47 Years of SID Symposia – Nurturing Progress in Projection Technology

Pre-SID

Image Generation Devices

1902
First recorded operating TV projector based on Nipkow Disk
Unknown

1958
Talaria sealed oil film light valve introduced
GE

1932-36
Curved faceplate CRTs form projection
Philips, RCA, Fernsehen

1943
Eidophor - oil film light valve
Swiss Fed. Inst. Of Tech.

1953
Color Field Sequential Eidophor
Gretag

Projection Components/ Architecture

1951
3 Tube/3 Lens color CRT Projector
RCA

Projection Lenses

1937
f/4.5 projection lens used for CRT projector
Philips

Illumination Sources

Projection Screens

1937
Rear projection screen with controlled gain
Philips

1940
Fresnel lens for rear projection screens
Strong & Hayward

Products & Applications

1937
Projection CRT systems demonstrated
Philips, RCA, Fernsehen

1948
Monochrome CRT Theater projection (15" Tube, 80KV anode, 42" Schmidt mirror)
RCA

1951
NTSC Color CRT theater projection
RCA

1950
75kV, 7" CRT for theater projection
RCA

1958
Eidophor Enters Production
Gretag

1936
Commercial TV broadcasting began in the UK
London Television Service

1948
Commercial CRT rear Projection TV
RCA

1958
Slide Scratcher color displays for command & control
FF&M, Northrop

1960's

Image Generation Devices

1961
3 Channel color Eidophor
Gretag

1962
TFT Active matrix
GE

1969 - 1970
Twisted Netmatic LC
J. Fergason, W. Helfrich,
M. Schadt

Projection Components/ Architecture

Projection Lenses

Illumination Sources

1960's
Xenon arclamp for projection
Westinghouse

1960's
Invention of the Laser
Hughes

Projection Screens

Products & Applications

1960-63
Rapid-process film color projection systems
ITT, Hughes, Burroughs

1970's

Image Generation Devices

1972
Laser (Thermal) Smetic Liquid Crystal Light Valve (LSLCLV)
Bell Labs

1974
ILA -Photo-addressed reflective liquid crystal light valve (LCLV)
Hughes

1971
Vertically alignment LCs
Schiekel, Fahreschon, Kahn

1978
Liquid crystal on silicon (LCoS) display
STL, Hughes

Projection Components/ Architecture

Projection Lenses

1979
f/1.0 aspheric projection lenses
US Precision Lens

Illumination Sources

Projection Screens

1970
Double Lenticular Screen for CRT RPTV
GE

1979
Lenticular, black stripe screens for rear-projection
Freen Screen

Products & Applications

1973
Giant VideoBeam CRT with integrated Schmidt optics
Advent

1978
Dual Talaria 1000-line high lumen projector
General Electric

1976
Monochrome ILA projector with fiberoptic-coupled CRT input
Hughes

1980's

Image Generation Devices

1981
First projected DMD image
Texas Instruments

1982
High brightness 7" PRT CRT with chemically strengthened glass
Hitachi

1987
Digital Micromirror Device (DMD) microdisplay
Texas Instruments

1989
Interference filter CRT
Philips

1982
Large Diameter Aperture Gun
Matsushita

1986
p-Si TFT LCD projection light-valve
Seiko Epson

1988
LCDs for projection introduced
Projectionvision Inc.

Projection Components/ Architecture

1982
Liquid coupling & cooling of flat CRT faceplate
Sony

1989
(3) LCD projection system; X-dichroic re-combining prism
Seiko Epson

1985
CRT Liquid coupling/ cooling in rear PTV
Philips

Projection Lenses

1986
Lens system for aspheric CRT faceplate
Hitachi

Illumination Sources

Projection Screens

1983
Black stripe rear screen with Fresnel and lenticular lenses
Dai Nippon

Products & Applications

1980
50" consumer rear projection TV
GTE Sylvania

1986
Full color, 7.5Mpixel LCSLV rear projection display
Greyhawk Systems

1988
Transmissive a-Si TFT LCD projection system
Sharp

1988
Overhead projector (OHP) LCD panel
N-View/Proxima/InFocus

1989
First commercial LCD projector
Sharp

1988
3-color ILA video projector
Hughes

1990's

Image Generation Devices

1992
First full-color DMD image
Texas Instruments

1993
DMD Hidden hinge demostrated
Texas Instruments

1996
Initial production DLP with 17µm pixels (0.7" SVGA)
Texas Instruments

1993
Grating light valve (GLV)
Stanford Univ. (Eschelle)

1997
First commercially available LCoS panel
IBM

Projection Components/ Architecture

1991
Single LV angular-color-separation projection
Sharp

1996
TIR Prism for DLP illumination
US Precision Lens

1993
Scrolling color single light-valve rear projection technology
Philips

1996
Polarization conversion; double fly-eye integration, PCS
Seiko Epson

1999
Wire grid polarizer & beam splitter
Moxtek

1997
Polymer retarder stacks for selective (color) polarization
Colorlink, Inc.

Projection Lenses

1992
Ultra-wide angle f.77 mm lenses
US Precision Lens

1995
Zoom lenses for LCD projectors
US Precision Lens

1999
Lenses for High - Resolution Microdisplays
US Precision Lens/OPCN Associates

1999
Telecentric projection lenses
Nikon

Illumination Sources

1993
UHP High-pressure mercury discharge lamp
Philips

1991
Metal halide discharge projection lamp
Iwasaki Electric

Projection Screens

1999
Rear projection screen for LCD projection
Toppan

Products & Applications

1990
a-Si LCD very high light output projector
Barco

1992
Introduction of the LCD "Light Cannon" dooms oil film sysems
Barco

1996
First commerical single chip DLP Projector
Barco

1990
(3) panel p-Si front screen projector
