Identification and Preservation of Digitally Printed Materials: Class Outlines for Educators
Image Permanence Institute (2017)

The following is an outline of the major ideas presented during IPI's Digital Print Preservation workshops. The ideas are free for anyone to use to develop classes of their own. Images from the DP3Project.org website are free for use with proper credit to IPI. IPI assumes that the user of this outline will already be familiar with the material and only needs assistance organizing the information into presentations/lectures. The individual sections can be used by themselves, in selected groups, in their entirety, or with additional material provide by the user. Reference to IPI for the outline should be given at least once. Reference for IPI images must accompany each instance within presentations.

INTRODUCTION

Title: *Preservation of Digitally Printed Materials*

Introduction of Class Objectives:

- Develop a common language
  - Descriptive terms
  - Naming conventions
- Develop a basic knowledge
  - History
  - Materials and processes
  - Print sensitivities
- Develop the basic skills
  - Identification
  - Care
- Know here to find more information

Defining "Digital Print"

- *The beginning of wisdom is to call things by their right names*
  - Confucius
- Breakout Group Activity:
  - Step One: Brainstorm 3-5 key words
  - Step Two: Come up with one sentence definition
  - DISCUSSION: Assess as class
    - Where do the definitions work?
    - How might they not work?
- NOTE: Return to complete this discussion after the presentation on naming conventions and descriptive terminology

What do museums, libraries & archives say? - IPI 2008 Survey

- If captured digitally, no matter how printed
- "Digital" printer only, no matter how captured
- If a "digital" step was used somewhere along the line
- If the artist says its digital
- No consensus in the field
- Burge, Daniel, Douglas Nishimura, and Mirasol Estrada, "Summary of the DP3 Project Survey of Digital Print Experience within Libraries, Archives, and Museums", IS&T's Archiving 2009, May 4-7 2009 Arlington, VA

Some useful stats from IPI's 2008 Survey

- 80% of institutions have digital prints
- 77% concerned about a future influx
- 83% do not feel well informed on proper care
- 71% do not have specific policies for these objects
- 71% have seen deterioration within their digital print collections
- 60% don't believe digital prints will last as long as traditional prints

Types of digital prints in institutions

- Inkjet – 78%
- Laser – 48%
- Dye sublimation – 33%
- Other – 11%
- Not sure – 29%
- None – 4%

Major types of digital print deterioration in collections

- Abrasion and scratch – 42%
- Fade/color shift – 41%
- Yellowing – 30%
- Color bleed or transfer – 23%
- Adhesion between prints, to enclosures, or to glass – 21%
- Binder cracking/delamination – 12%
- Other – 9%
- No deterioration – 23%

The Big Three: Most common digital print types

- In this workshop focus will be on:
  - Dye sublimation
  - Digital electrophotography
  - Inkjet

The Bottom Line Is Most Institutions:

- Have digital prints
- Have prints that are deteriorating
- Cannot always differentiate between types of digital prints ort between digital prints and traditional prints
- Do not feel well informed on how to care for them
- Do not have polices to guide them

PRINT BASIC TRAINING

Basic Components Needed to Make Analog Prints

- Mechanism to apply marking substance
  - Lines
  - Shapes
  - Colors
  - Tones
- Marking substance
- Substrate

Basic Components Needed to Make Digital Prints

- An image file
- Mechanism to apply marking substance
  - Lines
  - Shapes
  - Colors
  - Tones
- Marking substance
- Substrate

Digital image output is ***raster*** image or ***vector*** drawing output

- Raster image
  - Every spot in the image has
    - Two values for location (x,y)
    - A color value
  - Common file types: Jpg, tif, etc.
- Vector drawings
  - Simple graphics and text
    - Forms created by locations and strokes, fills, colors, etc.
  - Common file type: Postscript

Pixelation

- Pixel means picture element
- Early digital prints had large pixels which could be seen and betrayed the object as computer generated
- Modern prints have very small pixels that are invisible to the naked eye

