The New Textile Design Paradigm:
Digital Inkjet Printing Production as a new form of Craft

For

"Innovations in Printed Textiles"

at

Textile + Design LAB

AUT University

Auckland, NZ

Hitoshi Ujiie
Director of the Center of Excellence of Digital Inkjet Printing of Textiles
Philadelphia University
4201 Henry Avenue, Philadelphia, PA, 19144 USA
(01) 215.951.2682 ujiieH@PhilaU.edu

June 26, 2012

Digital Inkjet Textile Printing

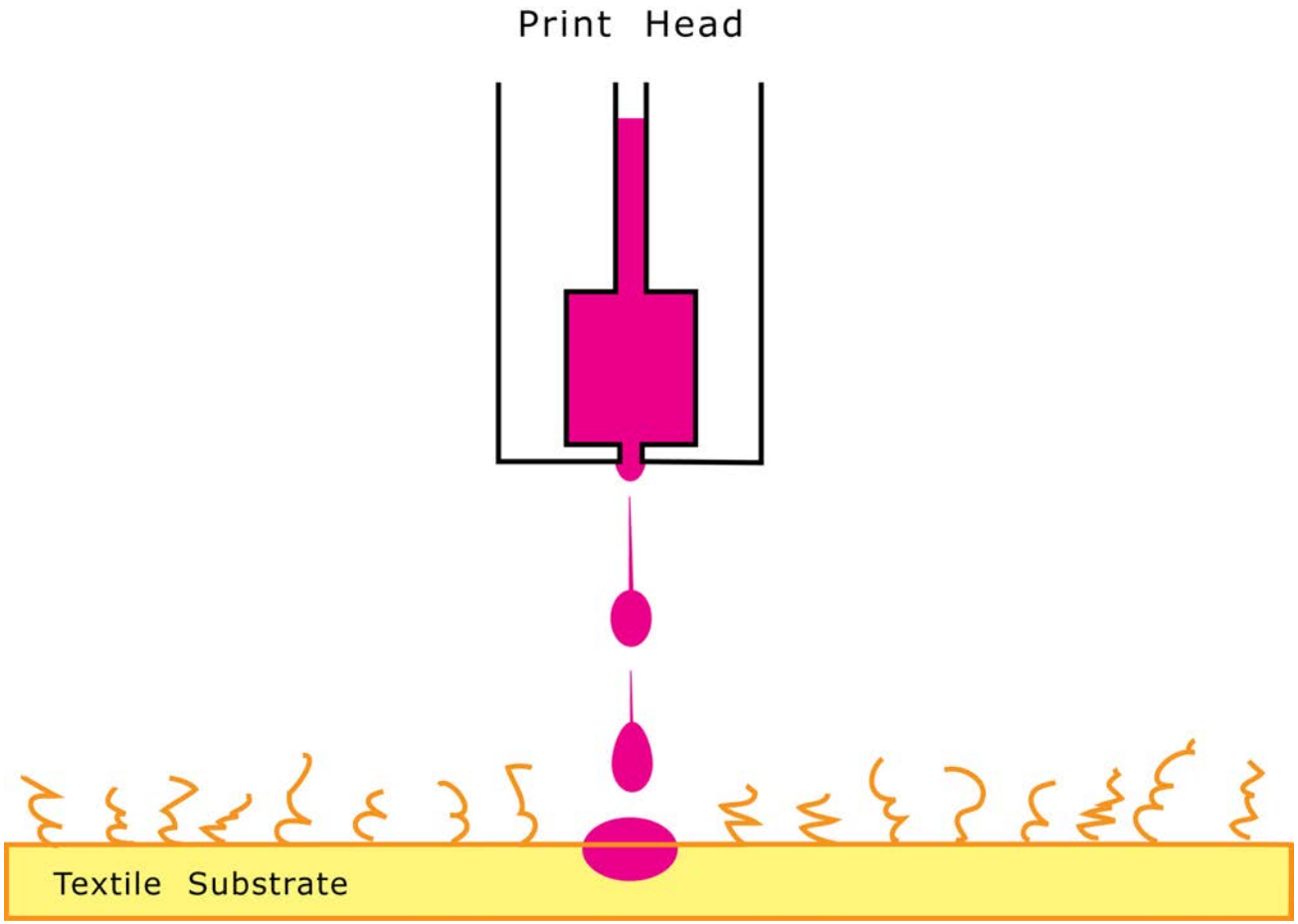
A **non-impact** printing process in which images are formed by the precise placement of small droplets (picoliter / a millionth of a liter - sized) of ink fired at high speeds from the nozzles of computer controlled print-heads.

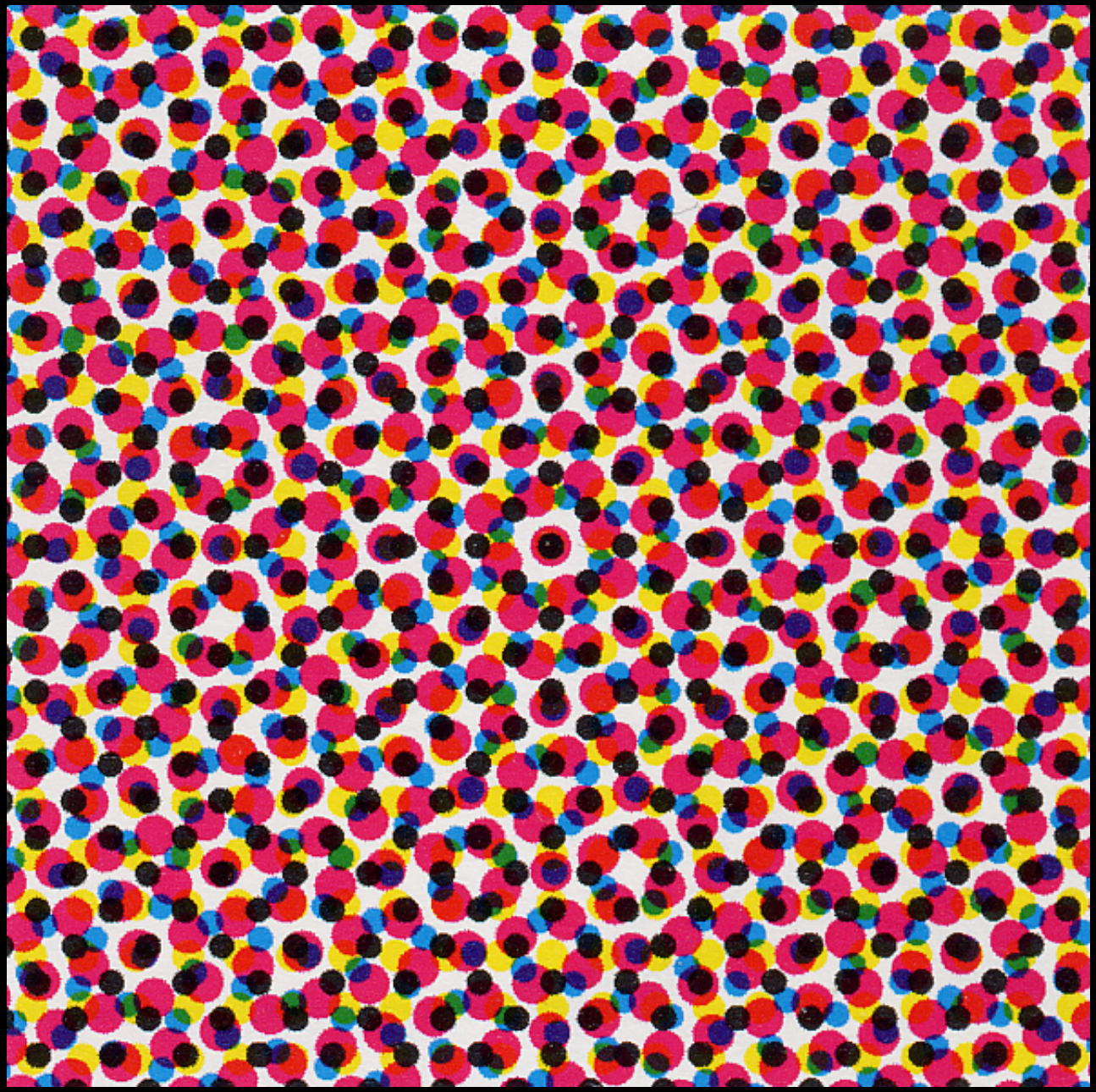
In the most common 4 color process, droplets of cyan, magenta, yellow and black inks (**CMYK)** are combine to form precisely placed dots of various colors, which form the images.

