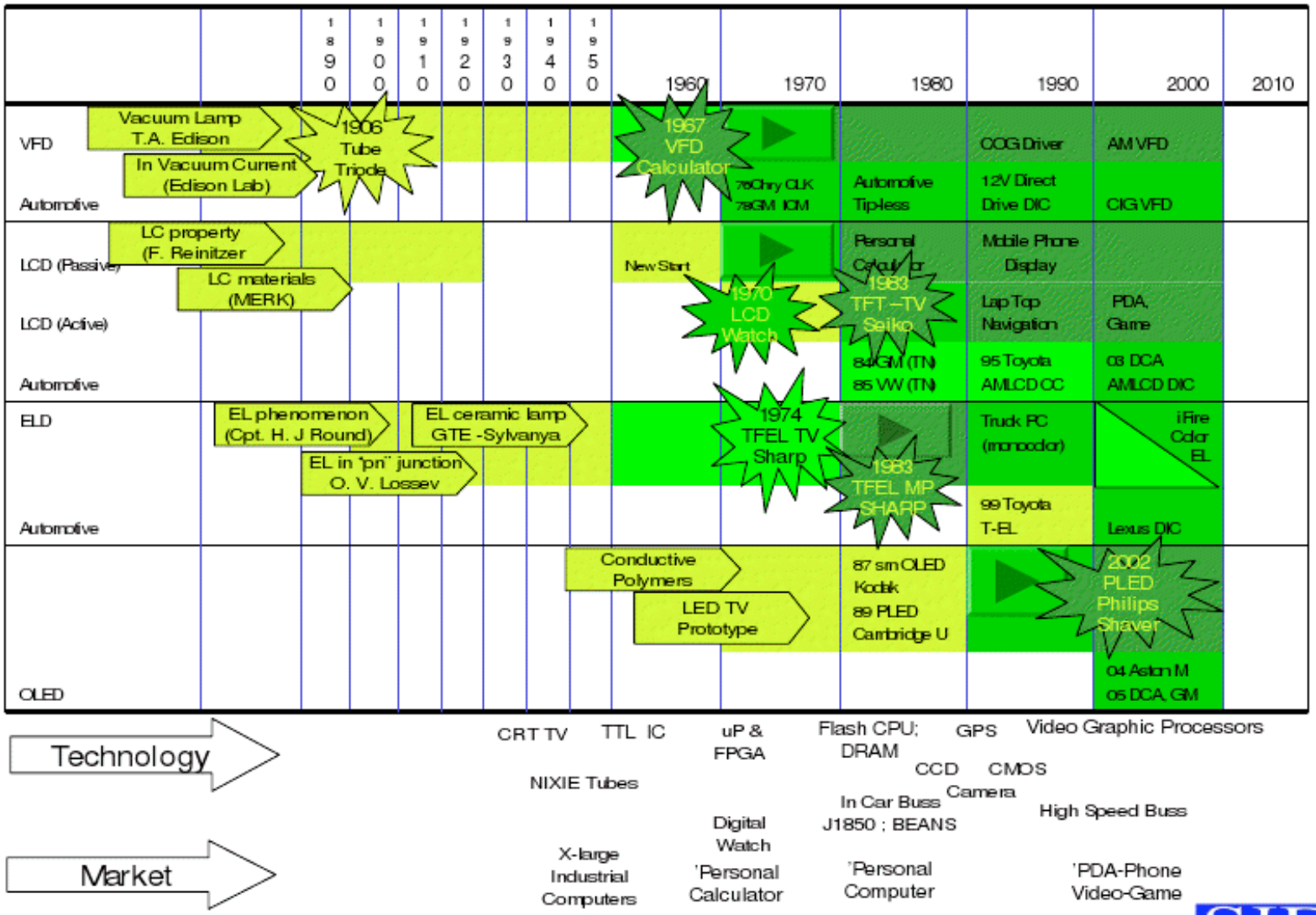
Figure 2. Schematic diagram of reconfigurable AMVFD. CMOS bistable latches control conduction state of high voltage p-MOS pixel driver transistors, which in turn control light emission from each individual pixel. Total electron accelerating voltage (V_A= 60 V).

HUDs (Stringfellow 2009)

More HUDs (Stringfellow 2009)

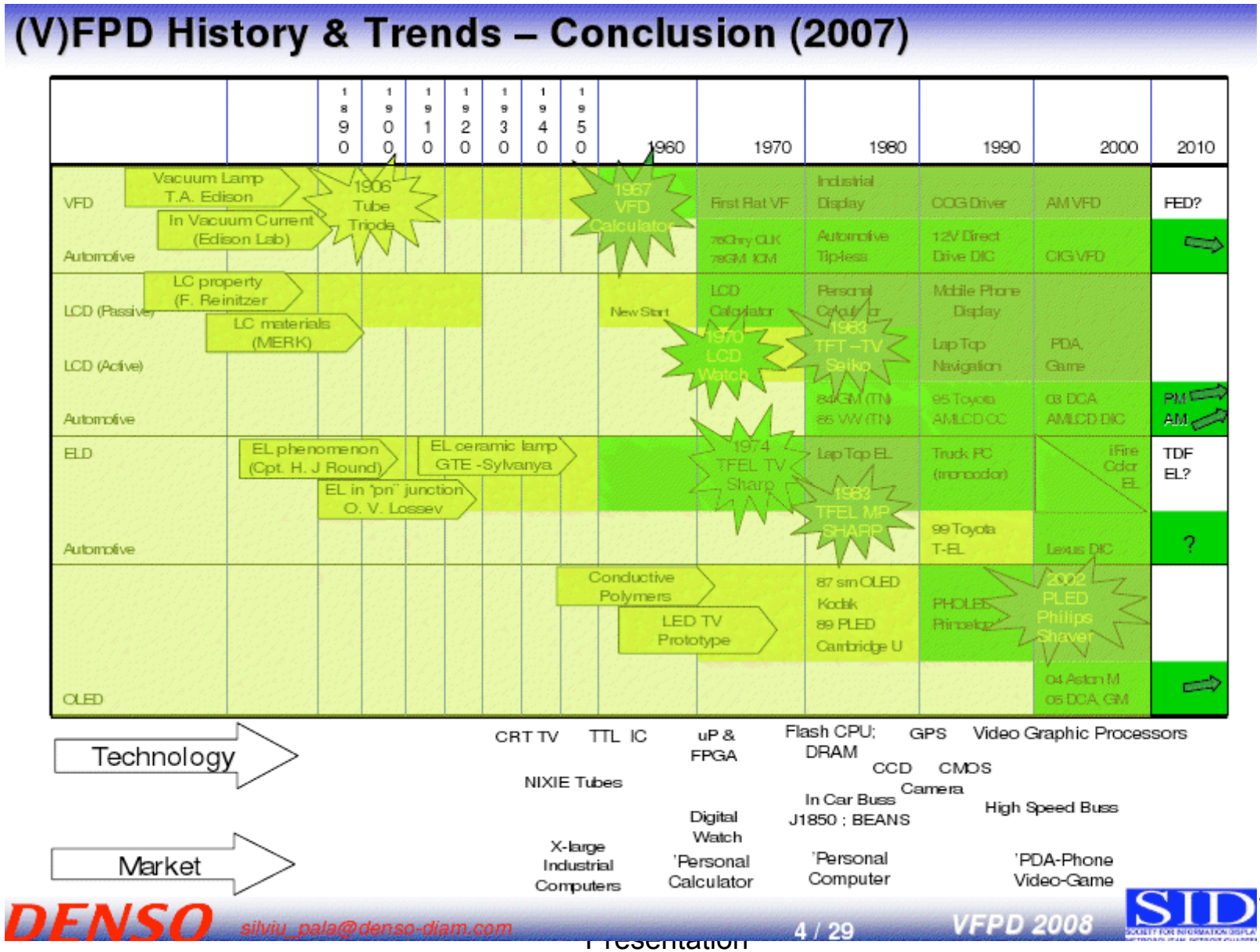
VD Technology History - Denso

(V)FPD History (2007 data)