Tone Reproduction

- Continuous tone – created by varying the density of colorants at each location
- Halftone – created by varying the ratio of white paper to printed ink

Halftone Screening

- Tone created by varying the ratio of printed area to white paper
- Amplitude Modulated (AM) Screen – dots equally spaced but varied in size
- Frequency Modulated (AM) Screen – dots equal in size but variably spaced

Marking Substances (inks and toners)

- Colorants
  - Dyes
  - Pigments
- Vehicles
  - Liquids
  - Solids
- Additives
  - Dispersion agents
  - Charge controls
  - Drying aids
  - Lubricants
  - Many others

Substrates

- Consist of
  - Support
    - Simple papers
    - Complex laminated structures
  - Coatings or treatments
    - None
    - Polymers
    - Minerals

In Summary

- Need an image file
- Need a way to make:
  - Lines
  - Shapes
  - Colors
  - Tones
- Need a marking substance
- Need a substrate

DYE SUBLIMATION

Percent Institutions with Dye Sublimation: 33%

History

- Dye sublimation discovered
  - Noël de Plasse 1957
- First to use for imaging
  - Nobutoshi Kihara 1982
  - Sony Corporation
  - Needed printer for still video camera
  - Analog to digital converter
- Commercially available in 1986

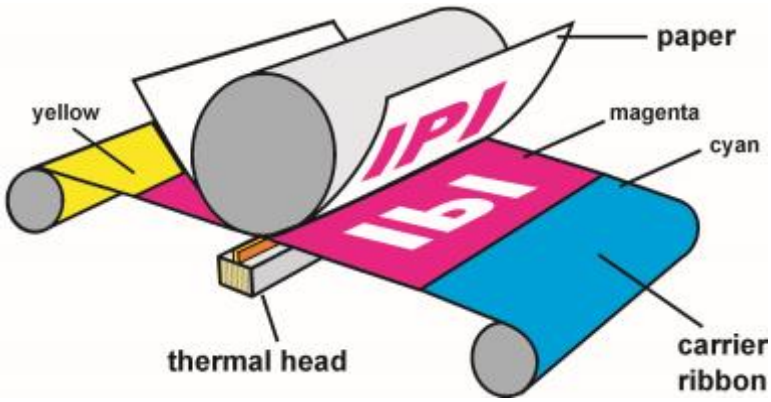
Dye Sublimation Synonyms:

- Dye diffusion thermal transfer
- D2T2
- Dye sub

Typical Printers

- Store kiosks
- Snapshot size home printers

Dye Sublimation Printing Technology:



Carrier Ribbon

- Individual panels of cyan, magenta, and yellow dyes + overcoat panel

Microscopic Characteristics:

- Image Structure
  - Squares (or lines)
  - No photographic grain
  - Difficult to focus on image elements

Dye Sublimation Paper

- Looks and feels like a traditional color photo paper
- Complex multiple layers
- Polyester image receiver layer (IRL)
- Insulation layer
- RC paper

Primary Uses/Formats

- Photo only
- 8.5 x 14 or smaller
- Usually 4x6

Protective Topcoat

- Before topcoats the prints were highly sensitive to
    - Pollution
    - Water
- First topcoat in 1994
    - Does not protect against light

Characteristics for ID

- RC base
- Most often 4x6
- Image structure
    - Squares (or lines)
    - No photographic grain
    - Difficult to focus on under magnification

Sensitivities of Dye Sub Prints Before & After Addition of Topcoat

- Before
    - Light
    - Moisture
    - Pollution
- After
    - Light

Storage Guidelines

- Temperature: Room 20°C
- Safe at low temps even frozen
- Humidity: 30%-50% RH

Recommended Enclosures

- ISO 18902:2013 *Imaging materials - Processed imaging materials - Albums, framing and storage materials*
    - Key points from 18902
        - For traditional and digital photographic prints
        - 2% alkaline reserve
        - Kappa 7 or less
        - Pass Photographic Activity Test (PAT)
        - No chlorinated, cellulosic or plasticized plastics
        - No rubber adhesives
        - *Use most current version: 2013*