Precise volume of ink – Precise timing – Precise location

Digital Inkjet Printing Technology

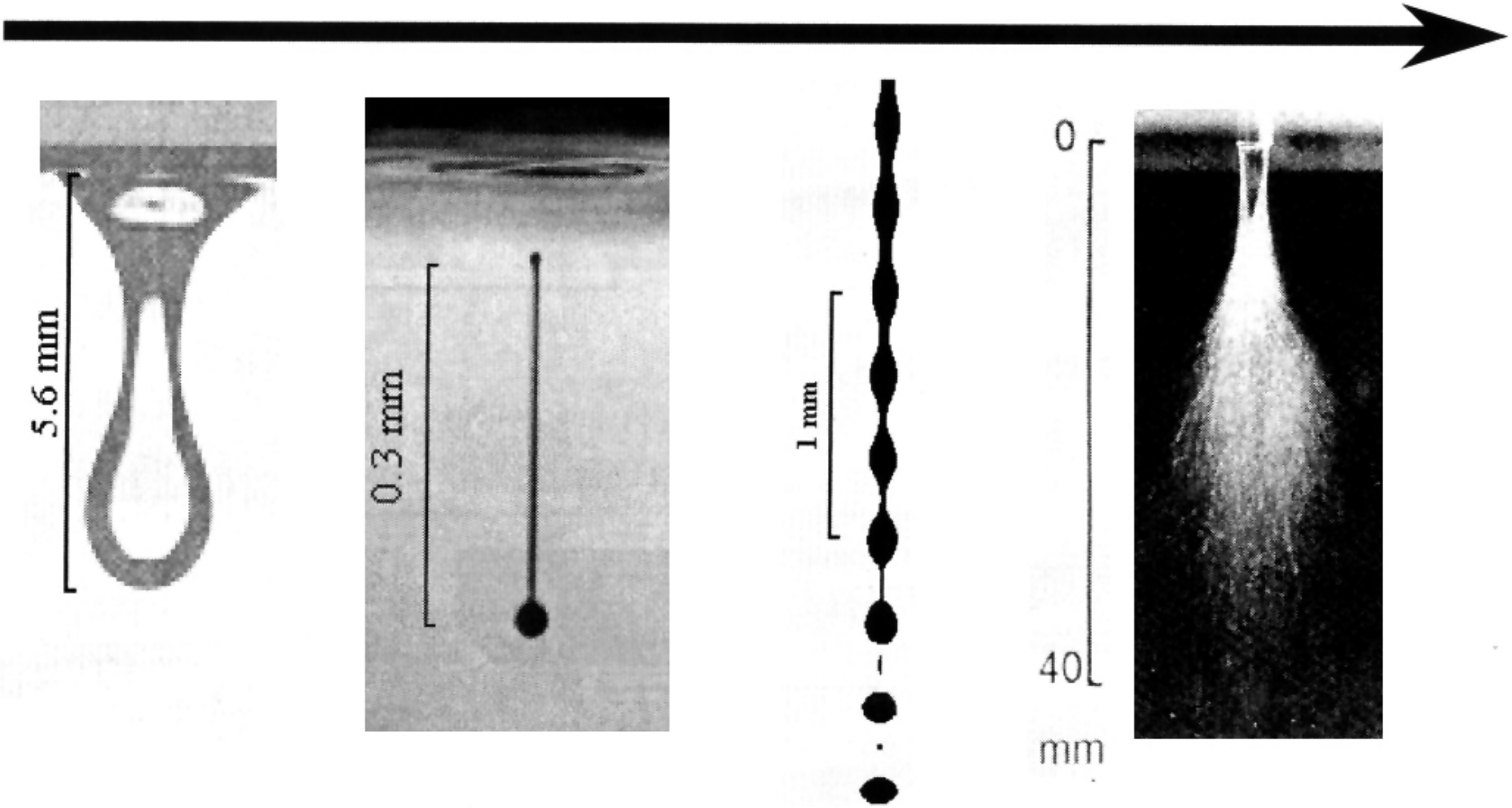
(Non Impact Printing)





June 26, 2012

Increase of flow rate



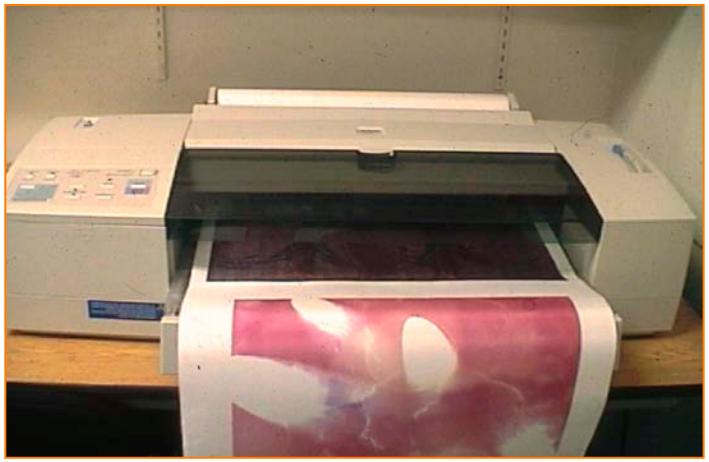
Dripping Faucet

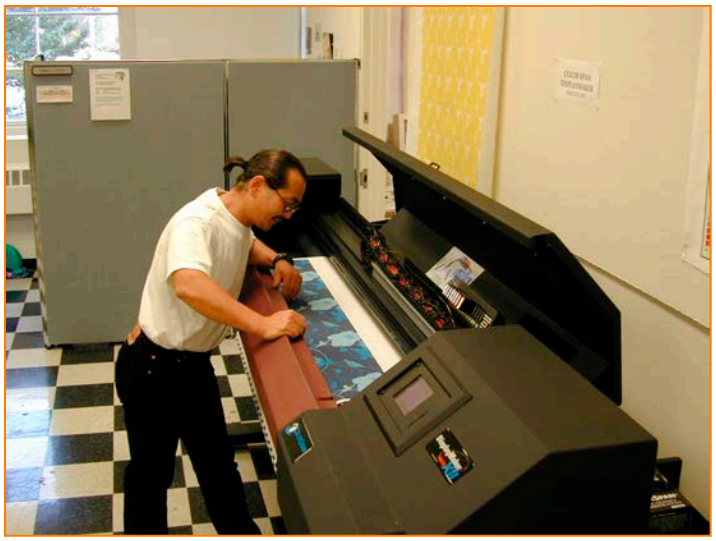
Drop On Demand (DOD)

Continuous Flow Inkjet (C I J)