Seiko Epson

1996
First commerical installation of a laser-based projector Color

1999
First demonstration of digital cinema to paying theater customers
Hughes/JVC & TI

1995
First LCoS projector - command and control centers
IBM

1999
2000 pixel D-ILA LCoS Projector
JVC

2000's

Image Generation Devices

2003
Production of DLP with13.7µm pixels (e.g. 0.7" XGA)
Texas Instruments

2005
Production of DLP with 10.8 µm pixels (e.g. 55" XGA)
Texas Instruments

2008
Production of DLP with 7.6 µm pixels (e.g. 17" HVGA)
Texas Instruments

2002
Last CRT projection paper at SID
Sony

2008
Introduction of color sequential LCoS with 5.4µm pixels (0.21" 854 x 600)
Syndiant

Projection Components/ Architecture

2001
Scrolling Color Recapture (color wheel)
Texas Instruments

Projection Lenses

Illumination Sources

2001
External cavity surface emitting lasers
Novalux

2006
Photonic lattice, large area LEDs
Luminus

2010
Direct emission green lasers
Kaai

2001
Arc stabilization of short-arc (UHP) lamps
Philips

Projection Screens

2002
Refractive/TIR fresnel for thin RPTV
Mitsubishi

2005
Contrast-enhanced single lenticular for LCD/DLP RPTV
Toppan

Contrast-enhancing front projections screens
2002 based on polarization **3M**
2007 based on viewing angle **Dai Nippon**
2007 based on spectrum **Sony**

Products & Applications

2000
DLP cinema projectors
Barco/Christie/ Digital Projection

SID Award Recipients – Projection Displays

Karl Ferdinand Braun Prize
William E. Glenn 1993
William E. Good 1993
Thomas T. True 1993
Larry J. Hornbeck 1999

Fellow of the SID
Petro Vlahos 1966
John A. Van Raalte 1975
Eiichi Yamazaki 1997
William E. Glenn 1998
Shinji Morozumi 1998
William P. Bleha 2003
Edward H. Stupp 2003

Special Recognition
William E. Good 1974

Post 2003 additions

PROJECTION
Karl Ferdinand Braun Prize
William Bleha 2005

Fellow
Arlie Conner 2004
Han-Ping Shieh 2005

Special Recognition Award
Hiroki Hamada 2010

Progress in Projection Displays

Projectors have been pushed towards large, bright, high-resolution, full-color images for many years now. They are used in a wide variety of applications, in sizes from 40 inches diagonal to nearly 40 feet diagonal for electronic cinema systems, with light outputs from a few hundred to over 10,000 lumens. Projection systems have achieved performance metrics higher than almost any other display technology.

For decades the best projectors used multiple CRTs with different phosphors for each primary color. The advent of efficient, high-maintenance (long-life) phosphors, advanced lens designs, transmissive screens which control the distribution of the output light, and liquid-cooled-faceplate CRTs enabled increasingly less-expensive and higher-performance projectors for consumer and industrial uses. Today more than 3 million consumer projectors are sold annually, some still based on CRT image generation but with most using light valves of one type or another.

Early requirements for large displays were met by projectors based on a deformable-oil-film Schlieren system (Eidophor,Talaria), and either complex rapid-processed photographic film or mechanically scribed plates. For the latter systems, response time was sacrificed to obtain the required light output and resolution. Starting in the late 1970's the higher-resolution ILA technology became the best approach for industrial use and military command & control systems. Remarkably, up the early 1990's the 1948-vintage Eidophor was the only technology for 5,000+ lumen theater-size displays.

The advent of small light valves based on pSi LCDs or the digital micro-mirror device (DMD, now DLP), plus the efficient small-arc UHP lamp—supported by a host of optical-component and architectural developments—has initiated dramatic growth in performance in the past decade. Luminous power efficacy has been improved by a factor of over 10, reliability has increased significantly, and system size, weight, and cost have all been greatly reduced. These trends are expected to continue for some time into the future, albeit at a slower pace.

All of these performance/attribute improvement factors have made possible many new applications. For example, he development of a new class of small projectors—picoprojectors—is spurring new uses for projected displays in a wide variety of sizes.

Except for recent advances in laser technology (noted for their potential future impact) all of the technology milestones in the adjacent chart are limited to first-of-kind developments for those technologies that resulted in commercially viable products. The coloring of the milestones should help the viewer to appreciate the great variety and fascinating evolution of techniques to project images, especially during the SID era.

Legend

CRTs	CRT Projection Systems
Oil Films LVs	Oil Film Light Valve Projectors
ILA/LCLV	ILA (Liquid Crystal Light Valve)
DLP/DMD	Digital Light Processor (Deformable Mirror Device)
LCDs	LCD Projectors (transmissive)
LCoS	LCoS Projectors (reflective)
LED/Lasers	LED/Laser Projectors

CRTs | Oil Films LVs | ILA/LCLV | DLP/DMD | LCDs | LCoS | LED/Lasers

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