Exhibition Guidelines

- Start with AIC-PMG Exhibition Guidelines for Photographic Materials
- Minimum light level to adequately view
- Reduce UV (filter source or object)
- Light damage is cumulative and permanent

Handling

- Just like chromogenic photographs

Other Dye Sub "Prints"

- ID/security cards
- Textiles
- Photo gifts

The Bottom Line for Dye Sublimation:

- *Looks* like traditional color photo
- *Feels* like traditional color photo
- *Acts* likes traditional color photo
- *Treat* it like a traditional color photo
- *But* it's not a traditional color photo

DIGITAL ELECTROPHOTOGRAPHY ("LASER" PRINTING)

Percent of Institutions with Electrophotography: 48%

Digital Electrophotography Synonyms

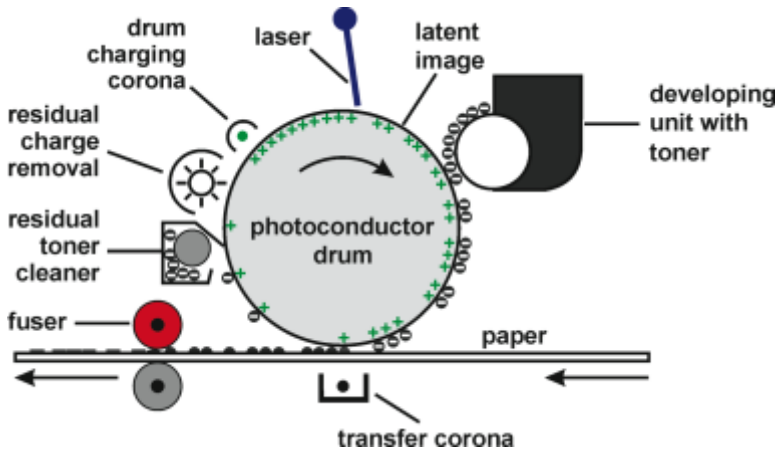
- EP
- Digital photocopiers
- Laser printers

History
- Analog
  - Invented by Chester Carlson in 1938
  - First commercial unit Model A in 1949 (did not sell well)
  - First successful commercial product Xerox 914 in 1959
  - First color copier Xerox 6500 in 1973
- Digital
  - Gary Starkweather of Xerox invents laser printer in 1969
  - First desktop Laser Printer in 1984
    - HP LaserJet – B&W text
  - First color laser printer in 1993
    - Color LaserWriter 12/600 PS

Typical Printers
- Desktop
- Office workgroup

Digital Presses - 1993
- Dry toner
- Liquid toner (Indigo)
  - ElectroInk
- Spot colors
- Transformed printing industry
  - On-demand
  - Short-run
  - Variable data

Digital Electrophotographic Printing Technology:



Electrophotography Image Structures
- Halftones
- Usually AM screening

Electrophotography Colorants

- Color needs CMYK toners
- Dry toner – pigment in plastic beads
- Liquid toner – colorant in volatile oil

Laser printer & copier papers

- Plain
- Coated
    - Mostly digital press
    - Glossy magazine type

Primary ID Attributes

- Dusty look for dry-toner electrophotography
- Round dots for liquid toner electrophotography with satellites

Primary Uses for Electrophotography

- Documents
- Short-run books and periodicals

Primary Damaging Forces

- Very high heat – toner softening
- PVC plasticizer – toner transfer
- Adjacent smooth surfaces – blocking/toner transfer
- Adjacent rough surfaces – abrasion
- Water – cracking and delamination
- Poor paper quality – yellowing & embrittlement

Storage Guidelines

- Temperature: Room 20°C
- Humidity: 30%-50% RH
- Poor quality paper may need lower temperature

