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QUALITY ASSURANCE WITH DIGITAL LEARNING EQUIPMENT FOR MOBILE SMART PHOTONIC DIMENSIONAL, COLOR and SPECTRAL MEASUREMENTS

B.Eng. Dieter Höfner, B.Eng. Paul-Gerald Dittrich,
Daniel Kraus, Prof. Dr. Dietrich Hofmann

SpectroNet c/o Technologie- und Innovationspark Jena GmbH

ABSTRACT & Introduction

Aim of the paper is a demonstration of the paradigm shift in education and training with digital equipment for mobile smart photonic dimensional, color and spectral measurements. Due to the major changes in computational devices by their transition from stationary desktop computers to consumerized mobile smartphones and smartpads - in short smartcomps - new possibilities in education and training for mobile smart photonic dimensional, color and spectral measurements are given. Manufacturers and system integrators of hardware apps and software apps for photonic image sensors and digital image processing software are trying to reduce the significant qualification deficits of potential users of modern equipment by special activities in education and training. Two efficient methods are promising:

1. Sensors & imaging specific multilingual digital text books (mbooks) and videos for end users on smartcomps,
2. Sensors & imaging specific hands-on trainings in industry and/or shared between universities and industry.

Index Terms **–** smart, mobile, learning, education, dimensional, color and spectral

1. Classification of the subject in the added value generation cycle

Fundamental aim of production processes is the generation of added value. The generation of added value is accomplished in added value generation cycles.
The practical application **PA** of products is key! (Figure 1).

