



ICC Color Experts Day, Germany



Radovan Slavuj



How CP 7.0 came to be ?

- Today's young researchers are vital to Europe's future. At Marie Curie Actions, we are well aware of that. So we want to make research careers more attractive to young people (ITN – Marie Curie Actions)
- Initial Training Networks (ITN) offer early-stage researchers the opportunity to improve their research skills, join established research teams and enhance their career prospects
- Multi-partner ITN: Well, it takes two to tango but three to network. So, at least three participants join together to propose a coherent programme for an ITN. The participants can be universities, research centres or companies (large or small).

What is the CP7.0 ?

Colour Printing 7.0: Next Generation Multi-Channel Printing (CP7.0) is a training and research project funded by Marie Curie Initial Training Networks (ITN) CP7.0 N-290154 funding. The project is led by The Norwegian Color Research Laboratory at Gjøvik University College and will be executed in collaboration with 5 full network partners and 6 associated partners from academia and industry throughout Europe. The project addresses a significant need for research, training and innovation in the printing industry. Through this project we plan to do research in the colour printing field by fully exploring the possibilities of using more than the conventional four colorants (CMYK) in printing and focussing particularly on the spectral properties. The goal will be to train a new generation of printing scientists who will be able to assume science and technology leadership in this established technological sector.

Four key scientific areas this project will focus on are:

- Spectral modeling of the printer/paper/ink combination
- Spectral gamut prediction and gamut mapping
- The effect of paper optical and surface properties on the color reproduction of multi-channel devices
- Optimal halftoning algorithms and tonal reproduction characteristics of multi-channel printing.

- Aims to match reflectance from originals
- Metameric match under multiple , real world illuminants
- Modeling of paper - colorant interaction
- Modeling printer behavior in spectral terms
- Increased spectral and color accuracy (x2 in some applications)

Optical and Physical dot gain
Paper - Ink interaction and modeling

Forward model
YNSN



Observer's metamerism:
Deviate Observers CMF's

Test objects
Prints, artwork, textiles

Hyperspectral camera
RGB camera
Telespectroradiometer



Halftoning

Prints and measurements

CMYKRGB
CMYKRGB mk

Inverse model
Optimization

Reflectance

Gamut mapping (spectral, color)

Radiance, reflectance



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NOT ENOUGH
A lot of colors out of gamut?
Creation of new colorants



University of the
West of England

Application
in Fine Art



2.5 D Printing



Texture Simulation
and printing

Extracted primaries
PCA, NMF

Vector correlation

Available Printing Colorants Database

NO COMBINATION

Colorants creation,
ONE OR MORE



ESR 1 – Spectral Modeling for Multichannel Printers and Displays

Researcher: Radovan Slavuj

Position at: HIG, Norway

Supervisor: Jon Yngve Hardeberg

- Spectral Printer Modeling (*paper at IARIGAI, 2013*)
- Colorant Selection
- Multi-Primary Displays and Projectors
- Texture Simulation and Reproduction
- Textile Color Reproduction (*paper at AIC, 2013*)

ESR 2 - Spectral gamut prediction and mapping

Researcher: Sepideh Samadzadegan

Position at: TUD, Germany

Supervisor: Philipp Urban

- To improve and extend the paramer mismatch-based spectral gamut mapping method using multi-illuminant XYZ space to remove or minimize its drawbacks, for example the banding artifacts (*paper submitted for CIC,2103*)
- To investigate a spatio-spectral gamut mapping algorithm for the general enhancement of pixel wise approaches for image reproduction.

PHD 3 - Paper optics and surface properties

Researcher: G M Atiqur Rahaman

Position at: VV, Sweden

Supervisor: Ole Norberg

- The objective of this project is to model the spectral behavior of print media interactions i.e., modeling the interactions between light, paper and ink. (*paper at AIC, 2013*)
- The main aim is to develop methods for predicting the reflectance of color print to reproduce accurate colours in a spectral printing system using optical simulation tools like DORT2002 and Monte Carlo.