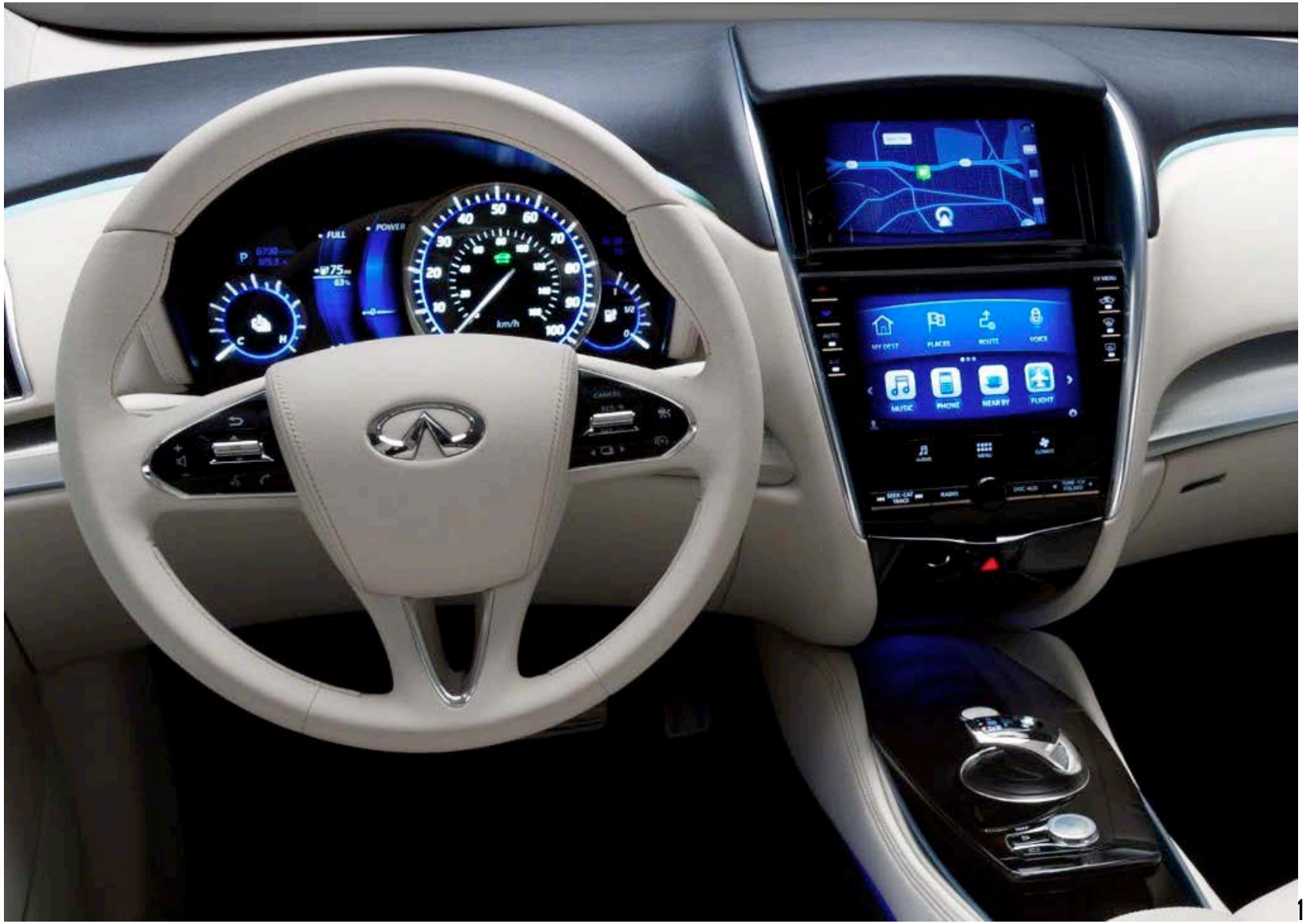


Presentation

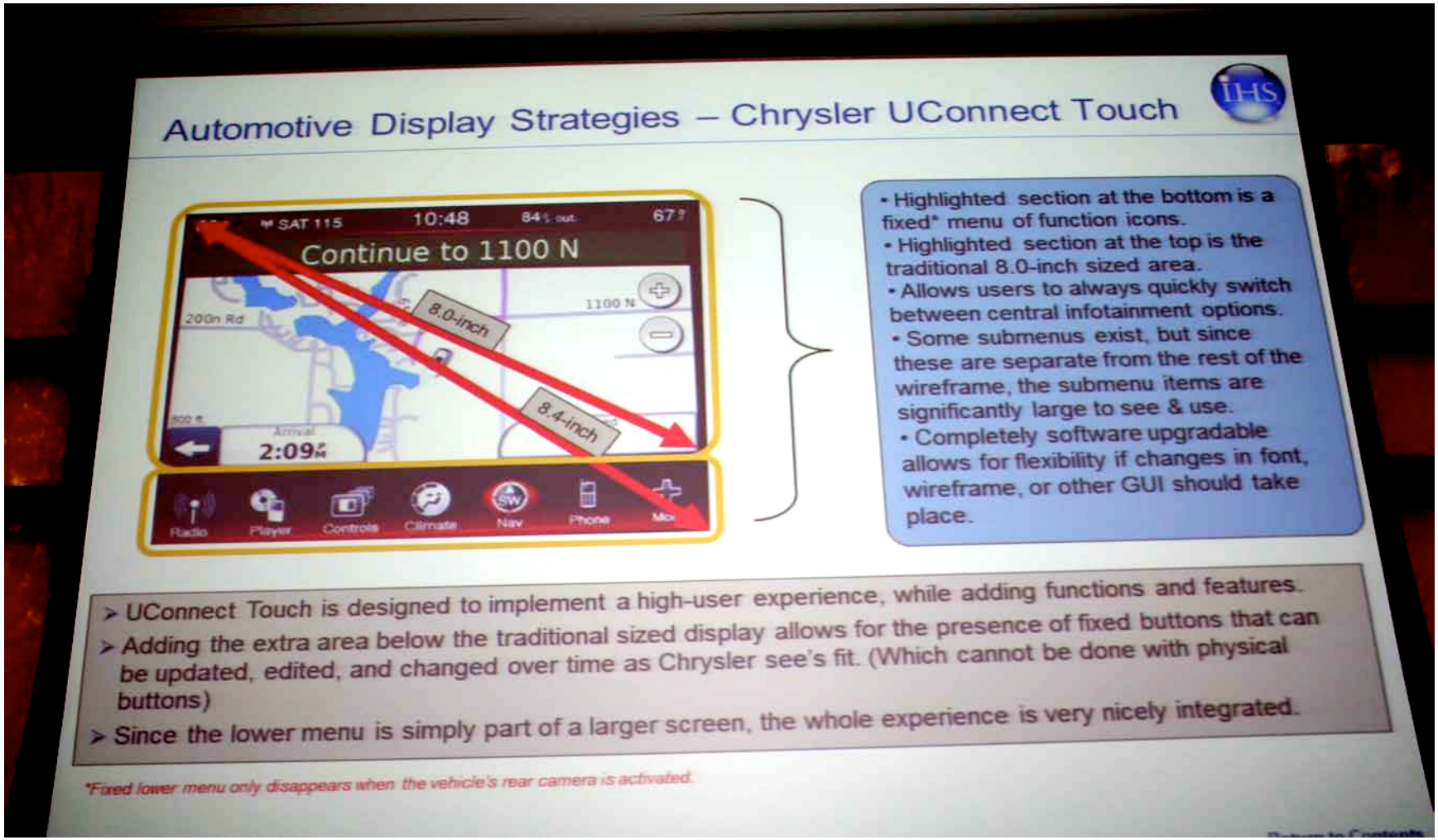
VD Developments updated to 2007-10 Denso