Recommended Enclosures

- ISO 18902:2013 *Imaging materials - Processed imaging materials - Albums, framing and storage materials*
    - Key points from 18902
        - For traditional and digital photographic prints
        - 2% alkaline reserve
        - Kappa 7 or less
        - Pass Photographic Activity Test (PAT)
        - No chlorinated, cellulosic or plasticized plastics
        - No rubber adhesives
        - *Use most current version: 2013*

Exhibition Guidelines

- Just like analog photocopies

Handling
- Just like analog photocopies

The Bottom Line for Electrophotography:
- *Looks* like analog photocopy
- *Feels* like analog photocopy
- *Acts* likes analog photocopy
- *Treat* it like a analog photocopy
- *But* it's not an analog photocopy

INKJET

Percent Collections with Inkjet: 78%

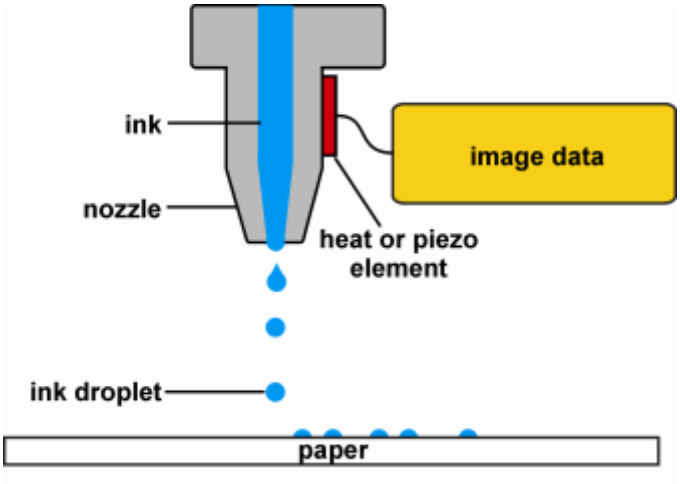
First Inkjet Printer 1867
- William Thomson a.k.a. Lord Kelvin
- Siphon recorder

Colored Facsimile System 1929
- Richard Ranger and Samuel Smith of RCA
- Patent No. 1,817,098 (continuous inkjet)

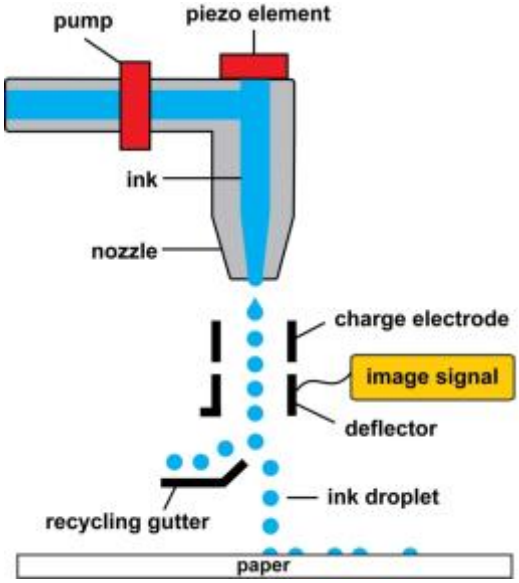
Rune Elmqvist 1948
- Inkjet used in early electrocardiogram
- Today EKG uses thermal output

Basic Concept
- Ink
- Nozzle
- Force
- Paper

Drop-on-demand Inkjet Technology:



Continuous Inkjet Technology:



Continuous Inkjet

- Commercial printer proofing system
- First model was Iris 3044 in 1985

Graham Nash and Nash Editions *(from Nash Editions website)*

- 1989 Graham Nash purchases an IRIS 3047 graphics printer
- First all inkjet shows
    - 1990 Sotheby's Auction, Photographs from the Collection of Graham & Susan Nash - *Sunlight On Silver*
    - 1990 *Graham Nash Photographs,* Parco Gallery, Tokyo
- 1991 Nash Editions opened July 1st