Atomization

Digital Inkjet Textile Printing

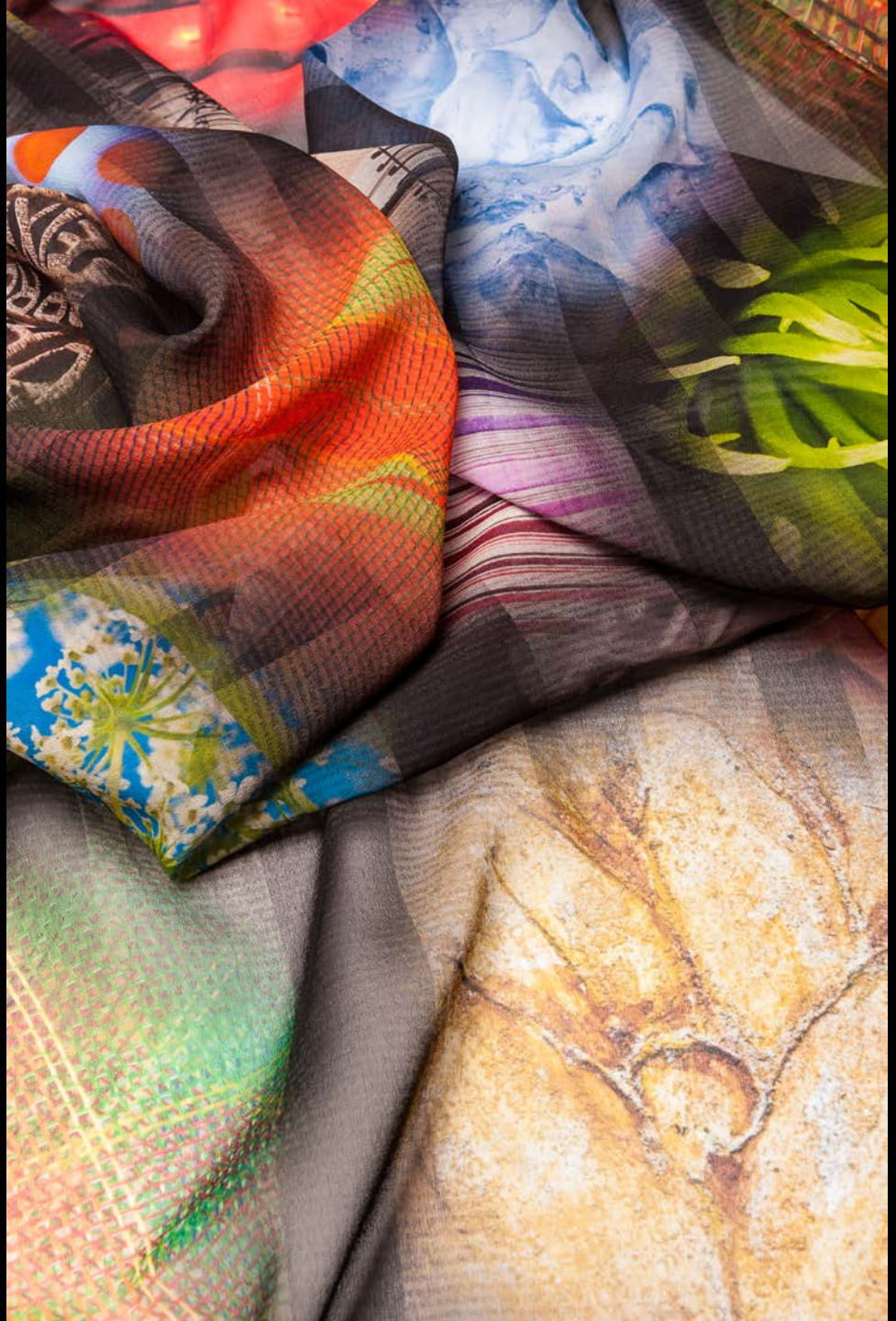




Digital Inkjet Textile Printing

- Computer Printing / Instant Printing
- On Demand / Press on Print / RIP and Fly /
- Any images (24 bits) can be printable on cloth
- Superficial approach
- Mechanical and uniform characteristics

T r u e



Crafted

Control

* Woolley M and Huddleston R (2011), "Maintaining the Human Touch – Exploring 'crafted control' within advanced textile production interface" presented at T.R.I.P. (textile research in progress) symposium at Loughborough University.

Characteristics of Craft Processes

According to David Pye:

"If I must ascribe a meaning to the word craftsmanship, I shall say as a first approximation that it means simply workmanship using any kind of technique or apparatus, in which ***the quality of the result is not predetermined, but depends on the judgment, dexterity and care*** *which the maker exercises as he works. The essential idea is that the quality of the result is continually at risk during the process of making; and so I shall call this kind of workmanship* ***'The workmanship of risk'****: an uncouth phrase, but at least descriptive."*

** Pye, D. (1968) "The Nature and Art of Workmanship", Cambridge Press

Characteristics of Craft Processes

- Hand-made (vs. Machine-made)
- Processes (*aura****:* physical / psychological)

  (Roles and use of Computer)
- Skills (mastery of skills)
- Presence of materials (vs. dematerialization / conceptual arts)
- Functional use

*** Benjamin, W. (1934) "The Work of Art in the Age of Mechanical Reproduction"
**** Alfoldy, S. (2007) "Neo Craft", NSCAD.
***** Adamson, G. (2007) "Thinking Through Craft", Berg Publishers.

Characteristics of Craft Processes

- Hand-made (vs. Machine-made)
- Processes (*aura***: physical / psychological)

  (Roles and use of Computer)
- Skills (mastery of skills)
- Presence of materials (vs. dematerialization / conceptual arts)
- Functional use

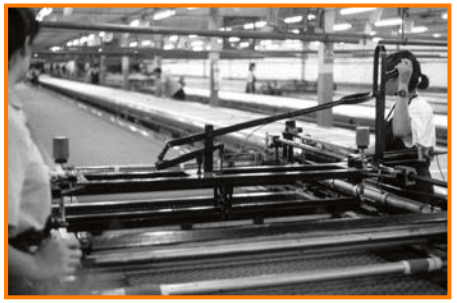
*** Benjamin, W. (1934) "The Work of Art in the Age of Mechanical Reproduction"
**** Alfoldy, S. (2007) "Neo Craft", NSCAD.
***** Adamson, G. (2007) "Thinking Through Craft", Berg Publishers.

Hand-made vs. Machine-made

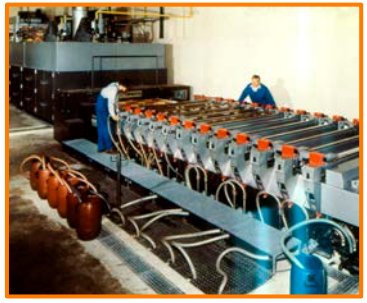
Screen Printing:

Hand Screen / Hand Carriage Screen / Automatic Carriage screen / Automatic Flat Bed / Rotary





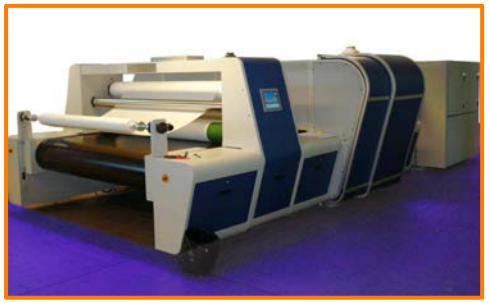




Hand-made vs. Machine-made

Digital Inkjet Textile Printing:

Modified desk top / Modified large format / Inkjet sampling printer / Inkjet production printer



Processes

- Digital Inkjet Textile Printing -

Design Process

Textile Design software
(AVA, Lectra, Nedgraphics, etc.)
Graphic CAD software
(Adobe packages)

Pre-Treatment of fabric substrates (Coloration chemistry)

Improve image quality (wicking and absorbency)
Thickening agents, *silica, clay,* binder, cationic agents etc.
Fixing colorants to the fibers
Fixing agent