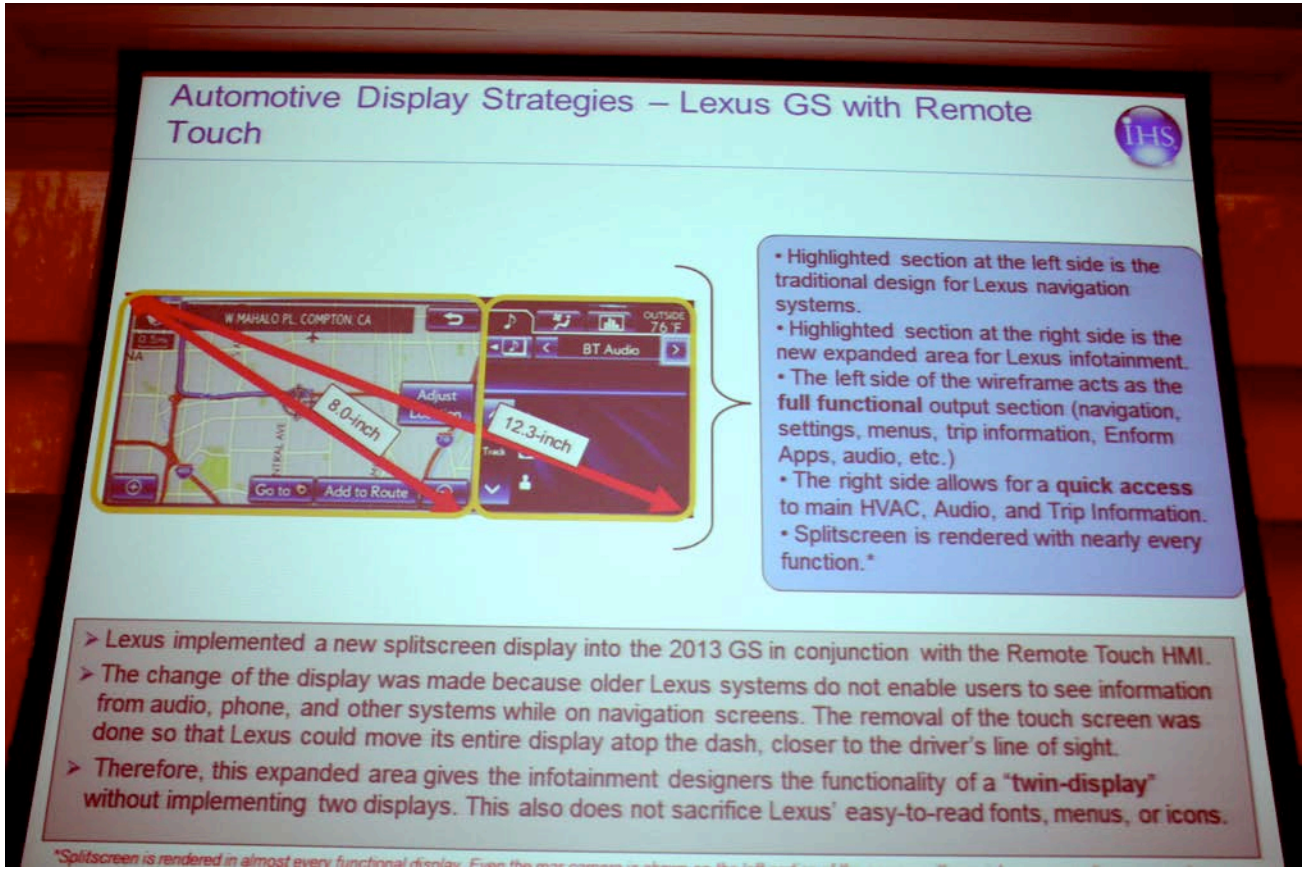
2013 Infinity Displays



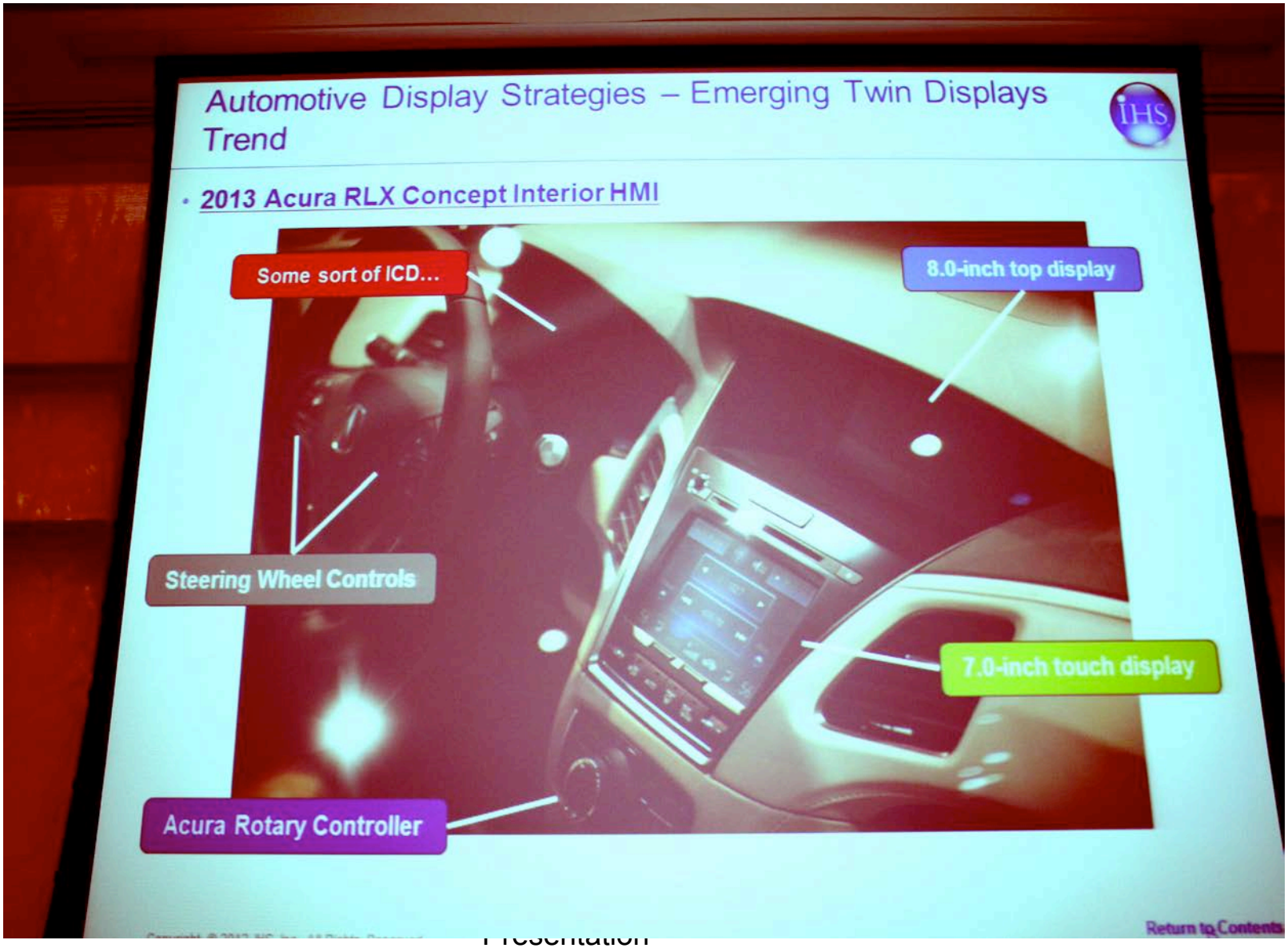
(IHS) Automotive Display Strategies



(IHS) Lexus

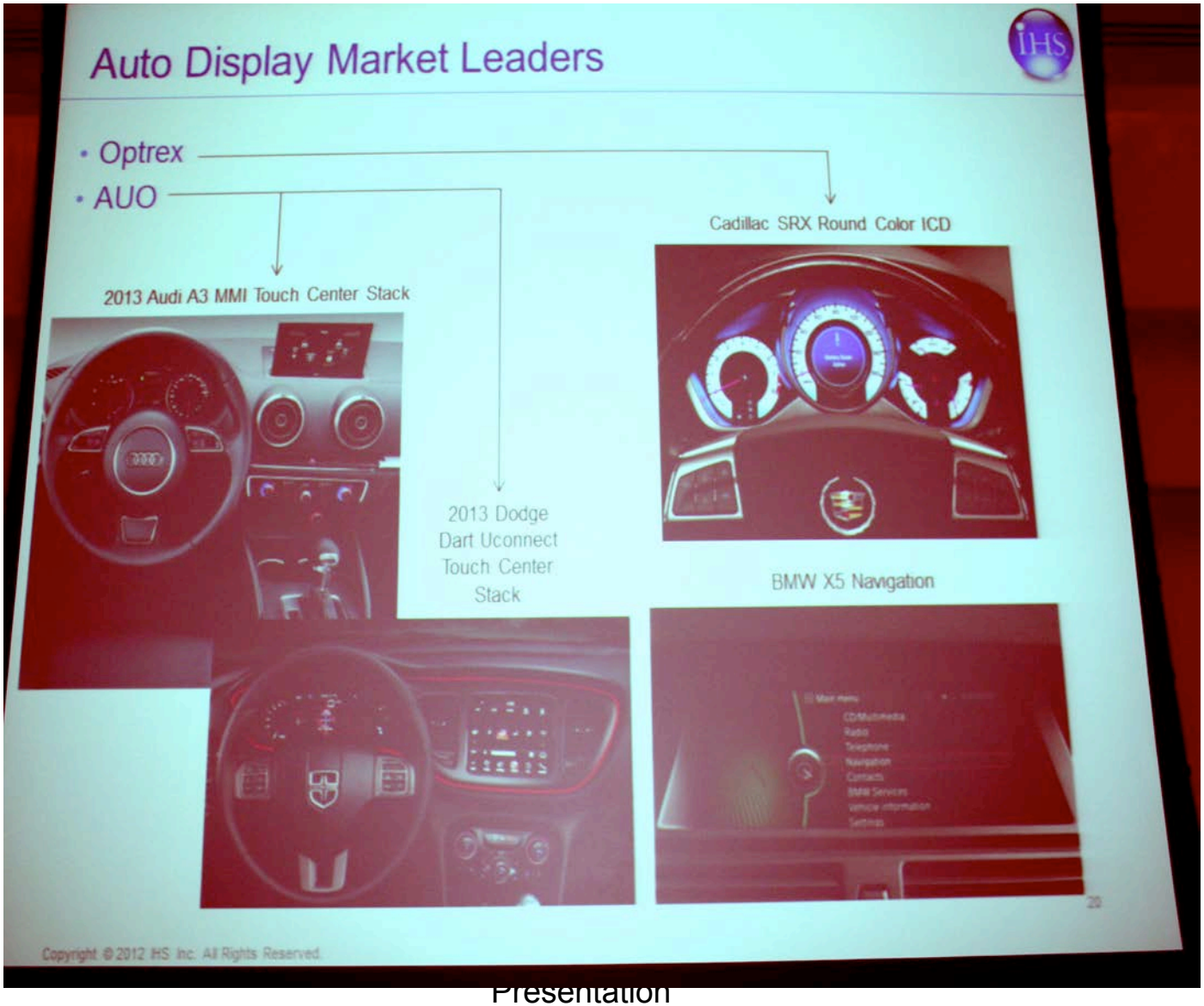

Automotive Display Strategies – Lexus GS with Remote Touch
IHS
W MAHALO PL COMPTON CA
OUTSIDE 76 °F
BT Audio
Adjust
8.0-inch
12.3-inch
Go to
Add to Route
• Highlighted section at the left side is the traditional design for Lexus navigation systems.
• Highlighted section at the right side is the new expanded area for Lexus infotainment.
• The left side of the wireframe acts as the full functional output section (navigation, settings, menus, trip information, Enform Apps, audio, etc.)
• The right side allows for a quick access to main HVAC, Audio, and Trip Information.
• Splitscreen is rendered with nearly every function.*
➢ Lexus implemented a new splitscreen display into the 2013 GS in conjunction with the Remote Touch HMI.
➢ The change of the display was made because older Lexus systems do not enable users to see information from audio, phone, and other systems while on navigation screens. The removal of the touch screen was done so that Lexus could move its entire display atop the dash, closer to the driver's line of sight.
➢ Therefore, this expanded area gives the infotainment designers the functionality of a "twin-display" without implementing two displays. This also does not sacrifice Lexus' easy-to-read fonts, menus, or icons.
*Splitscreen is rendered in almost every functional display.