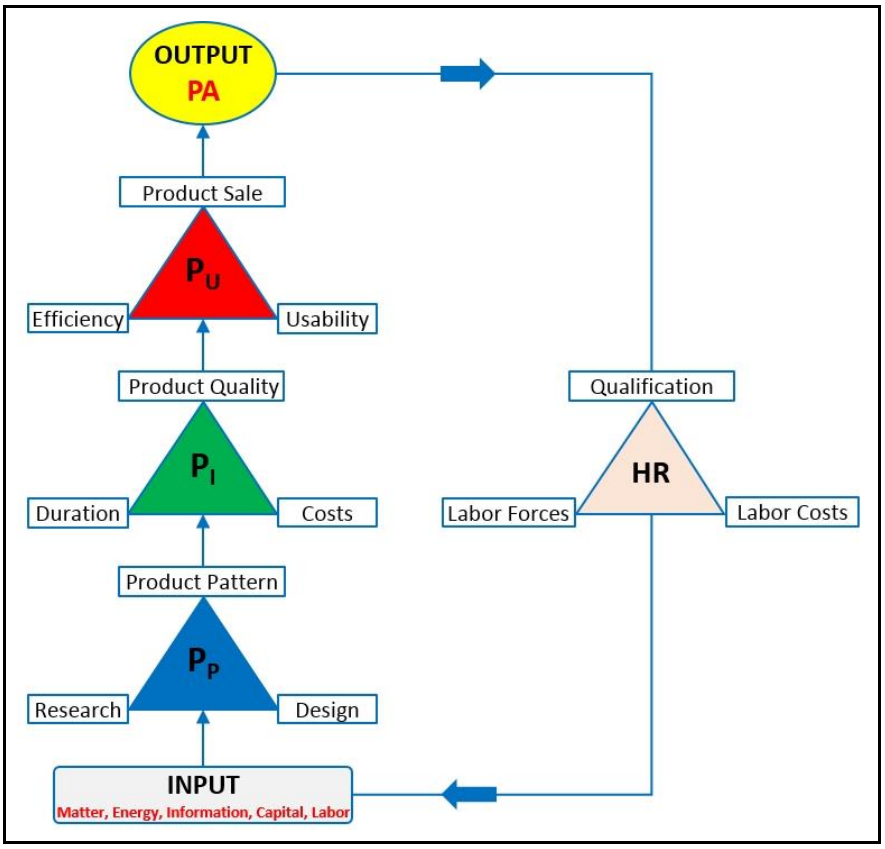


Figure 1: The 3+1 Triangle Rule of added value generation cycles [Hofmann 2014]
Notes: ***HR*** *Human Resources,* ***P_P*** *Product Preparation,*
P_I *Product Implementation,* ***P_U*** *Product Utilization,*
Efficiency *= Output/Mass {N.N./kg},* ***Products*** *= items and/or services [DIN EN ISO 9000],*
Qualification *= Education + Training + Experience,* ***Sale*** *= Promotion + Distribution,*
Usability *= Convenience + Reliability + Affordability,* ***PA*** *Practical Applications of Products*

The main topic of the paper is directly aligned with the qualification of human resources **HR** for successful measurement engineering and quality assurance with photonic dimensional, color and spectral sensors at their inputs as well as digital image processing for their outputs within the total added value generation cycle. For easier understanding of time dependent practical situations in different fields of interest some selected buzz words can be named (Figure 2)

Year	P_P	P_Q	P_A	HR	Computer
2000	Holistic Approach	Supply Chain Management	Internet Bubble	cb-training	Desktop
2005	Heuristic Approach	Lean Management	Web 2.0	b-learning	Laptop
2010	Software-as-a-Service	Enterprise Resource Management	Executable Internet	e-learning	Smartpad
2015	Big Data	Cluster Management	Internet of Things	m-learning	Smartwatch

Figure 2: Buzzwords in industry
Notes: ***cb*** *computer-based,* ***b*** *blended,* ***e*** *electronic,* ***m*** *mobile*

2. Mobile digital learning equipment for mobile smart photonic dimensional, color and spectral measurements

2.1 Mobile imaging specific mbooks and videos on smartcomps for end users

Highly recognized contributions to the current education and training in image processing are provided by AIA (visiononline.org), SPIE (spie.org), EMVA (emva.org), VDMA-Industrielle Bildverarbeitung (vdma.org), Fraunhofer-Allianz Vision (vision.fraunhofer.de) and AMA (ama-sensorik.de). The transition of analogue paper books, paper pictures and film videos to their digital versions on smartcomps is irreversible due to their convenience, reliability and affordability for an efficient and flexible individual use at work and at home. A convenient, reliable and affordable conversion of .pdf papers to ebooks is done for example by Yumpu (yumpu.com/de/browse/user/spectronet.de). Furthermore, clusterpartners of SpectroNet elaborated their own educational material (Figure 3).

analytikjena	AMA Verband für Sensorik + Messtechnik Innovatoren verbinden	Baumer Passion for Sensors	INSPECT	KONICA MINOLTA
analytik-jena.de/de/life-science/service-support/downloads.html	ama-weiterbildung.de	baumer.com/de-de/services/anwenderwissen	inspect-online.com/whitepaper	konicaminolta.eu/de/measuring-instruments/lernzentrum
Mahr	MAZeT ELECTRONIC ENGINEERING & MANUFACTURING SERVICES	Ocean Optics	OMRON	Pool-i.d.™
mahr.de/de/Know-how/Know-how	mazet.de/de/downloads/produkt-und-kundeninformationen/white-paper#.U1YQKfl_s00	spectroscopytv.com	ns.europe.omron.com	pool-id.com/html/index.php?option=com_content&view=article&id=84&Itemid=4&lang=de
pyramid building IT	STEMMER® IMAGING	VC Vision Components The Smart Camera People	ximea	ZEISS
polytouch.de/de/pr-media.html#section-bilder	stemmer-imaging.co.uk/en/handbook	vision-components.com/service-support/wissensdatenbankfaq	ximea.com/support/wiki/allprod/Knowledge_Base	zeiss-campus.magnet.fsu.edu

Figure 3: Imaging specific mbooks for mobile smart photonic dimensional, color and spectral measurements

To increase the efficiency of individual education and training processes, about 2000 digital applications and more than 1000 digital videos of mobile smart photonic dimensional, color and spectral measurements are open accessible on the cluster-platform www.spectronet.de (Figure 4).