Wide Format Inkjet -1993

- Inkjet prints can be really big
- Wide format
- Large format
- Giant format
- Grand format
- No standard definitions
- Loose definitions
    - Wide format - greater than 17 wide
    - Large, giant, or grand format (synonymous)- greater than 66 inches wide

Inkjet Digital Presses

- Dye or pigment
- 2007

Inkjet Inks

- Usually water-based
- Dyes
- Pigments

Pigment vs. Dye

- Particulate vs. molecule
- Insoluble vs. soluble
- Good vs. variable light fastness
- Good vs. variable pollution resistance
- Dye cheaper and better color range than pigment

Three Basic Possibilities for Printers

- All dye
- Dye CMY and pigment black
- All pigment

Colorant Timeline

- Before 1993
    - Dye only
- 1993-2000
    - Dye only
    - Dye CMY and pigment black
- 2000-present
    - Dye only
    - Dye CMY and pigment black
    - All pigment

Inkjet Printers Can Have More Than Four Inks

- CMYK plus light cyan and light magenta
- Eight levels of blacks for high end B&W images
- Extra colors to improve color range (i.e. red, orange, green, blue, or violet)

Half-tone Image

- Offset and electrophotography predominantly AM screening
- Inkjet predominantly FM screening
- But neither are hard and fast rules

Inkjet Paper Variations

- Sizes
- Thickness
- Textures
- Surface sheens
- Tints
- Whiteners
- Coatings for colorant control

Plain Inkjet Papers

- Bond/copy paper
    - Uncoated
    - Treated (e.g. *Colorlok*)
    - Inkjet-sized

Fine Art Inkjet Papers

- Printmaking paper
- Watercolor paper
- Uncoated
- Coated
    - Fine art substrate
    - Silica or alumina in binder

Inkjet Photo-coated Papers

- Polymer-coated RC paper
- Porous-coated RC paper
- Porous-coated baryta paper

Polymer-coated RC Paper

- RC paper
    - Plastic laminated high-quality paper
    - White pigmented top layer
    - Clear back layer
    - Anti-block backing
- Coating
    - Polymer/Swellable
    - Gelatin, PVOH, mix
    - Can be very glossy
- Colorants
    - Almost always dye

Porous-coated RC Paper

- Paper
    - Plastic laminated high-quality paper
    - White pigmented top layer
    - Clear back layer
    - No anti-block back
- Coating
    - Mineral/Porous
    - Silica, Alumina, mix
    - Hardened binder
    - Not as glossy as polymer-coated paper
- Colorants
    - Dye or pigment

Baryta Fiber-based Paper

- Paper
    - High-quality paper
    - Whitened polymer top layer
    - Smooth or fibrous back
- Coatings
    - Mineral/Porous
    - Silica, Alumina, mix
    - Hardened binder
- Colorants
    - Dye or pigment

Inkjet Canvas

- Canvas support
- Porous coating
- Dye or pigment

In Porous Prints - Particle Size Determines Gloss

- The glossier the print, the rounder the dot

Whiteners

- Calcium carbonate - $CaCO_3$
- Titanium dioxide - TiO_2
    - TiO_2 + light = Oxidizing gas
- Optical brightening agent (OBA)
    - Water soluble dye
    - UV absorbing - Visible emitting
    - Increases print whiteness and brightness
    - Various chemistries
    - Variable concentrations
    - Various layers in prints

OBA's Are Unstable

- Fade
    - In light
    - In pollution
    - Makes print dull/yellowish
- Bleeds in water
- May react with pollutants to cause yellowing

Primary Uses for Inkjet Printing

- Everything

Non-Aqueous Vehicle Variations

- Solvent
- Eco-, mild- or low- solvent
- Latex
- UV-curable
- Solid

Inkjet/Dye Sublimation Hybrid

- Four color - CMYK
- Inkjet print onto transfer paper
- Heat transfer/sublimate to final substrate
- ID: Very blurry dots

Drivers of Decay

- Heat
- Humidity
- Light
- Pollution
- Handling
- Wrong enclosures
- Water

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Two General Groups
- Books, periodicals, manuscripts, ephemera
- Photographs and fine art