(IHS) Acura



Presentation

(IHS) Market Leaders

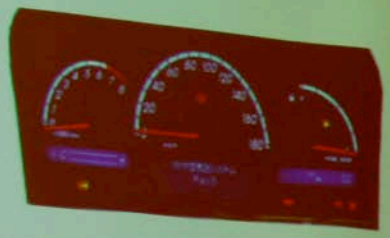


(iSupply) Display Categories

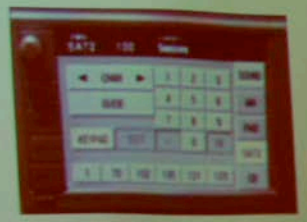
Main Display Categories

iSuppli

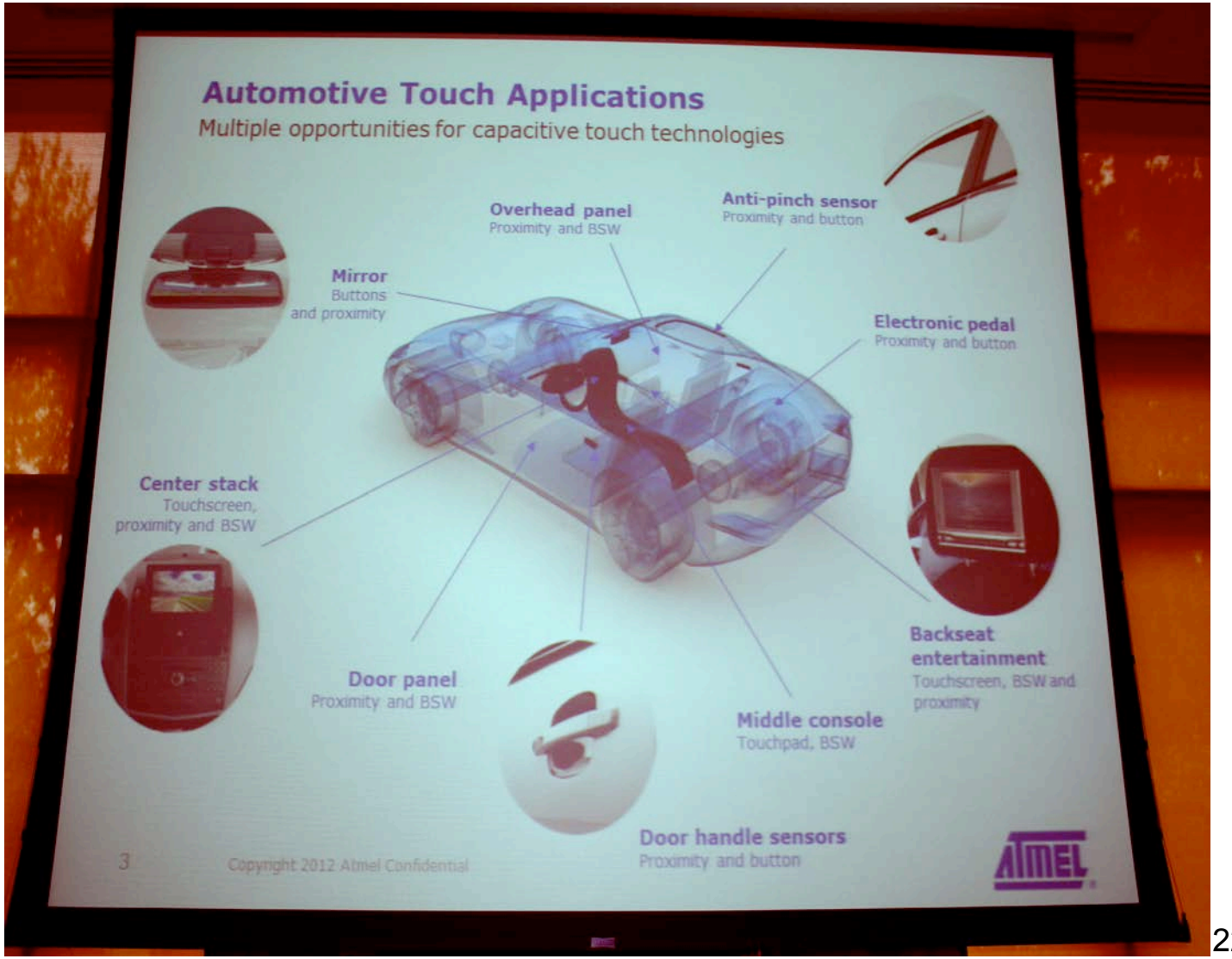
- Cluster/instrument panel/Driver Information Display (DID)
  - DID are replacing traditional analog instrument displays in front of the driver.
  - DIDs will be used by many of the auto's electronic system such as telematics, navigation and traditional driving information.
    - LCD, OLED
    - LTPS – curved displays
    - All In-line market
    - Main sizes – 2-in to 4-in



- Multifunction Head Unit/Center Information
  - Located in the auto's center area and are used by telematics, navigation, music systems and comfort control system - Infotainment
  - LCD with TOUCH
  - In-line and aftermarket (navigation)
  - Main sizes – 5.8-in to 7-in to 9-in
  - Center console
    - 2DIN allows for 6.5-in QVGA as main size, Europe shifted from 5 to 6.5-in to 7-in
    - Japan shifted from 5.8-in to 6.95-in



(ATMEL) Touch Screens

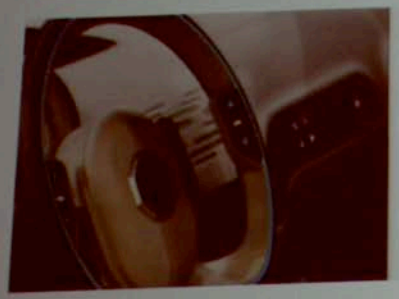


Presentation

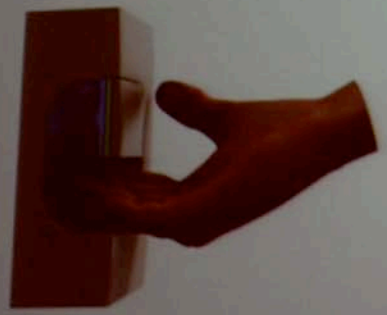
(ATMEL) Main Applications of Touch Technology