Printing Parameters

Calibrations- physical nozzle check

Ink selections (classes and numbers of colors)
Printing resolutions (180, 300, 600, 720 1440 dpi)
Digital dithering (AM screens, FM screens – error diffusions, stochastic)
Printing directions and passes (uni vs. bi; passages)
printing speed

ICC Color Management

Linearization (spectrum data)
Creation of *black* (black generations)
Numbers of color patches to measure
Generation of ICC profiles

Post-Treatment of printed fabrics

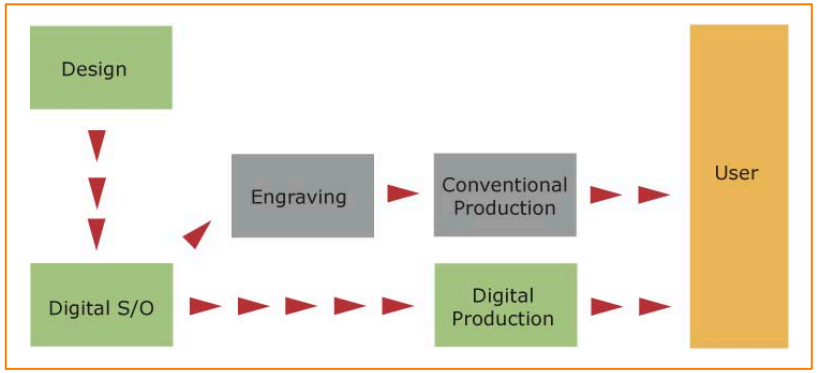
Steaming
Heat setting (Dry heat)

Washing

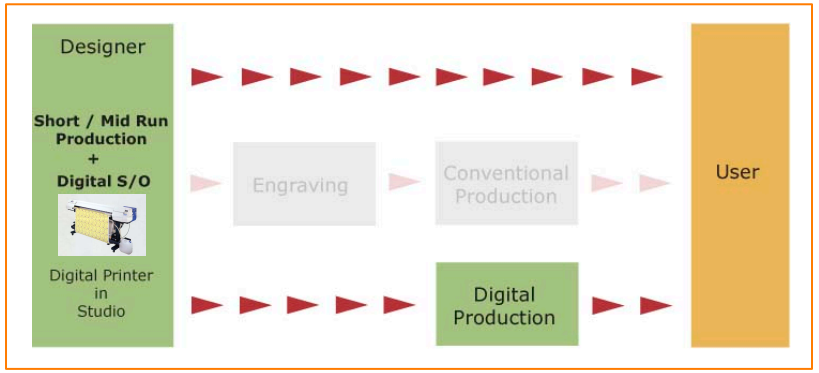
Processes

Physical and psychological involvement – *(aura**)*

Traditional Production Workflow



Neo Cottage Industry Workflow*****



Neo Cottage Industry Model

- Inkjet Textile Printers become economical and accessible.
- Printing operations become a part of creative processes.
- Printing operations become an extension of "hands".

*** Benjamin, W. (1934) "The Work of Art in the Age of Mechanical Reproduction"
****** Ujiie H, (2005), 'Innovative Product Development in Digital Fabric Printing', Presented at the Digital Textile 2005, Berlin, Germany.

Processes

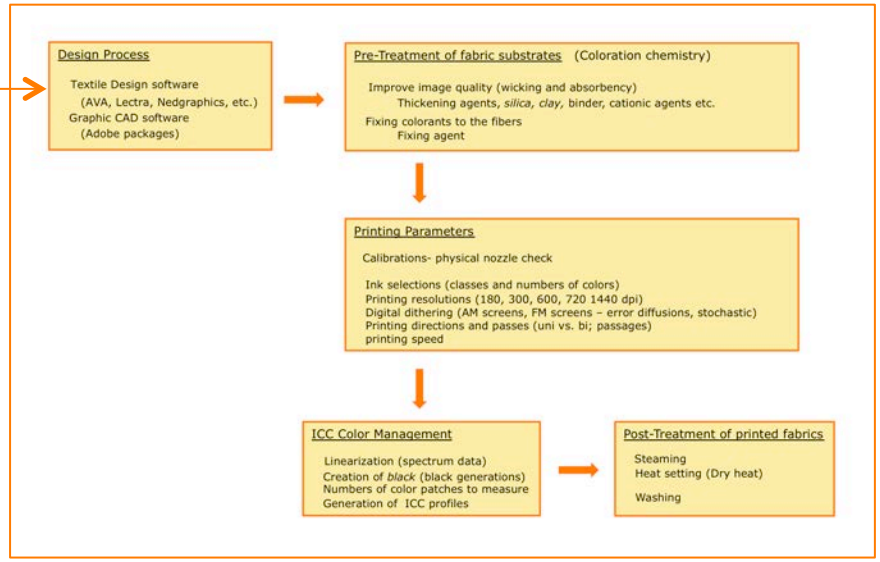
- Inkjet textile printing is the conglomerates of computer (digital) systems including hardware and software.
- From designing to productions, designers and practitioners can control the systems and processes as *metamedium*******, dynamic and creative medium with many outcomes and processes rather than programmable production machines.

HD Imaging*****

Higher printed image qualities that any conventional textile printing technologies. (Raster size: 500-170 vs. 50-35 micron)

New Imaging opportunities******

Photographic manipulation
Designs with millions of colors
Diminutive
Special digital effects with filters
Large single engineered images



****** Ujiie H, (2005), 'Innovative Product Development in Digital Fabric Printing', Presented at the Digital Textile 2005, Berlin, Germany
******* Kay A, (1984), 'Computer Software' , *Science American,* 25, 3, 52-59.
******** Ujiie H, (2006), Digital Printing of Textiles, Cambridge UK, Woodhead Publishing.
********* Ujiie H (2011), 'Computer technology from a textile designer's point of view', in Hu J, Computer Technology for Textiles and Apparel, Cambridge UK, Woodhead Publishing,

Processes

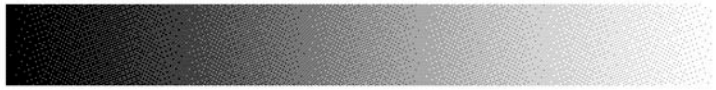
HD Imaging*****

Higher printed image qualities that any conventional textile printing technologies. (Raster size: 500-170 vs. 50-35 micron)

New Imaging opportunities******

Photographic manipulation
Designs with millions of colors
Diminutive
Special digital effects with filters
Large single engineered images

- Rasterizing for conventional printing:
  Consists of raster dots.
  50 to 150 dpi depending on types of printing technologies. (dot's size: 500-170 micron)



- Digital Printing
  256 grayscales - 540 to 720 lpi (printer's printing resolutions). (dot's size: far less than 50-35 micron)
  Tonal generations are true to the original images.
  HD Imaging

****** Ujiie H, (2005), 'Innovative Product Development in Digital Fabric Printing', Presented at the Digital Textile 2005, Berlin, Germany
******** Ujiie H, (2006), Digital Printing of Textiles, Cambridge UK, Woodhead Publishing.

