Surface Imaging

a new transdisciplinary discipline

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Definition

• A discipline that visualize any imageries on a wide range of substrates by advanced digital printing technologies including direct colorations, deposition and subtraction printing.

• A new discipline that moves beyond the boundaries of existing traditional fields of disciplines - Transdisciplinary

Surface Imaging Design
- Contained and Continuous Imaging
- Drawings and Paintings
- Raster and Vector Imaging
- Photo Imaging

Direct Digital Coloration
- Porous, Non Porous, Hard & Soft Substrates
- UV, Latex, Sublimation, Organic Solvent, Aqueous Dye

Digital Fabrication Printing
- Material Deposition
- Enhanced 3D Relief Surface, Metals, Composites, Functional Materials
- Subtraction Printing
- Laser Printing
**Evolution: Digital Printing for Textile – mid 90’s**

Digital inkjet printing on textile is one of the most challenging technologies among the rest of digital printing technologies – next to printable electronics.

- A wide variety of classes of substrates and colorants
  - no single universal colorants
- Substrates are flexible (not ridged)
  - woven, woven sheer, weft knit, warp knit etc.
- Surface characteristics (lint on surface)
- Performance requirements
  - penetration of colorants, fastness (light, wash, crock, etc.)

**History**

- 1878 The principal mechanism of inkjet technology (Lord Rayleigh)
- 1960s First inkjet system (Continuous Flow Inkjet System)
- 1972 Piezoelectric D.O.D. heads by Clevite Corp in Ohio
- 1975/76 Millitron Printing System by Milliken – Carpet and upholstery fabrics.
- 1979 Thermal D.O.D. inkjet heads. (HP and Canon -bubble jet)
- 1980's Desktop Publishing
- 1984 HP thermal D.O.D. desktop printer
- 1988/89 Advancement of CCD (charge-coupled device) for flatbed scanners.
  - Iris Continuous Flow Inkjet Printer by Iris Graphics – paper proofing.
- 1990's Screen printer, Photo LAB, Sign Printer – Moving to Digital
- 1994/96 Epson piezoelectric D.O.D. desktop printer
  - Seiren Viscotex System (Production inkjet printing on cloth)
  - Encad TX 1500 series (Thermal D.O.D. heads)
- 1998/99 Wide Format Printer (Epson, Roland, Mimaki) – graphic, photography and textile proofing
  - Development of archival paper ink
- 2000's Industrial Digital Printing- Archival Colorants (UV, Solvent, Textile, Material depositions )
- 2003 **Production Inkjet Textile Printers** (Reggiani, Konica/Minolta, Robustelli, Mimaki, Honghua, Zimmer)
  - Flat-Bed Garment Printers (Kornit, Brother, Mimaki)
- 2005 Archival ink for consumer photography market (Epson UltraChrome K3 ink )
- 2010's **ITMA 2011** High Speed Production Textile Printers
  - (EPI/Reggiani, Dover/MS, Stork SPG, Konica/Minolta, Durst, Zimmer, Epson/Robustelli, Mimaki, Kornit, dGen, Arisi, Honghua, DGT, Ichinose / Tashin, Roland)
- **2015 –** Single pass inkjet textile production printing system (ITMA 2015 -)
**State of the Art of Textile Printing Industry**

- **Worldwide Total Textile Printing**: $100+ B (analog and digital)

  **End User Expenditures**

  - Soft Signage: 33% (45% inkjet printing penetration)
  - Industrial Textile: 67% (3% inkjet printing penetration)


- **Worldwide Printing Growth (Industrial Textile Printing)**

  - 29.5+ Billion meters per year (2013)
  - 50+% for fashion, 40% for interior
  - At least 1% per year of increase
  - Reasons:
    - Acceleration of fashion cycles
    - Continuous world population growth

  Source: Okico, 2008; Reggiani Macchine, 2012

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**Scanning to Single pass inline**

**Scanning printer**

Most of inkjet printers are scanning type, in which a carriage with print heads and ink delivering system moves and prints on the substrate. Information is encoded in scanning strips on the carriage beam. Imagery is typically printed by multiple passages of the print heads.