Environmental Risk Factors For Inkjet-Printed *Documents, Books, Ephemera*
- Heat – yellowing
- Humidity – bleed or mold
- Pollution - yellowing

IPI Recommendations for Storage of Inkjet-Printed *Documents, Books, Ephemera*
- Temperature: Room 20°C
- Humidity: 30%-50% RH
- Poor quality paper may need lower temperature

Environmental Risk Factors For Inkjet-printed *Photographs and Fine Art*
- Heat – bleed, cracking, delamination, yellowing
- Humidity – bleed, blocking, cracking, cockling/curl, delamination, ferrotyping, or mold
- Pollution – bleed, cracking, delamination, fade, yellowing

IPI Recommendations for Storage of Inkjet-Printed *Photographs and Fine Art*
- Temperature: Cold 4°C
- Humidity: 30%-50% RH
- Can handle freezing

Humidity Problems
- High RH
  - Bleed
- Low RH
  - Cracking of surface coatings

Dye Inkjet Bleed Limits
- Based on worst case material: polymer inkjet
- Other types are more resistant (i.e. pigment inkjet on uncoated fine art)
- Time to bleed
  - <60% RH - safe
  - 65% RH - 4 weeks
  - 70% RH - 3 weeks
  - 75% RH - 7 days
  - >80% RH - less than 24 hours

Light Problems
- Fade
- Yellowing
- Embrittlement
- Delamination

Display Recommendations

- Frame behind UV glass
- Follow guidelines for color photographs
- Monitor for change
- Know that embrittlement may be invisible

Pollution

- Ambient air
- Adjacent objects
- Enclosures
- Internal

Pollution Problems

- Fade
- Yellowing
- Embrittlement
- Bleed
- Low temps have little impact on some pollutants

Pollution Mitigation

- Protect from air
- Polyester (or other safe plastic)
- Sealed frames
- Cover when laid out for conservation work or exhibition preparation

Handling Problems

- Abrasion
- Scratch
- Scuff
- Polishing
- Colorant smear
- Cracking
- Crimping
- Chipping

Handling for Inkjet Photographs and Fine Art

- Gloves: cotton or nitrile
- Secondary supports
- Do not roll
- Avoid bending or flexing
- Do not apply pressure to surface
- Do not stack in direct contact
- Window mats
- Clear plastic sleeves
- Interleave with smooth plastic
- Free Handling Do's and Don'ts poster at DP3Project.org

Beware of Spittle

- Use face mask when examining/handling prints

Framing Materials & Storage Enclosures Problems

- Abrasion
- Yellowing by adhesives
- Bleed from water-based adhesives

Recommended Enclosures

- ISO 18902:2013 *Imaging materials - Processed imaging materials - Albums, framing and storage materials*
    - Key points from 18902
        - For traditional and digital photographic prints
        - 2% alkaline reserve
        - Kappa 7 or less
        - Pass Photographic Activity Test (PAT)
        - No chlorinated, cellulosic or plasticized plastics
        - No rubber adhesives
        - *Use most current version: 2013*

Water Problems

- Planar deformation
- Bleed
- Coating dissolution/delamination
- Cracking
- Blocking (bonding between prints or to enclosures)

Recommendations

- Avoid Water!!!
- Water Damage Effects video
- See Flood section of DP3Project.org

The Bottom Line for Inkjet:

- A lot of different ***looks***
- A lot of different ***feels***
- A lot of different ***behaviors***
- Needs a lot of ***attention***
- Care requires a lot of ***skill***

ANALOG PRINTS

Analog Printing

- Offset lithography
- Photocopies
- Intaglio
- Relief
- Silver-halide photographs

All Have Been "Digitized"

- Offset lithography
- Photocopies
- Intaglio
- Relief
- Silver-halide photographs

Offset Lithography

- Offset is a planographic process
- Digital offset lithography
    - Digitally printed plates