Skills

Conventional hands-on craft

- Creative spontaneity and innovation
- Positive results by unexpectedness, irregularity, and human errors
- Workmanship of risk**

Digital Inkjet Printing

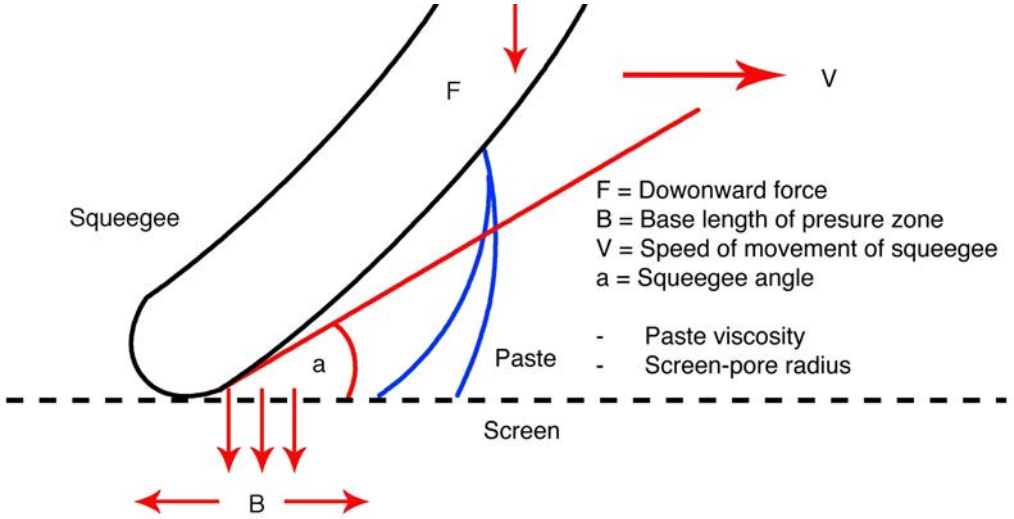
- Mechanical and uniform characteristics
- Superficial approach
- *Workmanship of certainty** ??*

** Pye, D. (1968) "The Nature and Art of Workmanship", Cambridge Press

Skills

- Rheology of Screen Printing -

Hydrodynamic Pressure



Skills

- Digital Inkjet Textile Printing-

Design Process

Textile Design software
(AVA, Lectra, Nedgraphics, etc.)
Graphic CAD software
(Adobe packages)

Pre-Treatment of fabric substrates (Coloration chemistry)

Improve image quality (wicking and absorbency)
Thickening agents, *silica, clay,* binder, cationic agents etc.
Fixing colorants to the fibers
Fixing agent

Digital Printing Parameters

Calibrations- physical nozzle check
Ink selections (classes and numbers of colors)
Drop formations (drop size, print engines, satellite, binary / dynamic drop)
Printing resolutions (180, 300, 600, 720 1440 dpi)
Digital dithering (AM screens, FM screens – error diffusions, stochastic)
Printing directions and passes (uni vs. bi; passages)
Printing speed

ICC Color Management

Linearization (spectrum data)
Creation of *black* (black generations)
Numbers of color patches to measure
Generation of ICC profiles

Post-Treatment of printed fabrics

Steaming
Heat setting (Dry heat)
Washing

Skills

- Digital Inkjet Textile Printing-

Design Process

Textile Design software
(AVA, Lectra, Nedgraphics, etc.)
Graphic CAD software
(Adobe packages)

Pre-Treatment of fabric substrates (Coloration chemistry)

Improve image quality (wicking and absorbency)
Thickening agents, *silica, clay,* binder, cationic agents etc.
Fixing colorants to the fibers
Fixing agent

Digital Printing Parameters

Calibrations- physical nozzle check
Ink selections (classes and numbers of colors)
Drop formations (drop size, print engines, satellite, binary / dynamic drop)
Printing resolutions (180, 300, 600, 720 1440 dpi)
Digital dithering (AM screens, FM screens – error diffusions, stochastic)
Printing directions and passes (uni vs. bi; passages)
Printing speed

ICC Color Management

Linearization (spectrum data)
Creation of *black* (black generations)
Numbers of color patches to measure
Generation of ICC profiles

Post-Treatment of printed fabrics

Steaming
Heat setting (Dry heat)
Washing

Skills / Knowledge

- Digital Printing Parameters-

- Calibrations- physical nozzle check
- Ink selections (classes and numbers of colors)
- Drop formations (drop size, print engines, satellite, binary / dynamic drop)
- Printing resolutions (180, 300, 600, 720, 1440 dpi)
- Digital dithering (AM screens, FM screens – error diffusions, stochastic)
- Printing directions and passes (uni vs. bi; passages)
- Printing speed

Skills / Knowledge

- Drop Formations-

- Drop Size
- Print Engine (noise)
- Satellite Drop
- Binary / Dynamic Drop

Skills / Knowledge

- Drop Sizes-

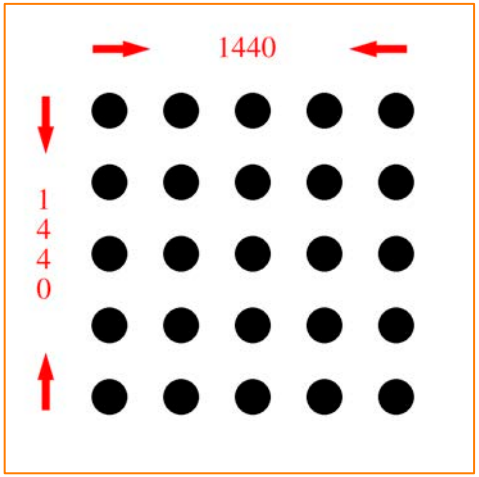
Smaller drops:	Capture fine details Reduce graininess Finer tonal curve
Larger drops:	Produce better solids Better penetrations

40 Pl

10 Pl

Skills / Knowledge

- Printing Resolutions -



300 dpi

600 dpi

Skills / Knowledge

- Print Engine (Noises)-

StyleWriter 6500 plain paper
StyleWriter 6500 plain paper
StyleWriter 6500 plain paper
StyleWriter 6500 plain paper
StyleWriter 6500 plain paper
StyleWriter 6500 plain paper

Epson 800 plain paper
Epson 800 plain paper
Epson 800 plain paper
Epson 800 plain paper
Epson 800 plain paper
Epson 800 plain paper