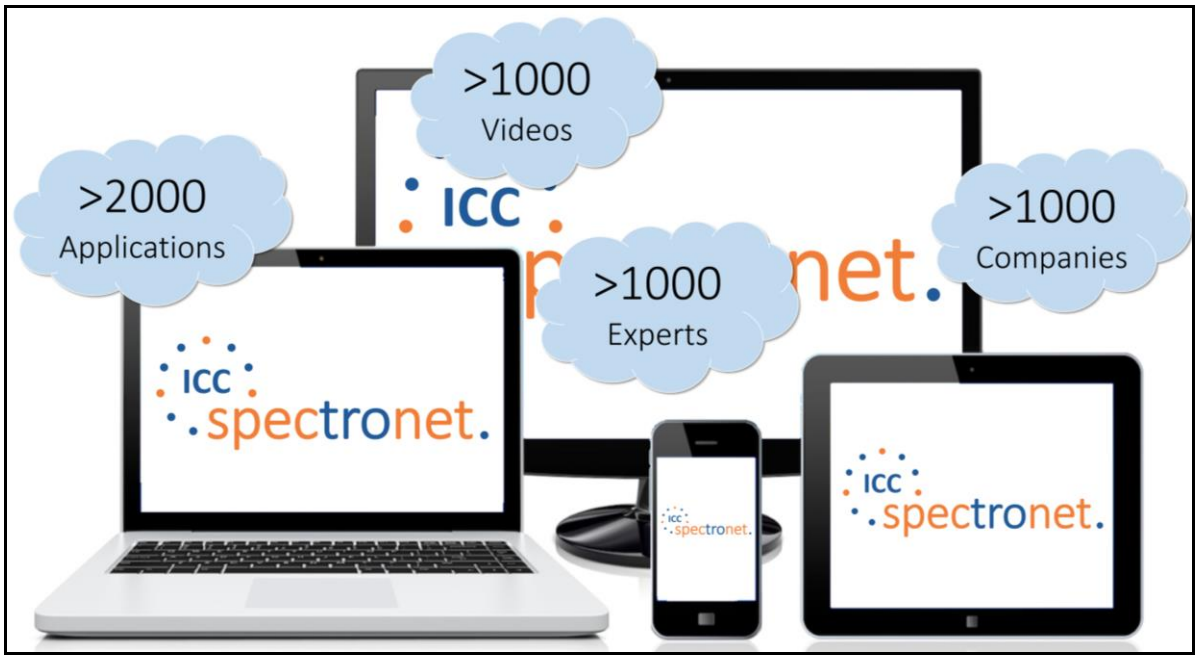


Figure 4: Digitized material with applications, videos, experts, institutions and enterprises dealing with developments in mobile smart photonic dimensional, color and spectral measurements on www.spectronet.de

2.2 Mobile imaging specific mbooks and videos on smartcomps for end users

The search function in www.spectronet.de enables the users to identify experts, institutions, enterprises and professional content, represented by professional keywords. Due to its longstanding existence and experiences the www.spectronet.de platform can be recommended for trend scanning and trend watching.

Selected practical examples for education & training are:

