

# Reliability Communication

PLUS Vision Corp.

# Caution:

## A. How to explain about LCD Reliability

**Required to explain objectively. It is mandatory to communicate the test results just as fact.**

**Ex. “When third party conducted the test, it got the following results.”**

**(Never convince that All LCD machines result in suffering degradation of picture quality, etc.)**

## B. Never quote/edit for use

**Any quote/edit for the following material is prohibited.**

## **Note:**

**This study was carried out by an independent company - the Munsell Color Science Laboratory (MCSL) at Rochester Institute of Technology - at the request of Texas Instruments (TI). The findings of the study, and their interpretation, should be attributed to MSCSL/TI and not to PLUS Vision Corp. PLUS Vision Corp.'s endorsement should not be implied.**

**Questions concerning this study may be addressed in the first instance to PLUS Vision Corp. at: [plusvision@plus.co.jp](mailto:plusvision@plus.co.jp) with subject of “Picture Reliability”.**



# Texas Instruments Picture Reliability



YOU'VE GOT TO SEE IT.

# Picture Reliability

**As projector use steadily increases in an expanding sphere of applications, picture reliability is becoming a key customer concern.**

1. Picture reliability should be expected for the lifetime of a projector.
2. DLP™ technology is *immune* to degradation, guaranteeing optimum picture reliability.
3. DLP™ technology's picture reliability results in lower total cost-of-ownership.

# Picture Reliability Study

- ◆ Anecdotal evidence suggested LCD picture quality degrades over time
- ◆ No empirical evidence of this: conducted side-by-side test of LCD vs. DLP™ technology
- ◆ 5 LCD projectors and 2 DLP™ technology-enabled projectors tested
- ◆ Experiment duration ~4000 hours: picture reliability attributes compared
- ◆ Conclusion: test results strongly supported anecdotal evidence

# Expanding Power of Projection

- ◆ Office projectors go home for the weekend
  - ❖ Movies
  - ❖ Video games
  - ❖ Sports parties
  
- ◆ Educational uses
  - ❖ Projector in classroom
  - ❖ “Oral reports” now require PowerPoint presentations
  - ❖ Projector as technology integrator
  
- ◆ Houses of worship
  
- ◆ Commercial
  - ❖ Projected advertisements (airports, malls, etc.)
  
- ◆ Public entertainment (e.g. sports bars, karaoke, etc.)

***As projector use steadily increases in an expanding sphere of applications, picture reliability is becoming a key customer concern.***



# Example: Education Market



Education could account for  
20% of worldwide projector market

In 2005: 700,000-800,000 units per year

DTC and other data

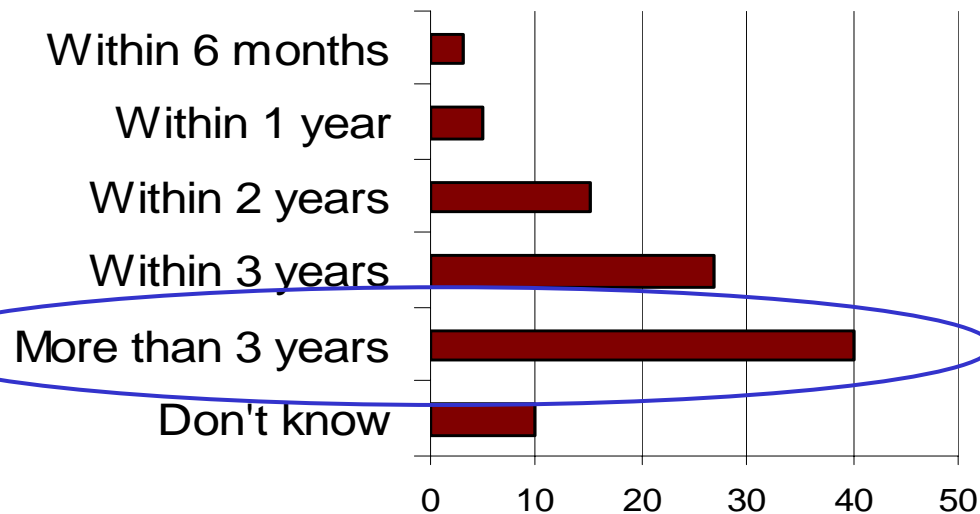


## Long-Term IT Investments

- ◆ High volume, phased deployment
- ◆ Longevity of investment is key: picture reliability is more important

# Picture Reliability IT Buyer Expectations

**How long do you expect a data projector's picture reliability to last before it begins to degrade?**



*Merrill Research data*

- ◆ Average usage of 75 hours/month for large corporations (900 hrs/year) - *Pacific Media*

# Aided Care-About Results

Picture reliability should be expected for the lifetime of a projector.