Photocopying

- Photocopying is an electrophotographic process
- Digital photocopier – 1987
    - Scanner plus laser printer

Intaglio and Relief

- Laser or blade cuts wood blocks
- Laser etches resist
- Mechanical engraving

Silver-halide

- Silver halide is a chemical process
- Laser exposure of chromogenic paper

Preservation of Digital Offset, Photocopy, Intaglio, Relief, Painting, & AgX

- Same as any analog offset print
- Same as any analog photocopy
- Same as any analog intaglio print
- Same as any analog relief print
- Same as any analog photographic print

MEDIA NAMING AND DESCRIPTIVE TERMINOLOGY

Some Common and Uncommon Media Names for Inkjet on Gallery Labels

- Digital print
- Digital print on Somerset Velvet Enhanced
- Digital dye print on paper mounted on paper
- Pigment print
- Pigment ink print
- Archival pigment print
- Archival inkjet print (with beeswax, chalk, and oil pastel)
- Inkjet print
- Inkjet print – exhibition copy
- Inkjet archival print
- Inkjet photograph on rag paper
- Archival digital photographic print

Naming Reasons

- Curators need names that are explanative and educational
- Catalogers/registrars need names that are informative and contextual
- Conservators need names that are care actionable
- DISCUSSION: Are there names that meet everyone's needs or does everyone need their own name/terms?

Brand Names

- Do not use in media naming (i.e. Epson Print)
- If known they can be included in catalog and other records related to the object

What We Have Learned?

- No standard definition for "digital print"
- A variety of very different digital processes with unique care concerns
- Even traditional is now sometimes digital
- The term "digital print" does not provide any direction on care

Current Approaches

- Getty Art and Architecture Thesaurus
- Library of Congress Thesaurus for Graphic Materials
- Martin Jürgens
- Philadelphia Museum of Art
- Image Permanence Institute

Art and Architecture Thesaurus®
Hierarchical Position:

Objects Facet
Visual and Verbal Communication (Hierarchy Name)
Visual Works (Hierarchy Name)
visual works (works)
<visual works by material or technique>
prints (visual works)
<prints by process or technique>
digital prints
inkjet prints
laser prints
dye diffusion thermal transfer prints

Library of Congress - Thesaurus for Graphic Materials

- Pictures
  - Prints
    - Digital prints
      - Inkjet prints
- *No dye sub, EP etc.*

Martin Jürgens

- Process – Minimum term – qualifier one – qualifier two
- Example: Liquid inkjet – liquid inkjet – dye – on paper

Philadelphia Museum of Art (PMA)

- Medium and Extended Medium
- Examples:
  - Medium: Inkjet print
  - Extended medium: Piezoelectric inkjet print

IPI

- More detailed version of combined of Jürgens and PMA
- Dye sublimation
    - Medium: Dye sublimation
    - Extended medium: same as above
- Digital Electrophotography
    - Medium: Digital Electrophotography
    - Extended medium: technology – colorant – support
    - Example: Dry-toner electrophotography on plain paper
- Inkjet
    - Medium: Inkjet
    - Extended medium: technology – colorant – vehicle – coating – support
    - Example: Aqueous dye inkjet on polymer-coated RC paper

How to Collect Print Information

- Photograph Information Record - AIC PMG
- Data Sheet for Documentation of Digital Prints – Martin Jürgens

RESOURCES

DP3Project.org

- Technologies
- Identification
- Deterioration
- Preservation
- Flood
- Resources

DP3 Newsletter

- Quarterly
- 1500+ subscribers
- Articles, ID tips, announcements, etc.
- Sign up at dp3project.org

Free for download at the DP3Project.org website

- IPI Guide to Preservation of Digitally Printed Photographs
- Descriptive Terminology for Inkjet-Printed Photographs and Fine Art
- Handling Do's and Don'ts poster
- Atlas of Water Damage on Inkjet-Printed Fine Art

The Digital Print: Identification and Preservation by Martin C. Jürgens

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