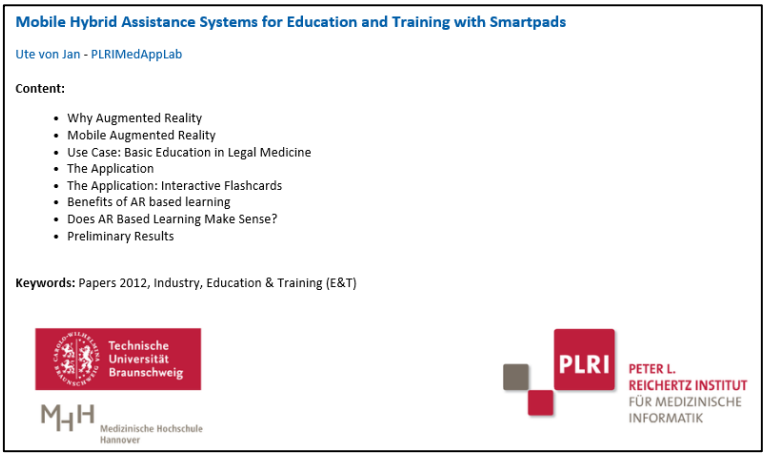
2014

Source: http://spectronet.de/de/videos_2014/video-basics-of-machine-vision-%E2%80%93-a-short-introduct_hspt6rwt.html?&highlight=1&keys=education+training&lang=1

2013

Source: http://spectronet.de/de/videos_2013/video-promotion-of-education-training-with-an-onli_hle56wg1.html?&highlight=1&keys=education+training&lang=1

2012

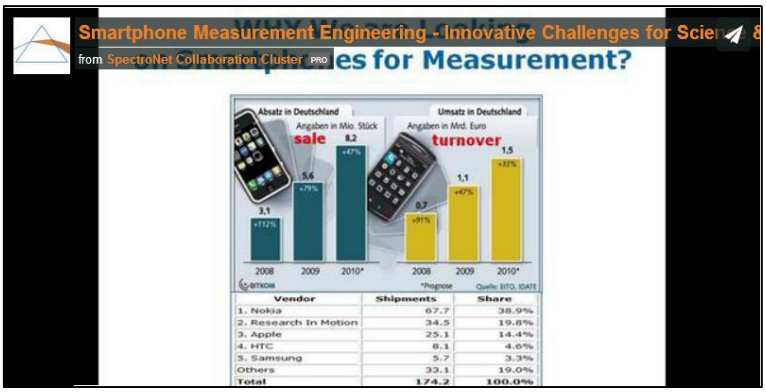


Source: http://spectronet.de/de/videos_2012/mobile-hybrid-assistance-systems-for-education-and_hazh8jkd.html?&highlight=1&keys=education+training&lang=1

2011

Source: http://spectronet.de/de/videos_2011/welcome-to-the-graduate-school-for-creating-new-ph_gzn38vo0.html?&highlight=1&keys=education+training&lang=1

2010



Source: http://spectronet.de/de/videos_2010/video--smartphone-measurement-engineering---innova_ge09nr07.html?&highlight=1&keys=education+training&lang=1

2.3 Imaging specific hands-on trainings either in industry and/or shared between industry and universities

To streamline the enormous qualification deficits in photonic sensorics and digital imaging as well as in qualified measurement engineering and quality assurance, several up-to-date manufacturers and system integrators increasingly are taking the qualification of their labor forces and customers in their own hands (Figure 5).

EUROPEAN IMAGING ACADEMY	Mahr	Ocean Optics	stw	ZEISS
				
stemmer-imaging.de/de/support/schulungen	spectronet.de/de/vortraege_bilder/vortraege_2010/vorlesung---optische-koordinatenmesstechnik_ginfkrex.html?s=w94cMjViwJ5u8bKIH	oceanoptics.com/Products/education_new.asp	spectronet.de/de/vortraege_bilder/vortraege_2014/steinbeis-spectronet-collaboration-forum-2014-ilme_htfjcn4k.html	www.zeiss.de/microscopy/de_de/service-support/microscopy-labs.html

Figure 5: Imaging specific hands-on trainings

For example since many years an efficient collaboration between the Ernst-Abbe-University of Applied Sciences Jena and the Mahr Company Jena is performed. The University of Applied Sciences Jena is increasingly defined by interdisciplinary collaboration [fh-jena.de]. The Mahr Group is the world's third largest manufacturer of a complete range in dimensional measuring products from calipers to optical coordinate measuring systems [mahr.com]. Aims of the imaging specific hands-on trainings of students at the Ernst-Abbe-University of Applied Sciences Jena together with Mahr Company Jena is an efficient sharing of resources. Typical examples are the application of current hardware apps and software apps for qualification purposes (Figure 6).