**Single pass inline printer (ITMA 2015: MS, Konica/Minolta, Stork-SPG, Honghua)**

Multiple print heads are placed from edge to edge for the substrate width. Ink is ejected in a single pass mode from the heads in high speed. Perfect for high speed production but it is a high investment system.
Case Study - Como region

Digital Textile Printing Capital – early 2000 to 2017

- It is known for high end prints including for fashion and home. Avantgard Studio, Chiara, De-Ca Stamp, Di Cassa Pirzardi, Lipomo, Luce, Maver, Mantero, Miroglio, Nomega, Olonia, Ratti, Seride, etc.

- Started with multiple Mimaki TX printers (with Epson DX2 / DX4) in early 2000 have been replaced with high speed production printers. Epson - Monna Lisa, EFI Reggiani - ReNOIR, Dover MS - JP / JPK, etc.

- Integrations of conventional and digital productions.

- End users demand for Digital Printing production.

- One of the most installation numbers of digital printer in a world.

- "Speed is not the issue, the quality is.”

Case Study - Como region

Finishing Operation

- Steaming, washing, finishing and tentering
- Former engraver becomes finishing operation for digital textile printing
- One of the biggest problems in the US
Heimtextil 2014

One of the main annual tradeshows for interior textiles

- A larger popularity for digital printing with reactive dye on bedding (3.2 m)
  Conventionally, a majority of bedding has been printed by pigments.
- Market domination of latex pigment technology on wall covering
  A large scale wall murals with HP latex technology

Menderes

- Vertical home textile mills in Turkey (Bedding)
- Yarn spinning - Fabric constructions (weave & Knit) - Printing & Finishing
- 400,000 meter / day: Printing and dyeing
- One of MS LaRio installation site (1 single pass printer = 20x multi pass printers)

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<thead>
<tr>
<th>Description</th>
<th>Digital Textile Printing</th>
<th>Traditional Textile Printing</th>
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<tbody>
<tr>
<td></td>
<td>Single Pass</td>
<td>Multi Pass</td>
</tr>
<tr>
<td>Number of Cycles per Design</td>
<td>Unlimited</td>
<td>Limited to Screens</td>
</tr>
<tr>
<td>Max. Dimensions of Design</td>
<td>Unlimited</td>
<td>Limited to Screen Number</td>
</tr>
<tr>
<td>Resolution of Design</td>
<td>Up to 600 dpi</td>
<td>Screen’s Theoretical Limit (&gt;130 dpi)</td>
</tr>
<tr>
<td>Ecological Effects</td>
<td>Close to Zero</td>
<td>High Amount of Energy is needed for the treatment of this waste water, excess dyes</td>
</tr>
<tr>
<td>Minimum Quantities</td>
<td>200 Sheet Sets</td>
<td>1000 Sheet Sets</td>
</tr>
<tr>
<td>Down Time for Changes</td>
<td>Close to Zero</td>
<td>30-60 mins.</td>
</tr>
<tr>
<td>Sail-off/Prototype Scribing</td>
<td>1-3 Days</td>
<td>1-3 Weeks</td>
</tr>
<tr>
<td>Consistency of Printing Quality</td>
<td>Very Consistent</td>
<td>Should be checked periodically</td>
</tr>
<tr>
<td>Printing Speed</td>
<td>Up to 75m/min</td>
<td>10m/min</td>
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<tr>
<th>Year</th>
<th>Menderes</th>
<th>Worldwide</th>
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<tr>
<td>2013</td>
<td>Digital: 1%</td>
<td>Digital: 1%</td>
</tr>
<tr>
<td>2014</td>
<td>Digital: 10%</td>
<td>Digital: 1%</td>
</tr>
<tr>
<td>2020</td>
<td>Digital: 50%</td>
<td>Digital: 2-4%</td>
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Textile printing industry in the U.S.

### Apparel:
Almost diminished - a couple of specialized printers (swimwear / silk)

### Home Furnishing (Decorative):
Several vat dye rotary printers – (technical applications for military)

### Home Furnishing (Domestic):
Diminished – Pigment printers

Dupont targeted digital production printer for this market in 2001 - (Artistri 3210: 3.2 meter wide pigment printer)

**Digital Textile Printing in the U.S.**

- Many digital printing operations are from engravers and new comers.
  - CAD Fab, First2Print, Rothtec Engraving, Advanced Digital Textiles (Master Screen), Ultimate Textile (Cheran Digital Imaging), B3 Studio, Fabrics2Dye4, Adaptive Textiles, Spoonflower, etc.