Main Applications

- Touchscreens/ Touchpads – Bringing the iPad® Experience Into the Car



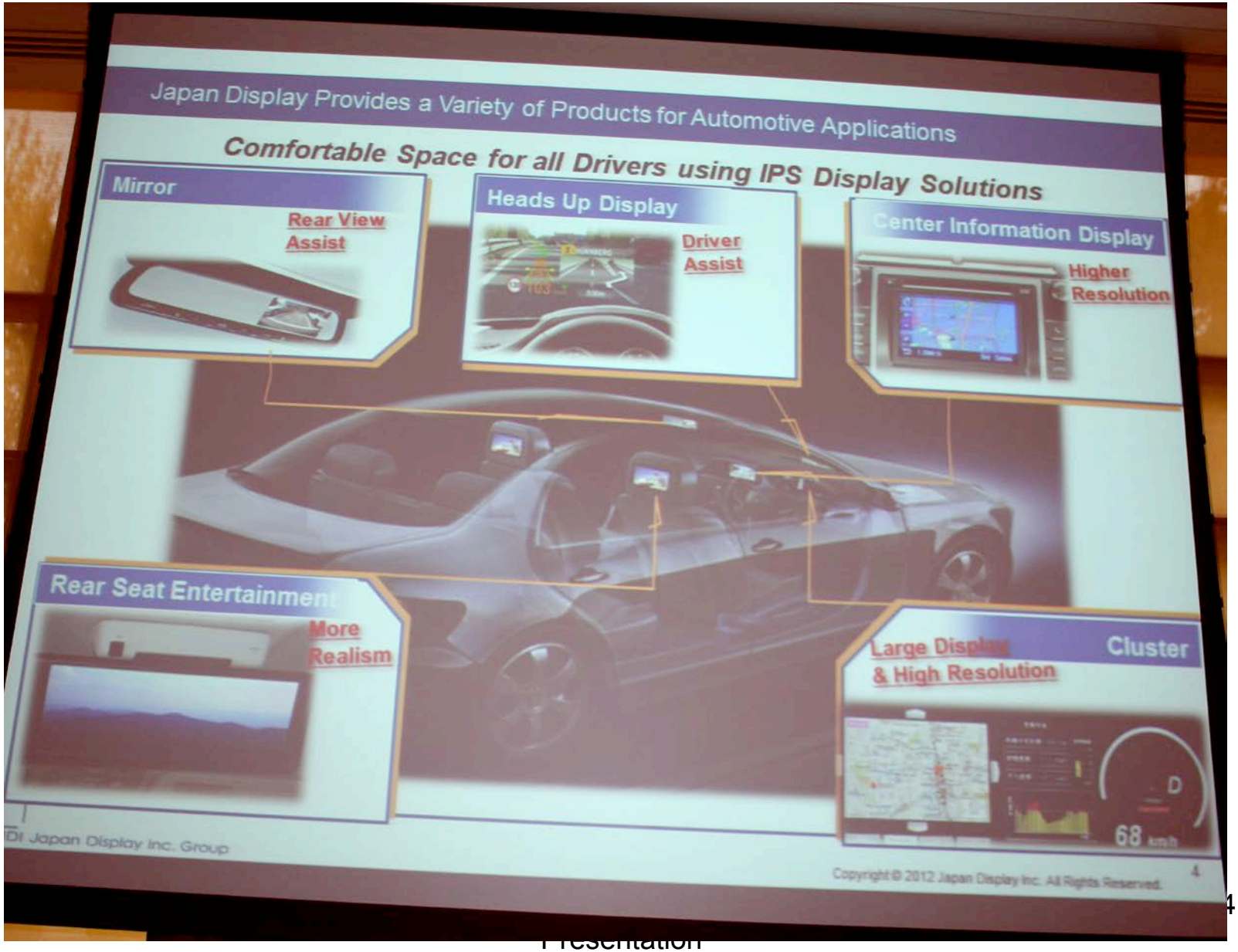
- Buttons, Sliders and/or Wheels (BSW) – Replacing Mechanical Switches and Knobs with a Simple Touch



- Proximity Detection – Smart Sensing of Driver Intention to Interface with the Car

Presentation

JDI Automotive Displays



MicroVision HUD

MicroVision Advantages

MicroVision

- **Brightness**
  - >15,000 cd.m^{-2} for a 10°x4° FOV
- **Contrast**
  - ✓ 25,000:1 dynamic
  - ✓ 300:1 checkerboard
- **Color saturation** 245% of sRGB
- **No "background glow"**
  - Perfect for night driving
  - Ideal for Augmented Reality (AR) applications

Pioneer Cyber Navi AR HUD with PicoP display technology

Presentation

Osram LED RELIABILITY

- Aviation L70 >10-20Khrs
- Automotive interior L50 > 7-10Khrs
- Automotive Exterior L70 > 7-10Khrs
- LCD Backlighting L70 > 30Khrs
- Lifetime ----------10,000 hrs to 70% brightness

Packaging ----------< 5mm Deep

Info from Osram Sylvania LEDs for Autos and projection systems

(Delco) DISPLAY ATTRIBUTES and TARGETS

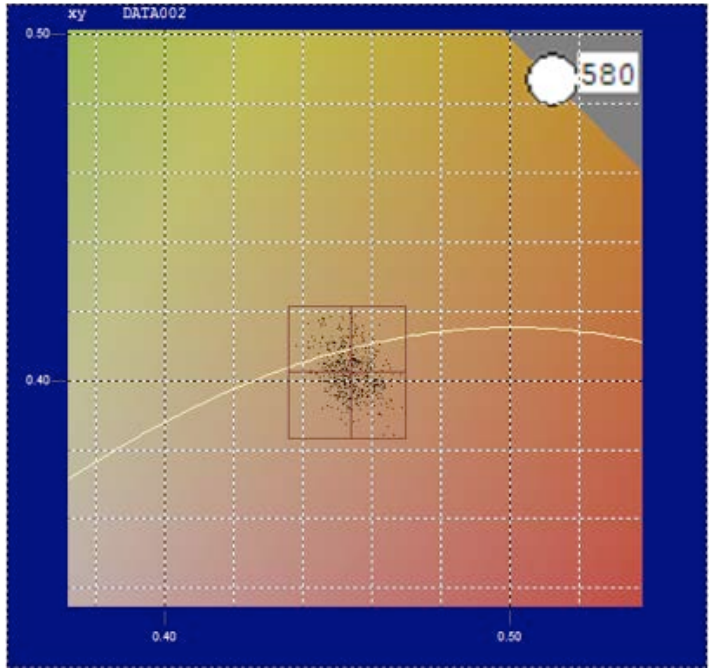
. Luminance ----------1000 cd/m2
- Contrast Ratio (@ all viewing angles) ----------2000:1
- Sunlight Viewability ----------10:1 @ 45k Lux
- Color Performance ----------100% NTSC(1987)
- Resolution (video) ----------1280 x 480
- Operation Temperature Range ---------- -40C / +85C