Figure 6: Training of students of Ernst-Abbe-University at Mahr Company Jena

Another example is the sharing of resources (man power, equipment and experiences) with the Steinbeis Transfer Centre for Quality Assurance and Image Processing Ilmenau (Figure 7).

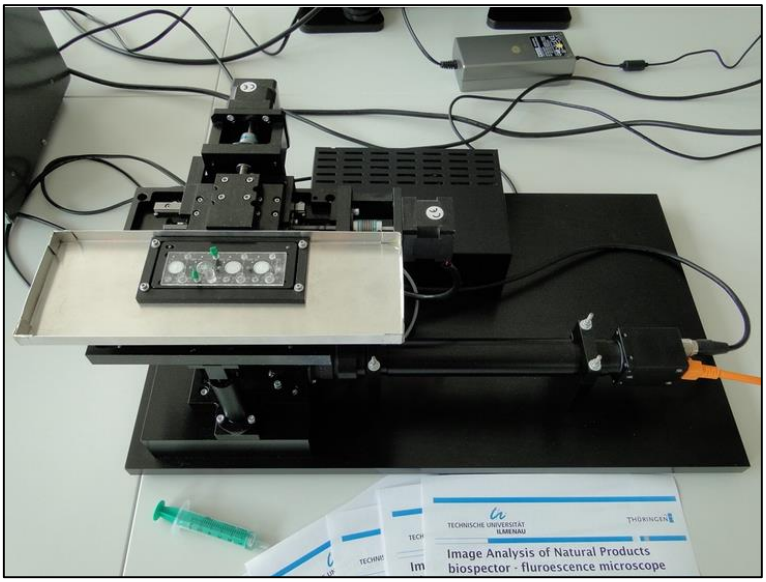


Figure 7: Image Analysis Biospector Fluorescence Microscope at Steinbeis Transfer Centre for Quality Assurance and Image Processing Ilmenau

2.4 Imaging specific communication and collaboration services

Mobile smart education and training also need new digital tools for communication and collaboration. A transition from bidirectional communication (phone) to multidirectional communication (smartpads) is increasing. Typical tools for efficient digital communication and collaboration are Skype and Teamviewer (Figure 8). An open platform for mobile communication and collaboration in the field of mobile smart photonic dimensional, color and spectral measurements is www.spectronet.de (Figure 8).

Online communication and collaboration tool	Online communication and collaboration tool	Online information communication and collaboration platform
		
skype.com	teamviewer.com	spectronet.de

Figure 8: Imaging specific information, communication and collaboration tools

3. Conclusions

Aim of the paper was the demonstration of the paradigm shift in education and training with digital equipment for mobile smart photonic dimensional, color and spectral measurements. The transition from stationary analogue methods to mobile digital methods is up to date. This situation is also valid for mobile smart photonic dimensional, color and spectral measurements. The added values for the users of spectronet.de are:

1. **convenient** open sources with about 2000 digital applications, about 1000 digital videos and about 1000 addresses of experts, institutions and enterprises dealing with photonic dimensional (shape), color and spectral measurement engineering and quality assurance

2. **reliable** trendscanner for the development of mobile smart photonic dimensional, color and spectral measurement methods and devices for the recent 10 years as an enabler also for sound predictions concerning future developments

3. **affordable** sources with open digital methods, .pdf-papers, mbooks, videos and experimental structures for learning anywhere at work and at home with efficient modules for mobile smart photonic dimensional, color and spectral measurement engineering and quality assurance, independent of the individual conditions concerning time and space and financial resources.
Please feel free to use the search box of www.spectronet.de to get support for your tasks and visions.

CONTACTS

Prof. Dr. Dietrich Hofmann d.hofmann@spectronet.de
B.Eng. Paul-Gerald Dittrich pg.dittrich@spectronet.de
B.Eng. Dieter Höfner d.hoefner@spectronet.de
Daniel Kraus d.kraus@spectronet.de