- Lack of driving factors for the digital textile printing marketplace (after 2008)
  - In 2000’s, the US market was stimulated by sales and marketing forces of printing manufactures – Dupont, Reggiani, etc.

- Lack of resources for Pre and Post treatment in wet processing – favor to dry processing

Until 2010 (late 1990’s to 2010)

Digital printing penetration in industrial textile ($67B)

1.2%

Digital printing penetration in soft signage ($33B)

45%

AATCC/SGIA Digital Textile Printing: The Future is Now Conference

December 7, 2016
Today’s Reality

Digital printing penetration in industrial textile ($67B)

3.8 %

Digital printing penetration in soft signage ($33B)

45%

Within 10 years

Digital printing penetration in industrial textile ($67B)

5 + %

Popularity of Rotary Screen Printing (1963) – more than 10 years
Introduction of production digital textile printer - 2003

Sources: I.T. Strategies 2012
Analysis

Rationale for Surface Imaging Initiative

• Cool factors: New opportunities.
  new design creativity / no engraving / minimum machine downtime / sustainable (minimum
dye waste, minimum inventory) / personalization / mass-customization / short run production /
fast turn around / no color registration problems / etc....

• Transdisciplinary movements:
  "...digital process can blur the boundaries and distinctiveness between specialisms in a number
of ways that allow for multiple interdisciplinary outputs."
(Crafting Textiles in the Digital Age, edited by Faith Kane et al, 2016, Broomsbury Publishing.)

• Lack of understanding and communication among machine manufactures, printing operations and
application users including designers, project leaders and end users.
  No connections among design, engineering and business
  Lack of systems thinking

• Design, engineering and business components in this industry have not been properly integrated, partly
because they have retrofit their systems and processes into preexisting workflows.
  New ways of thinking and concepts

New Design Creativities

New Design Styles

• Photographic
• Unlimited use of color
• Diminutive
• Digital effect
• Engineered
From Graphic Signage

To Decorative Environmental Graphics

(Architectural Substrates, Wood, Glass, Laminates, Flooring, Interior Textiles, etc.)
Digital Printing Penetration

Soft Signage (45%) - Industrial Textile (1%)

Surface Imaging is Large and Growing Market

Surface Imaging industry – 800 billion dollar market and over 10% CAGR in North America

Worldwide Value of Print: Traditional Print Markets reaches $800 billion
Reva, Green car
Surface Imaging by Ella Doran
The MS in Surface Imaging offers students the opportunity to develop imagery for various physical forms using a variety of advanced digital printing technologies.

Students will explore direct surface imaging on diverse porous and non-porous substrates. Fabrication printing, including additive material deposition and subtraction printing technologies (enhanced 3D and laser printing), will become an integral part of the program.
Program

• Uniqueness and Compact
  Only program exists worldwide
  33 credit with minimal prerequisites in 16 months.

• Advanced Digital Printing System
  Digital means going beyond the traditional fields of disciplines and boundaries.
  Specialist to Versatilist – T Shaped Skills
  Transdisciplinary program for a future design practitioner, product developer,
  product manager, environmental graphics, interior products, apparel products
  and all facets of imaging industries.

• Systems Thinking
  Integration of design, engineering and business.

  Concept  Development  Production  Distribution  Marketing  Selling

• Innovative state-of-the art facilities
  Affiliation with the Center for Excellence in Surface Imaging – required internship
  Provide Business Incubators for entrepreneurial approaches to the program
Courses and Curriculum

- 1 Year (16 months) MS degree program
- MS degree program for full-time and part-time students for a total of 33 credits
- Program starts from Summer semester and ends at the following Summer semester.

* Students with a business education/background may waive this requirement if admitted with Advanced Standing. (1.5 credit each).
** Philadelphia University undergraduate students can take SI Design 1 as an advanced elective course upon approval of Program Director.
*** Selection comes from lists in Designated elective.
**** Master project requires creation of Business Plan and this is a prerequisite for those who do not have knowledge and experience of business plan creation. The Program Director will make the final decision and the course is offered under SBA.
***** This is a studio elective course that can be chosen from any graduate level design studio courses offered in the university.