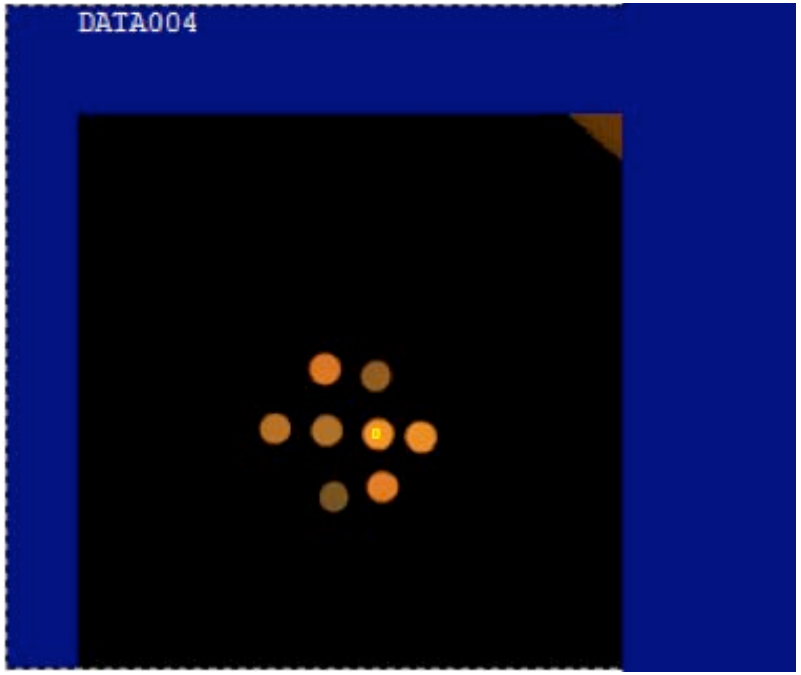
Some Measurement Tools

- Photometer
- Colorimeter
- 2D Photometer/Colorimeter
- Spectro-radiometer
- etc

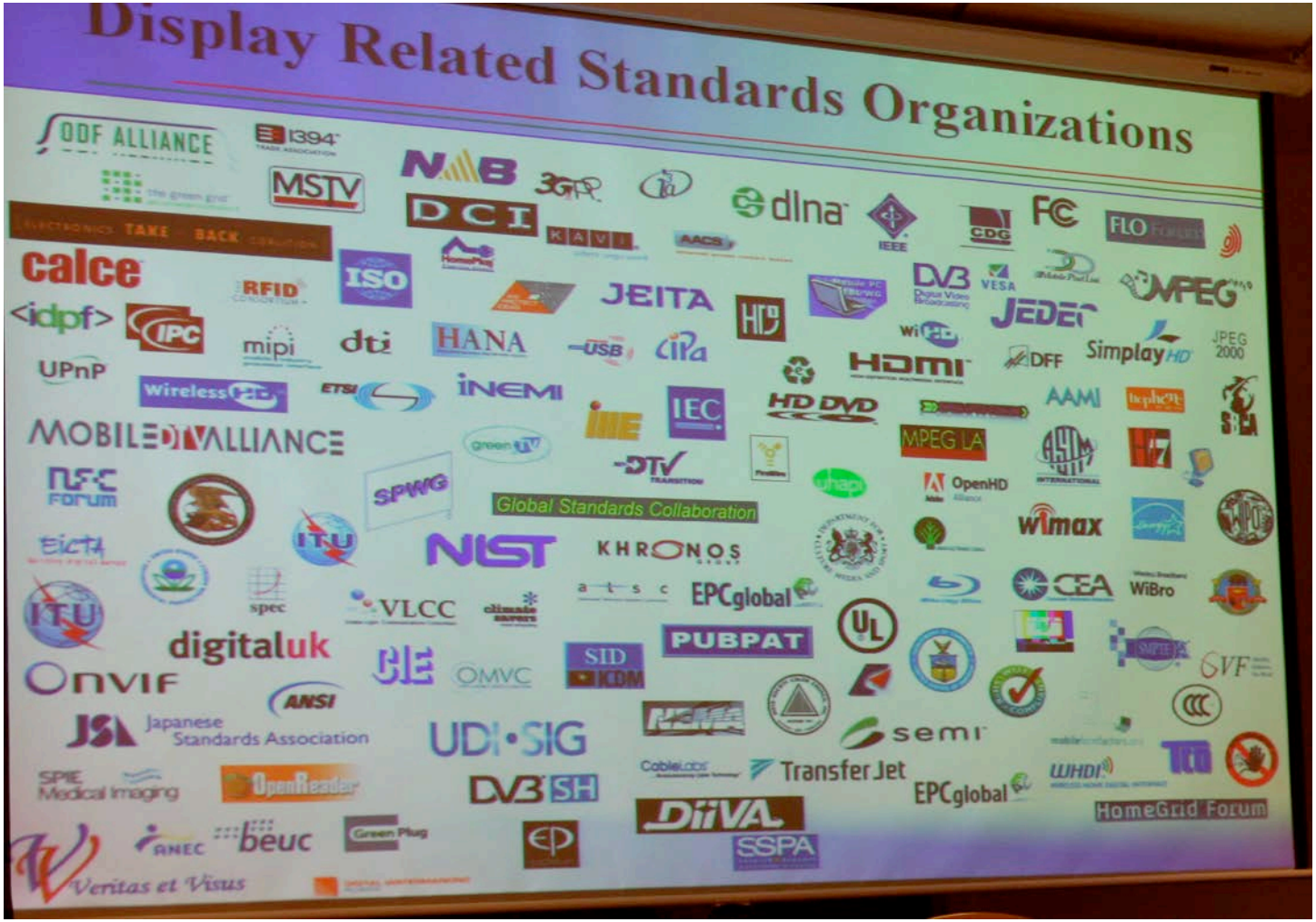
2D Measurements on Simulated Automotive Display

Example of using 2D Photometer/Colorimeter to evaluate the color of an Automotive Display





(VD) Standards Organizations



SAE J1757

- This SAE Standard defines a consistent terminology and metrology for vehicular Flat Panel Displays (FPD). It will allow the user to measure the automotive compliance of the FPD.

Contrast (C) and Contrast Ratio (CR) are related by the formula:

$$C = CR - 1 \qquad \text{(Eq. 3)}$$

3.7 Central Critical Specular Line (Central CSL)

It is defined, in the vehicle, as a line from the center of the display to the center of the driver's cyclopean eye-ellipse (see ISO 4513 for eye-ellipse definition). This line is within the Driver's Cone, and may be different than Vehicle CSL (depends on display position, orientation and vehicle openings / windows)

3.8 Critical Light Source Cone

It is generated from the Specular Light Source Cone with the apex angle increased 10 degrees all around (see Figure 1). Note Critical Light Source Cone includes Specular Light Cone, Central Critical Specular Light Direction (Central CSLD) and / or Vehicle CSLD. Ambient light coming from directions within this cone toward the display determines the contrast (and legibility).