## When IT buyers are made aware of the picture reliability issue:

- ◆ 61% said picture reliability is either a very or extremely important purchasing criterion
- ◆ 87% of IT buyers said they would pay a 20% premium for a projector with picture reliability that lasts twice as long

*Merrill Research*

# Picture Reliability Tests

- ◆ Conducted by Munsell Color Science Laboratory (MCSL) at Rochester Institute of Technology
- ◆ Began in May 2002
- ◆ The goal was to evaluate picture reliability of DLP™ technology vs. LCD technology over time
- ◆ Sample of five LCD and two projectors enabled by DLP™ technology
- ◆ Measurement included:
  - ❖ Luminance/brightness
  - ❖ Full On/Full Off (FOFO) contrast
  - ❖ ANSI contrast
  - ❖ FOFO and ANSI contrast for red, green, and blue colors
  - ❖ Color chromaticity for white, red, green, and blue

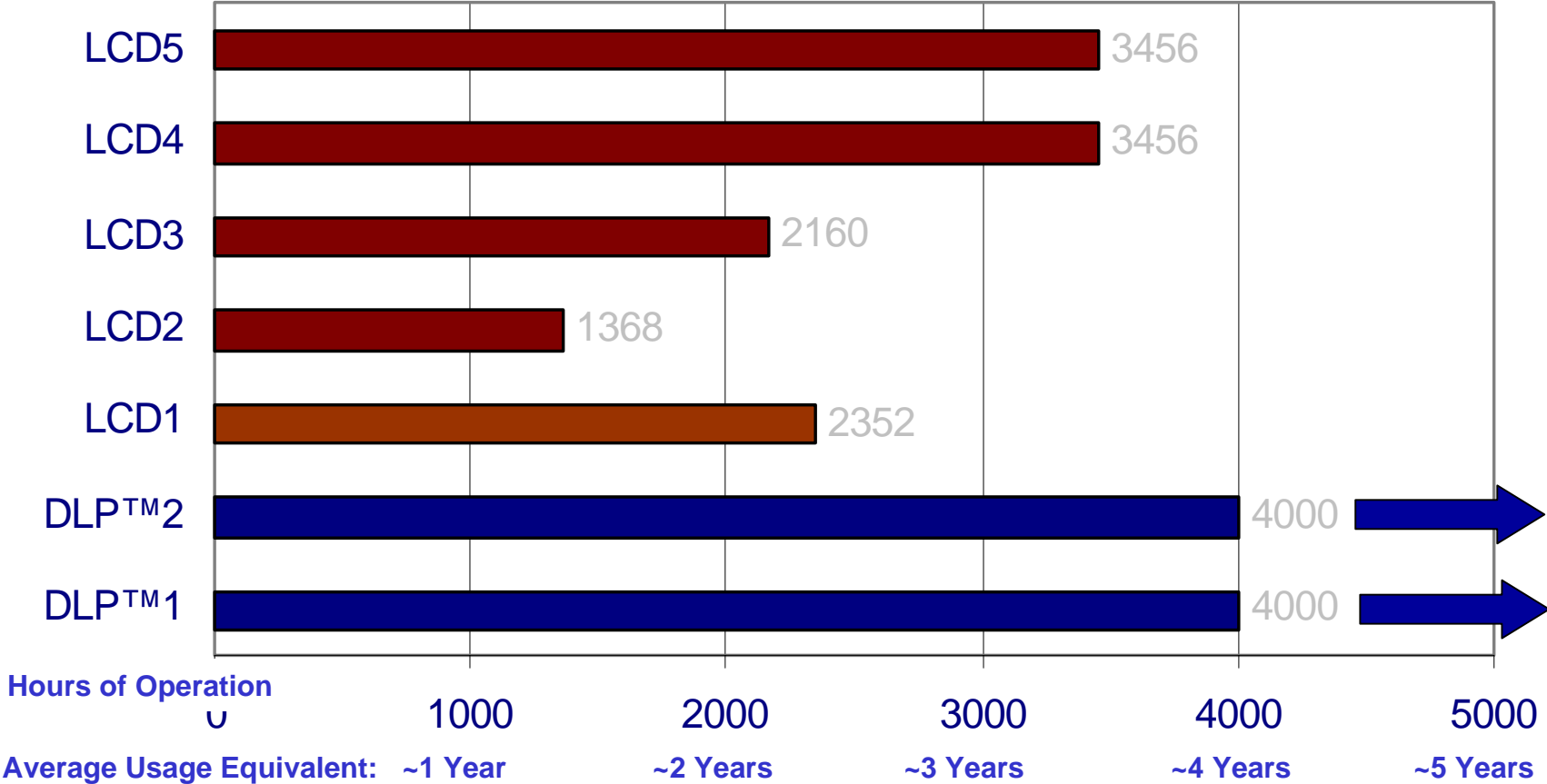


# Picture Reliability Experiment

Results at 4000 hours

	LCD 5 units	DLP™ 2 units
<b>Contrast</b>	<b>Falling (5 of 5)</b>	<b>Steady</b>
<b>Uniformity</b>	<b>Steady</b>	<b>Steady</b>
<b>Brightness</b>	<b>Steady</b>	<b>Steady</b>
<b>Colorimetry</b>	<b>Failure - color shift (5 of 5)</b>	<b>Consistent</b>
<b>Visible Picture Defect</b>	<b>Failure - visible defect (5 of 5)</b>	<b>Consistent picture</b>