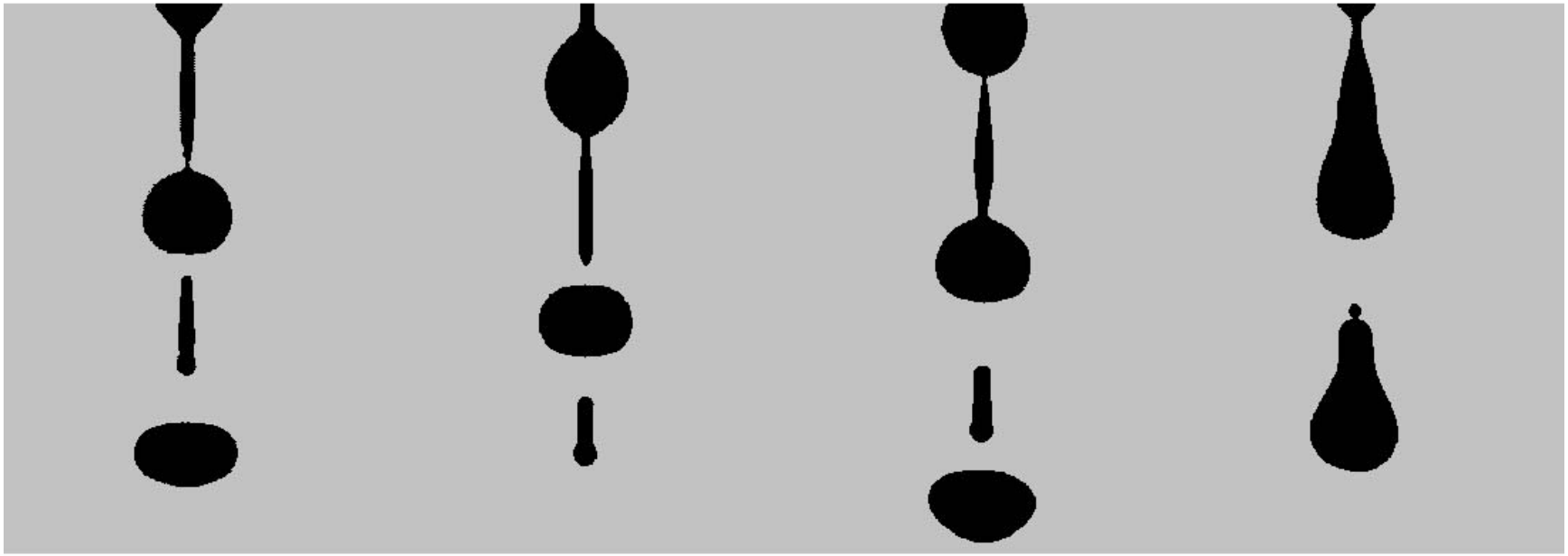
600 dpi

1440 dpi

Skills / Knowledge

- Satellite Drops-

Extra Droplets created by improper pinch off

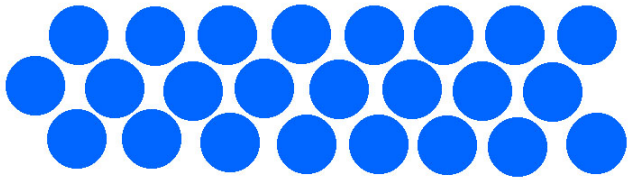


Slow Satellite	Infinite Satellite	Fast Satellite	No Satellite
(3V)	(20V)	(30V)	(60V)

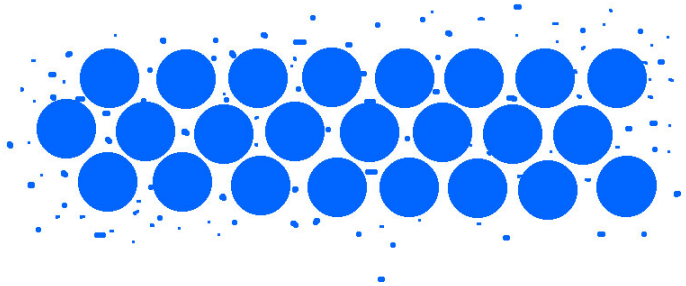
Skills / Knowledge

- Satellite Drops-

No Satellite Drop



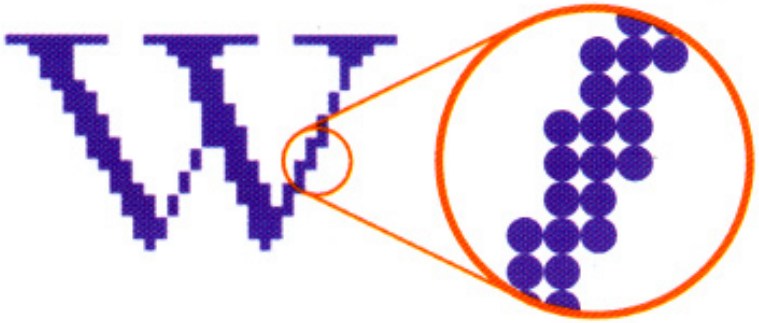
Satellite Drop



Skills / Knowledge

- Binary / Dynamic Drops-

Binary (Static) drops



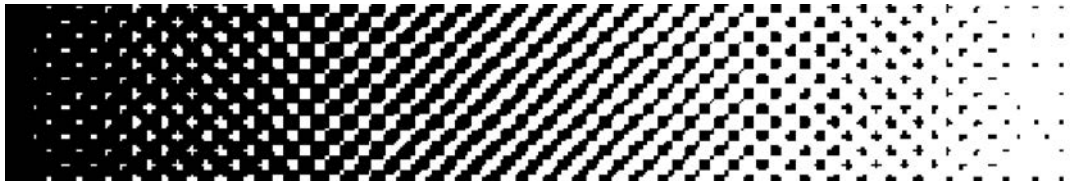
Dynamic (Variable) drops

Skills / Knowledge

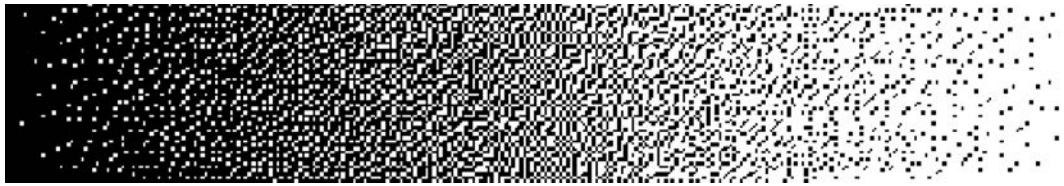
- Digital Dithering (Half tone Screening)-

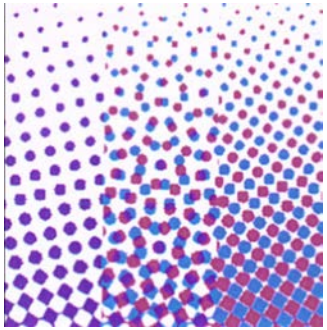
Grey tones

AM screen (Amplitude Modulated) – Fixed linear dot patterns

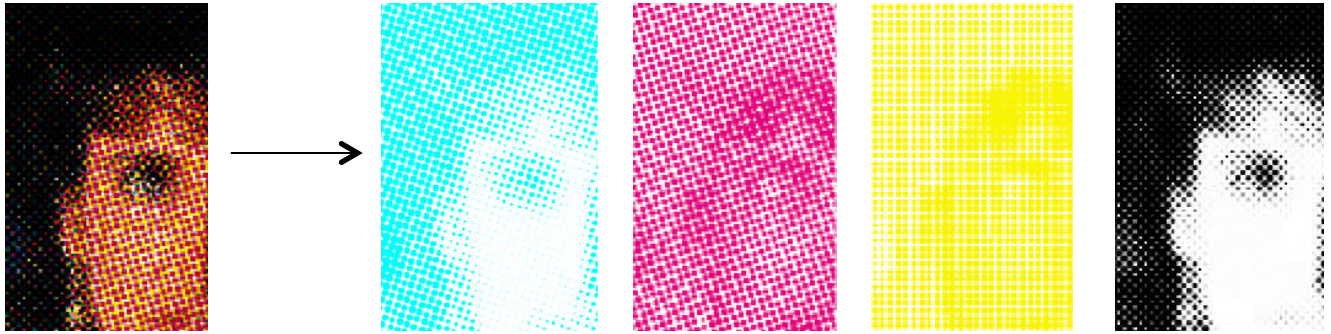


FM screen (Frequency Modulated) / Stochastic / Error Diffusion – High level computational algorithms





AM screen Separation



Skills / Knowledge

- Printing Directions, Passes and Layer-

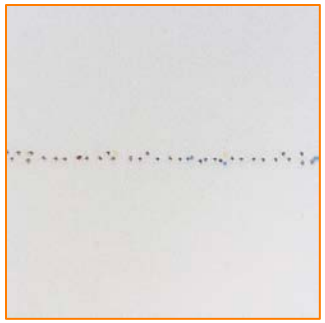
- Printing directions (print head movements)
  - Uni (one directional)
  - Bi (both traversed directional) directional printing
  - Sometimes this effects printing speed – dry time

- Printing passage (print pass)
  - Numbers of passage of complete one set of printing information

- Layer printing
  - Printing same multiple drops with the same printing information