3.9 Central Critical Specular Light Direction (Central CSLD)

Is defined as the line symmetrical to Central CSL in respect to the normal direction to the center of the display. See Figure 1 for more information. Add white shirt direction

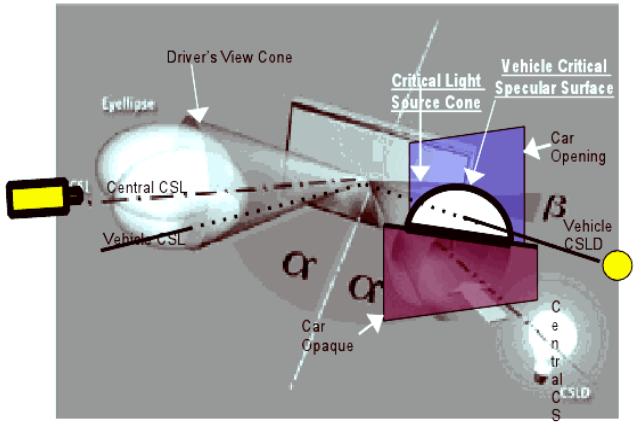


FIGURE 1 - CRITICAL LIGHT ILLUMINATION: CRITICAL SPECULARLLINE (CSL), CRITICAL SPECULAR LIGHT DIRECTION (CSLD) ANDD CRITICAL SPECULAR LIGHT CONE (β = 10 DEGREES)

3.10 Diffuse-Lambertian Reflection (D_L)

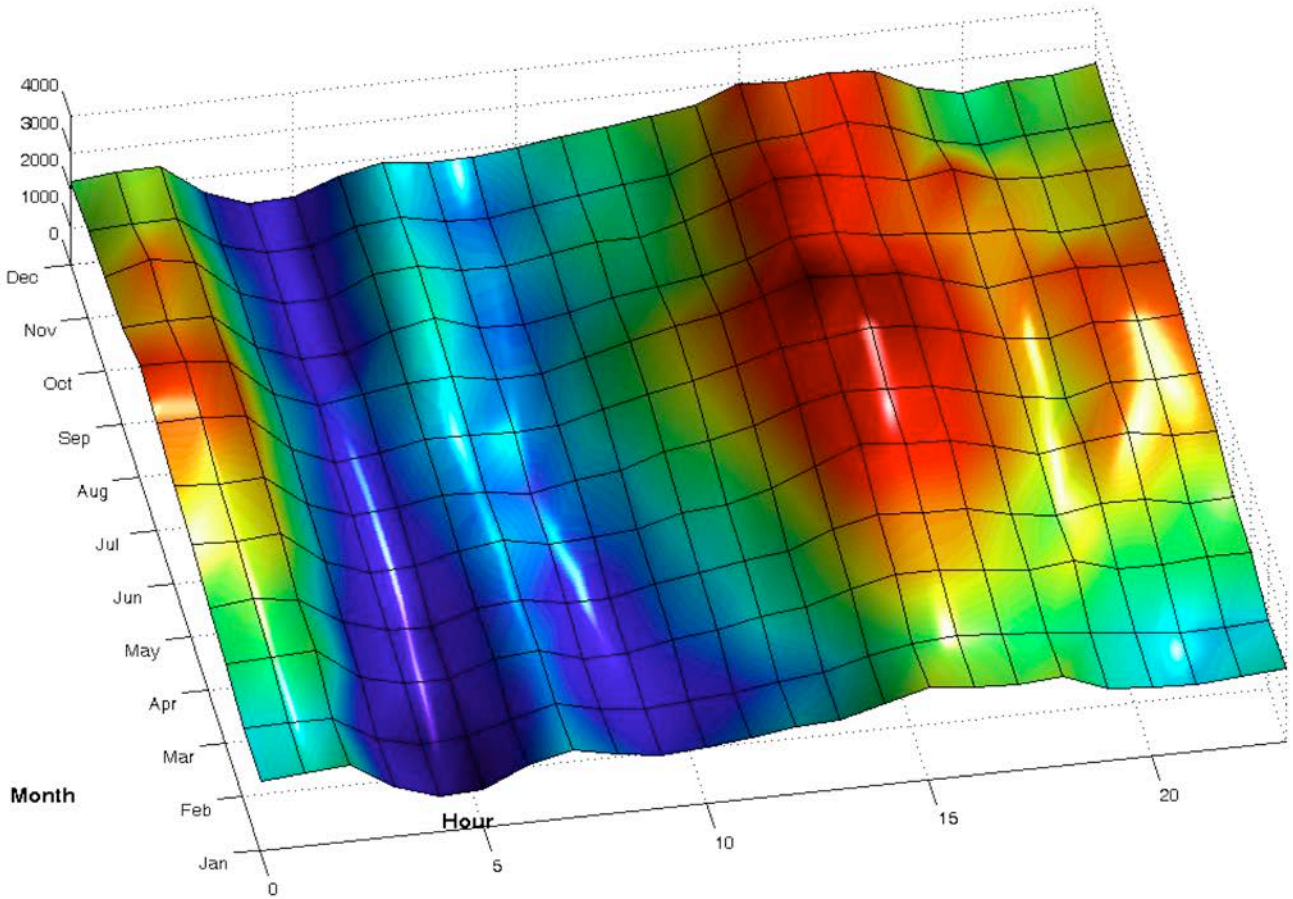
Is a diffuse reflection (a scattering of light out from the specular direction) whereby the observed luminance is independent of observation direction and only depends upon the illuminance falling upon the surface. The luminous intensity from a Lambertian surface is given by $I = I_0 \cos q$, where I_0 is the luminous intensity in the normal direction. A flat (matte) paint, barium sulfate ($BaSO_4$) reflection coating, pressed polytetrafluoroethylene or barium sulfate powders are typical Lambertian-like diffusing surfaces.

3.11 Diffuse-Haze Reflection (D_H)

Night Time Driving Issues

- Bright Head lights both from on coming cars and cars in back of you
- Glare
- Haze

(U of M) Vehicle Occupant Deaths 1987-2003



CONCLUSIONS

We have shown;

- a brief view of a century of developments for Automotive Displays
- That displays are now found all over the inside of the vehicle
- Display Technology has give us improved luminance,contrast etc.
- New measurement tools have given us faster ways of evaluating displays
- Improved Standards to compare results
- Improvements in displays and standards are still needed in night time driving with glare, older drivers etc.
- In J1757 we sre presently trying to determine measurement methods for the day time glare of white shirts on a display.

Some References

- David Holland, “Dashboards” Published by Phaidon Press LtD, London, England, 1994 & 1999 paperback (release not obtained)
- Lee & Donofrio, “Automotive and Avionics Applications of CRTs”

Proceedings of the SPIE - Cockpit Displays IV: Flat Panel Displays for Defense Applications; ed. Hopper, 4/23-25/1997 pp414-425.

Ed. Ronald K. Jurgen, “Electronic Instrument Panel Displays” Seciion on CRT Displays (three articles in this book) published by the SAE 1998.

. Brandt & Jamieson, “A CRT Display System for a Concept Vehicle 890283, Shoji etal , “Toyota Electro Multivision” 880220 and Kimura etal, Visibity Requirements for Automotive CRT Color, Contrast & Luminance”

. SAE J1757 VFPD Standard

. SID ICDM Standard Measurement Techniques

. Silviu Pala, “VFPD History” 2012 SID VFPD Symposium at U of M in Dearborn MI.