# Time to Failure



Failure = visible picture defect

# Experiment Results

3312 Hours

LCD 1



Photo at 24 hours



DLPTM 1



LCD 2



LCD 3



DLPTM 2



LCD 4

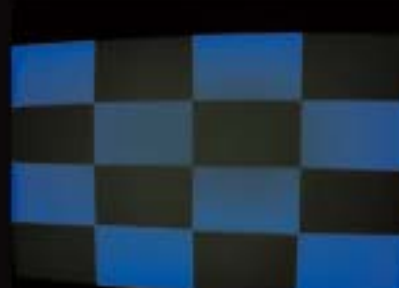


LCD 5



# Progressive Degradation

LCD 2



24 hours

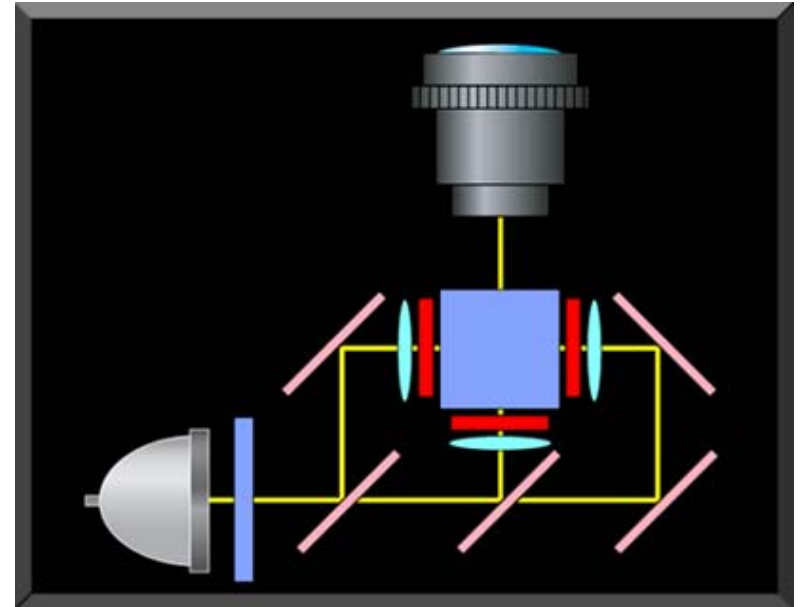
1440 hours

2256 hours

3312 hours

# LCD Projector Architecture

- ◆ Light from lamp split into primary colors: red, green, blue
- ◆ Light is modulated by one panel for each color
- ◆ Output from each panel is optically recombined to create on-screen image

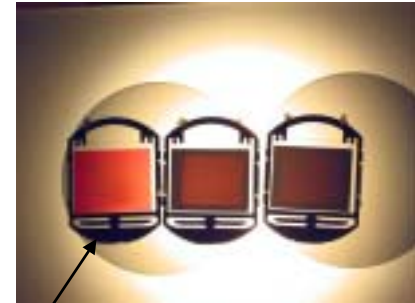


# LCD Degradation Theory

All 5 LCD projectors experienced the same degradation pattern

## 1. Blue Channel Polarizer

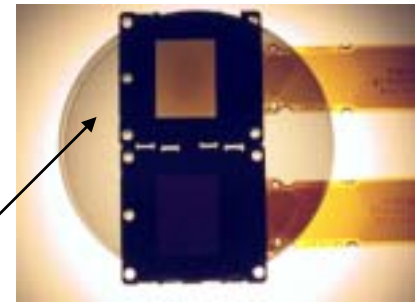
- Failure: Reduces the polarization effect
- Reason: Polymers/dyes break down due to exposure to high intensity light
- Results: poor extinction in blue channel causes overall blue tint to image



Blue polarizer shows poor extinction (3:1)

## 2. Blue Panel

- Failure: Panel transmits the light when it is not supposed to/vice versa
- Reason: loss of LC alignment due to alignment layer breakdown; breakdown of LC molecules
- Results: lowered contrast in blue channel, large blemishes onscreen