Skills / Knowledge

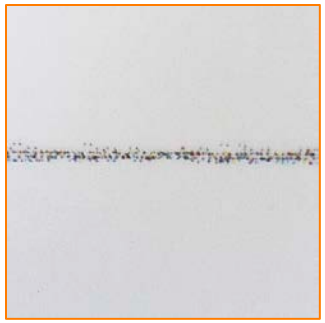
360 dpi / 1 pass / Uni / Variable



360 dpi / 1 pass / Uni / Variable

360 dpi / 1 pass / Uni / Variable

720 dpi / 8 pass / Uni / Variable



720 dpi / 8 pass / Uni / Variable

720 dpi / 8 pass / Uni / Variable

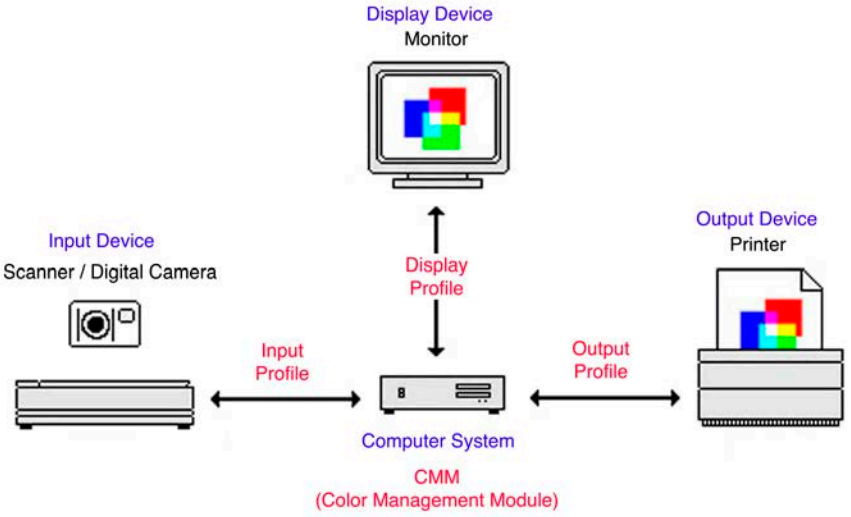
Skills / Knowledge

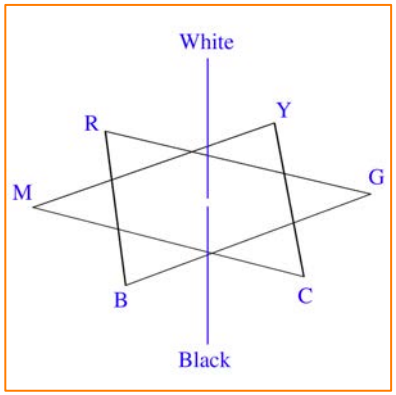
- ICC Color Management-

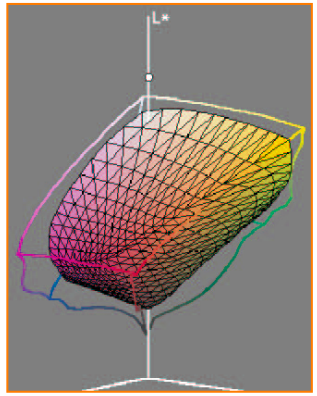
- Linearization (spectrum data)
- Creation of *black* (black generations) – Neutral Grey
- Numbers of color patches to measure - expansion of color gamut
- Determination of Hifi color for expansion of color gamut
- Generation of ICC profiles
- Rendering intents

Skills / Knowledge

- ICC Color Management-





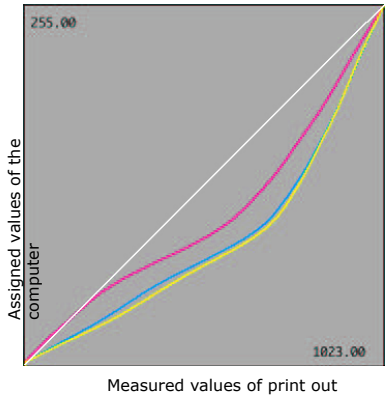


- Try to match the colors in different color spaces
- Expand color gamut as much as possible (especially with Hifi colors)
- cmyk + ORANGE, GREEN, BLUE, VIOLET, RED, etc.

Linearization / Density adjustments

First Print out of density adjustment chart of all device colors of CMYK

Print out of density adjustment chart after the software adjusted the density



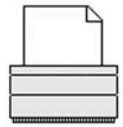
ICC Profile Creation

R	G	B	L	a	b
253	4	3	59	73	75
251	4	3	56	71	75
248	4	3	55	70	73
243	1	11	54	69	70
230	9	9	52	67	68
217	9	9	50	65	65
204	8	8	47	63	64

Source Profile

L	a	b	C	M	Y	K
54	69	70	0	89	100	0
52	67	68	0	90	100	0
50	65	65	7	91	100	1
47	63	64	13	91	100	2

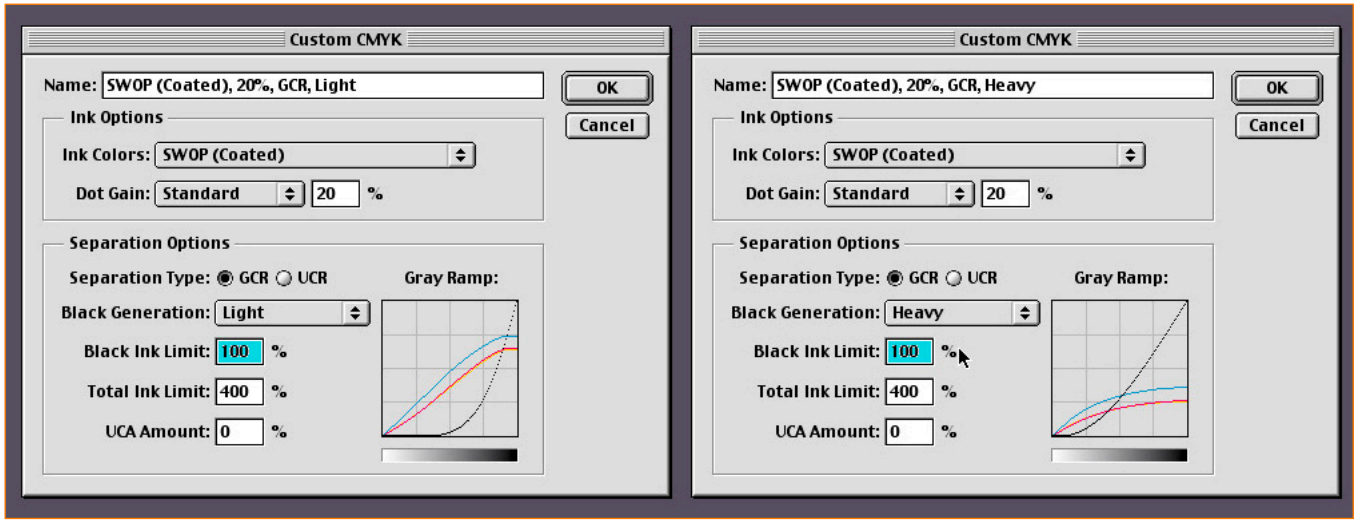
Destination Profile



Skills / Knowledge

- Black Generation-

- Tonal generations created by black is a key for the image quality.
- Blacks can be created by K=C+M+Y or Blac**K** (CMY**K)**
- Black Generation a mechanism to controls a use of "black".
- K=**C+M+Y** can not generate a ideal black color.