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<th>Total credit hours (33 CR)</th>
<th>Designated elective (3 CR)</th>
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<tr>
<td>Core courses (30 CR)</td>
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<tr>
<td>MSSI-500 Surface Imaging Design Foundation</td>
<td>Business Foundation MBB 604 Accounting MMB 555 Finance 3 CR</td>
</tr>
<tr>
<td>MSSI-401 Surface Imaging Design I</td>
<td>MSSI-697 Printing Technology for Surface Imaging 3 CR</td>
</tr>
<tr>
<td>MSSI-602 Introduction to Materials and Manufacturing 3 CR</td>
<td>MSSI-607 Surface Imaging Design II 3 CR</td>
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<tr>
<td>MSSI-700 Surface Imaging Design III</td>
<td>MSSI-700 Transdisciplinary Project I 3 CR</td>
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<tr>
<td>MSSI-604 Surface Imaging Master Project MCR (Portfolio / Business Plan)</td>
<td>MSSI-702 Transdisciplinary Project II – 3 CR</td>
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<tr>
<td>MSSI-601 (1.5 credit)</td>
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<tr>
<td>Study Abroad Start Trip</td>
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<td>MBEA-709 Design/Preparation 3 CR***</td>
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The State of the Art - Advanced Digital Printing Center

To enhance and improve Professional imaging industry.

To provide and exchange:
- information in neutral position.

To educate:
- future leaders for the industry.

To conduct:
- research
- proof of concept testing
- educational events
- printing service

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Textile Applications
Printing system for all colorations for all fiber classes

**MIMAKI Textile Printing Systems:**
- MIMAKI TX300P: 2 units
  - Acid and Reactive Dye Ink
- MIMAKI TS300P:
  - Flourescent DyeSub Ink

**ROLAND Textile Printing System:**
- ROLAND RT640: 8 Color DyeSub ink

**MUTOH Textile Printing System:**
- Mutoh ValueJet 1624TD: 8 color Direct to Textile Printer

**EPSON Textile Printing US Beta site:**
- EPSON SureColor F2000
  - Direct to Garment printer
- EPSON SureColor F6200
  - Disperse Dye Transfer printer
- EPSON SureColor P9000
  - Archival Photo Printer

AATCC/SGIA Digital Textile Printing: The Future is Now Conference
December 7, 2016
Non Porous Application

Printing system for all available colorations

**Mimaki JFX-200 UV flatbed printer:**
- UV flat bed printer for 4’ x 8’ ridged substrates
- Up to 2 inch thick substrates
- UV printer with colors, white, and clear

**Mimaki JV-400 LX Latex printer:**
- Roll to roll latex ink printer
- For non porous films, PVC, non woven

**Mimaki UJF-6042 UV flatbed printer:**
- UV Pad Printer for the bed size 24 inch x 16 inch
- UV printer with colors, white, primer and clear
- Craft printing

**Mimaki CJV 30-160 Eco Solvent printer/cutter**

**Roland RE 640 – Eco solvent printer:**
- Roll to roll Eco Solvent Printer

**Roland GX 300 – Roll to roll cutter:**

**Mutoh ValueJet – 1626UVH UV printer:**
- Roll to roll / Flatbed Hybrid UV Printer
- UV printer with colors, white, and clear
Research

- Design research
  - New design styles
  - New product application and production workflows
    - "Smart Algorithm for Printed Textile Design"
- Marketing research
  - A Various Digital Textile Printing Marketing consultations and researches for private companies.
- Engineering research
  - "Creation of Textile-Based Durable Printed Antenna Systems"
  - "Encapsulated Ink for Digital Ink Jet Technology"
  - "Integration of fabric formation and coloration processes
    - "Universal Set of Dyes for Digital Inkjet Textile Printing"
  - "Inkjet printing textile archives - Barnes Museum", etc.
- Proof-of-concept projects
  - Inkjet printing for Military Camouflage printing
  - Inkjet printing narrow band
  - Automotive polyester tubing
  - Chemical Impregnations, etc.
- Testing (Print performance, Line acuity, optical density, fastness, etc.)
  - Various inks and substrates; Software.
- Production (samples to short runs)
  - Scarves, ties, umbrellas, bags, T-shirts, yardages.

Education

- Conferences and workshops
  - Designer Meets Technology (2004)
  - Designer Meets Technology: Europe (2005)
  - Digital Surface Imaging and Printing for Textiles Workshop (2013)
  - Digital Surface Imaging and Printing for Textiles Workshop (2014)
  - Surface Imaging Symposium (2015)
Application for 2017-2018

www.PhilaU.edu/MSSurfaceImaging

Next program starts May 16, 2017

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