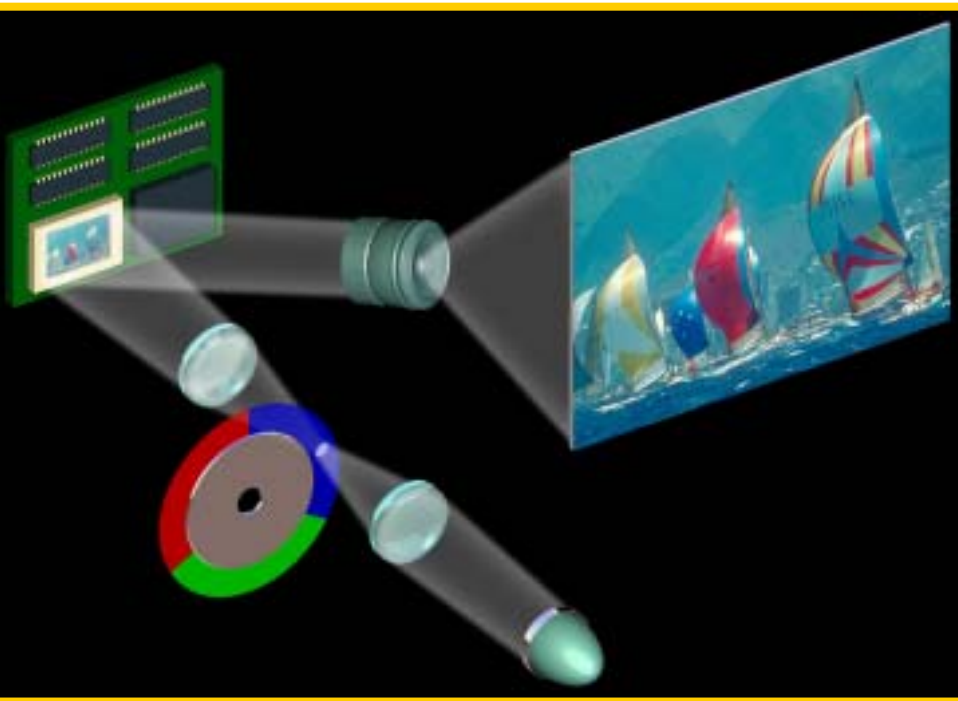
Blue panel should be black here

## 3. Rest of the System

- Failure: Signs of degradation in the red and green polarizers and panels
- Reason: Same as for blue channel
- Results: lowered contrast, blemishes of various colors

# DLP™ Picture Reliability

DLP™ technology is *immune* to degradation, guaranteeing optimum picture reliability.



- ◆ DLP™ system components are robust to long term light exposure
- ◆ Reflective technology minimizes light absorption
- ◆ All-digital – unaffected by aging
- ◆ 100,000 hours lifetime
- ◆ Reliable semiconductor process

# Test Conclusions

- ◆ Marked difference in picture reliability over time between LCD- and DLP™ technology-enabled projectors
- ◆ DLP™ technology demonstrated picture reliability over the test period
- ◆ Image quality defects caused by optical degradation were highly visible for LCD
- ◆ Downward trends in optical performance for LCD on most of the parametric data
- ◆ Image degradation for LCD was permanent: not recoverable by lamp replacement

# Total Cost of Ownership

## **DLP™ technology offers at least 33% saving in Total Cost of Ownership**

- ◆ Projectors that degrade quickly:
  - ❖ Must be replaced far sooner
  - ❖ Impair perceived quality of presentations
- ◆ Projector lifetime cost of ownership is far lower for DLP™ technology-based projectors

DLP™ technology offers at least 33% saving in Total Cost of Ownership

Theoretical sample case:

- 10 year program
- 100 projectors
- \$2,000 per unit
- LCD projectors replaced at *least* twice
- DLP™ technology-based projectors replaced at *most* once
  
- LCD TCO: \$600,000 (minimum)
- DLP™ TCO: \$400,000 (maximum)

# Conclusion

**As projector use steadily increases in an expanding sphere of applications, picture reliability is becoming a key customer concern.**

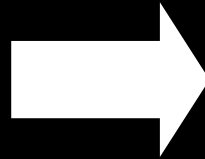
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# Picture Reliability Comparison

**DLPT™**



**DLPT™ at 24 hours**



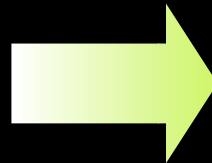
**DLPT™ at 3312 hours**

**DLPT™**

**LCD**



**LCD at 24 hours**



**LCD at 3312 hours**

**LCD**