Blac**K** (CMY**K)**:	Better tonal generation obvious black dots in light color
K=**C+M+Y**:	Poor tonal generation not too obvious dots in light color

Use of "Grey" – dilution of Blac**K** (CMY**K**)

Skills / Knowledge

- Rendering Intent-

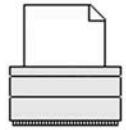
- A majority of the colors are out of gamut.
- Rendering Intent remaps out of gamut colors to in gamut colors.
- **Perceptual** Intent and **Color Metric** (Absolute / Relative) Intent

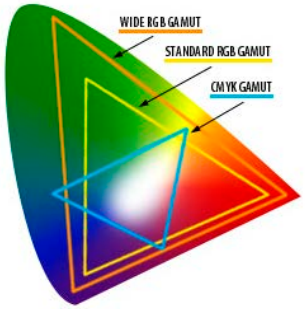
R	G	B	L	a	b
253	4	3	59	73	75
251	4	3	56	71	75
248	4	3	55	70	73
243	1	11	54	69	70
230	9	9	52	67	68
217	9	9	50	65	65
204	8	8	47	63	64

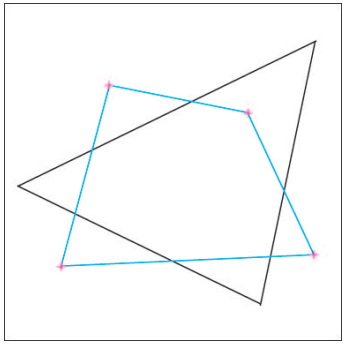
Source Profile

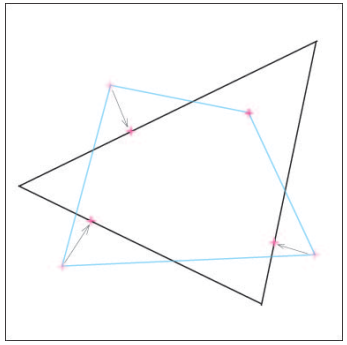
L	a	b	C	M	Y	K
54	69	70	0	89	100	0
52	67	68	0	90	100	0
50	65	65	7	91	100	1
47	63	64	13	91	100	2

Destination Profile



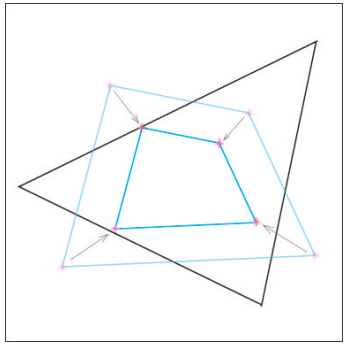






Color Metric Intent

- In gamut colors are untouched.
- Out of gamut colors remaps the closest in gamut colors.
- Good for spot color (conventional textile) design – 8 bit.



Perceptual Intent

- Proportionally shrinks the color gamut to fit it into in gamut.
- In gamut colors are also remapped.
- Keeps good tonal reproduction.
- Good for photographic images- 24 bit.

Skills / Knowledge

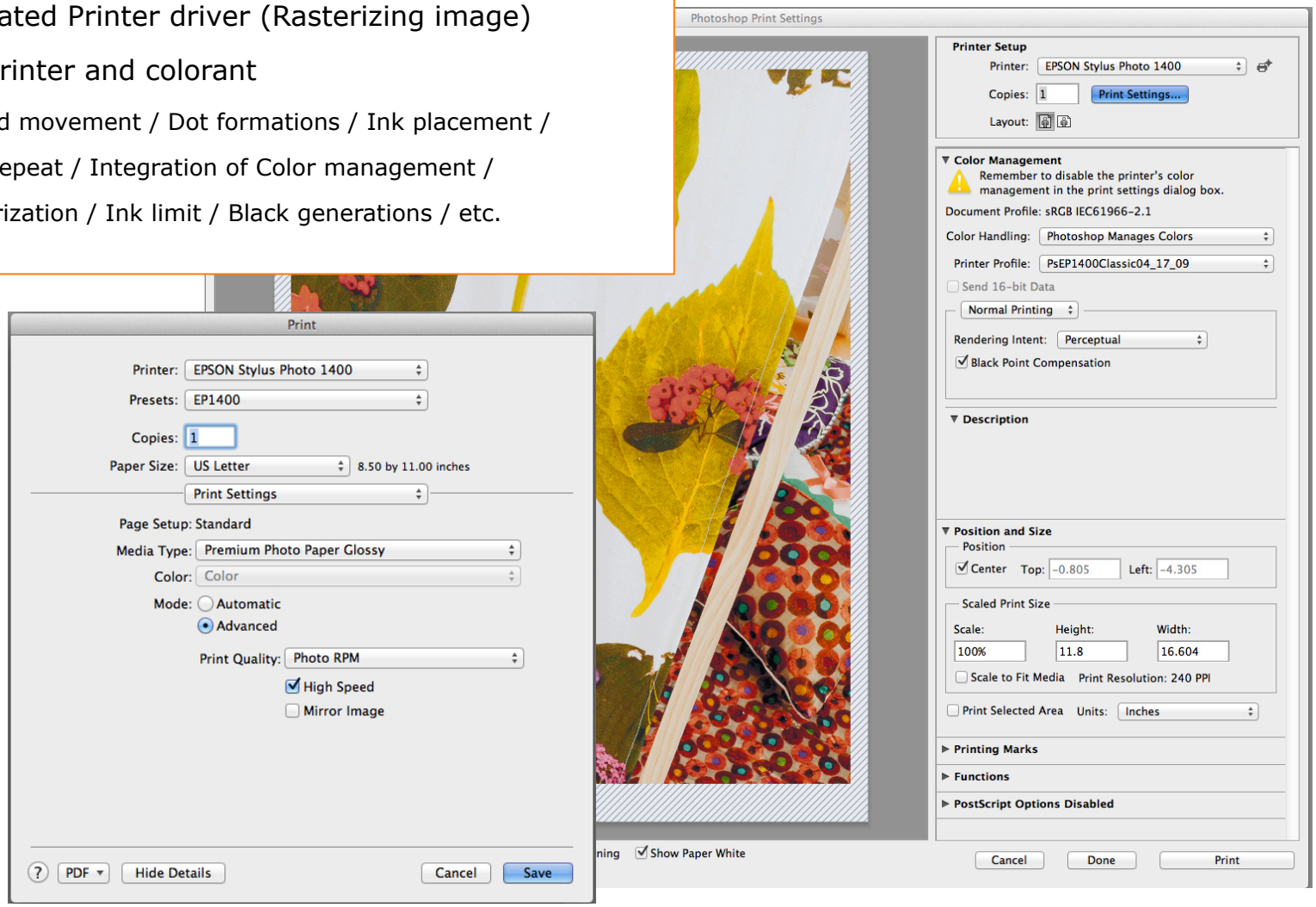
- RIP (Raster Image Processor)-

- Sophisticated Printer driver (Rasterizing image)
- Control printer and colorant

  Print head movement / Dot formations / Ink placement /

  Print in Repeat / Integration of Color management /

  Ink linearization / Ink limit / Black generations / etc.



Conclusions

- Digital inkjet printing can be a new form of craft and the concept of "*crafted control"* becomes critical.
- Definitions of hand v.s. machine made as well as physical and psychological *distance / involvements* in working processes in digital inkjet textile printing need to be considered.
- Inkjet textile printing is conglomerates of the technologies and processes, which include textile coloration chemistry and digital processes. Technological understanding and technical competency are crucial factors for proper evaluations of the printing systems.

References

Adamson G. (2007) "Thinking Through Craft", Berg Publishers.

Alfoldy S. (2007) "Neo Craft", NSCAD.

Benjamin W. (1934) "The Work of Art in the Age of Mechanical Reproduction".

Kay A, (1984), 'Computer Software' , *Science American,* 25, 3, 52-59.

Pye D. (1968) "The Nature and Art of Workmanship", Cambridge Press.

Ujiie H, (2005), "Innovative Product Development in Digital Fabric Printing" presented at the Digital Textile 2005, Berlin, Germany

Ujiie H, (2006), Digital Printing of Textiles, Cambridge UK, Woodhead Publishing.

Ujiie H (2011), 'Computer technology from a textile designer's point of view', in Hu J, Computer Technology for Textiles and Apparel, Cambridge UK, Woodhead Publishing.

Woolley M and Huddleston R (2011), "Maintaining the Human Touch – Exploring 'crafted control' within advanced textile production interface" presented at T.R.I.P. (textile research in progress) symposium at Loughborough University.


www.PhilaU.edu/TextileDesign
www.HitoshiUjiie.com
ujiieH@philaU.edu