ESR 4 - Applications in Fine Arts

Researcher: Melissa Olen

Position at: UWE, Bristol, UK

Supervisor: Carinna Parraman

- Multi-channel inkjet printing methods that incorporate artist colour mixing principles relevant to traditional print processes through direct n-channel printing.
- How modifications to the print workflow can influence the reproducible colour gamut for artist prints through the development of bespoke inkjet printing methods (*paper at AIC, 2013*)

ESR 5 - Halftoning and tonal reproduction

Researcher: Paula Žitinski Elías

Position at: LiU, Sweden

Supervisor: Daniel Nyström

- Application of AM halftoning for multichannel printing – question of how to include more than four channels (e.g. elliptical dots) (*paper at AIC,2013*)
- Dependent iteration based FM halftoning – taking into account individual separations for dot placement

ESR 6 - Optimization of Print Quality

Researcher: Teun Baar

Position at: Océ, France

Supervisor: Maria V. Segovia Ortiz

- Optimization of Print Quality
- Measuring BRDF
- Application of the 2.5 D printing (*paper at AIC,2013*)

ESR 7 - Design and development of spectral color management workflows

Researcher: Srikrishna Nudurumati

Position at: HIG, Norway

Supervisor: Jon Yngve Hardeberg

- This research aims at addressing the color appearance matching in practical applications for observers whose CMFs vary from each other (inter-observer variability) and within a given observer (intra-observer variability).
- A Spectral Visualization and Management System would be developed to serve the purpose of handling various spectral transforms

ER 1: Spectral Image Quality

Researcher: Steven Le Moan

Position at: TUD, Germany

Supervisor: Philipp Urban

- How to compare two images with dozens of channels in terms of perception? To which extent can we apply traditional (color) image difference measures and pool the results over a variety of renderings corresponding to different viewing conditions?
(*paper at ICIP, 2013*)
- How much, and which aspects of the perceptual difference between two images remain unchanged from one set of VC to another (e.g. from daylight to incandescent light)?

ER 2: **Interaction of light with printed papers**

Researcher: Ludovic Gustafsson Coppel

Position at: HIG, Norway

Supervisor: Jon Yngve Hardeberg

- Implementation strategies for models developed in the CP7.0
- Simulation models that predicts the appearance of materials in different visual environments from the material structure and composition (*CVCS, Gjøvik, 2013*)

- Highly accurate industrial color communication
- Proofing
- Fine art
- Catalogues (Textiles , Paint)
- Security

Challenges vs

Opportunities

New set of inks needed for each application	Manufacturing of multiple ink sets that can be changeable within printer
Original material a lot different than printing substrate	Developing specific printing substrates, modeling surface properties (e.g. gloss)
Texture of the original material different from printing substrate	Simulation of the Texture, halftoning, 2.5 D
Illuminants at original's environment (Art Gallery)	Specific light sources used with reproduction
Controlling and interchange of individual channel in multichannel printing	Addition to functionality and diversity of the printers
Building spectral reproduction workflows	Extension of the ICC workflows, individual vendor workflows



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G M Atiqur Rahaman halftoning

Hardeberg IARIGAI ICIP Linköping

Ludovic Coppel Marius Pedersen

melissa olen norberg Océ optical

paper Paula Žitinski Elfas Peter

CP 7.0 Training Event 3, LiU Sweden



The third training event of the project was organised at the network partner Linköpings Universitet, Campus Norrköping, Sweden on May 27 – 31, 2013. The event was attended by all the ESRs as part of training program in the CP7.0 project.

This training event covered the fundamental knowledge about halftoning concepts and methodologies, as well as models predicting the spectral outcome of halftone prints. For more details click [here](#).

31. May 2013 by *Aditya Sole*

Categories: Training Events | Tags: cp7.0, G M Atiqur Rahaman, halftoning, Linköping, Ludovic Coppel, melissa olen, Paula Žitinski Elías, Radovan Slavuj, Sepideh Samadzadegan, Srikrishna Nudurumati, Teun Robert Baar, training | [Leave a comment](#)

Paper accepted at ICIP 2013

NEXT
GENERATION
MULTI-
CHANNEL
PRINTING

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CP 7.0 Training Event 3, LiU Sweden

Paper accepted at ICIP 2013

Ludovic Gustafsson Coppel joins GUC as a Post doc

CP7.0 Project member presentation at Océ Business Week

Paper accepted at IARIGAI 2013

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Thank you !!!



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