Digital Transformation of Education & Training for Mobile Photonic Sensors 4.0 & Digital Image Processing with Smartpads

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Abstract. *Aim of the paper is a demonstration of the paradigm change in education and training with mobile smart digital computers, photonic micro sensors (sensors 4.0) and software apps for mobile smart photonic shape, color, spectral and hyperspectral measurement engineering and quality assurance. Due to the irreversible transformations in computational devices by their transitions from stationary desktop computers to consumerized mobile smartphones and smartpads new possibilities in education and training in photonic shape, color, spectral and hyperspectral measurement engineering and quality assurance are given. Manufacturers and system integrators of hardware modules for photonic imaging sensors (hardware apps) and software packages for digital image processing (software apps) are trying to reduce the significant qualification deficits of potential users for modern equipment by special activities in education and training.*

Keywords: Education, Training, Mobile, Smart, Micro sensors

1. Role of Subjects in the Added Value Generation Cycle

Fundamental aim of production processes is **first** to meet the customer's needs and **second** to generate sustainable added values for the manufacturers. With other words:

- The practical applications **PA** of products and/or services are key!
- The generation of added values is **not** accomplished in value chains, but in added value **cycles** (Fig. 1).
- The positive feedback of users is essential for sustainable demands of products and/or services by the users.

Due to the fantastic new possibilities in processing of big data the role of knowledge in the reproduction processes is currently overestimated. The reproduction pyramid has much more levels than knowledge. The source of economical most valuable knowledge are applications (Fig. 2). Main topic of the paper is directly aligned with the qualification of human resources **HR** for successful applications in measurement engineering and quality assurance.
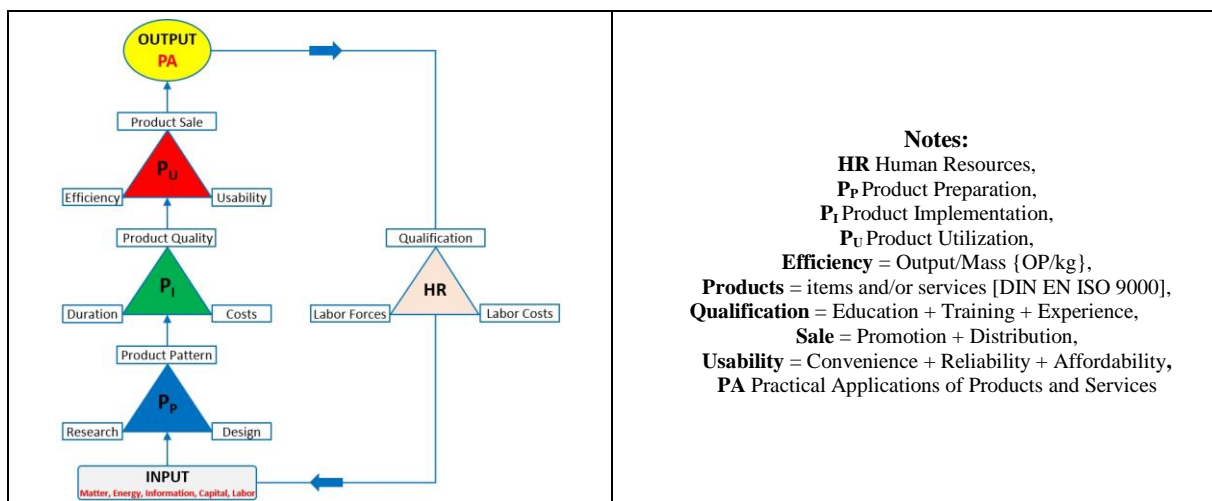

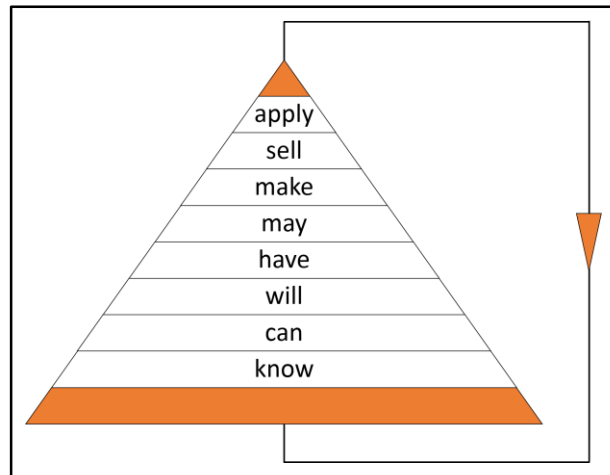Figure 1: The 3+1 Triangle rule of added value generation cycles [Hofmann 2014]

Figure 2: Reproduction pyramid and cycle

Enormous developments currently can be observed at mobile photonic shape, color, spectral and hyperspectral sensors as well as mobile digital image processing within the total added value generation cycle. For easier understanding of time dependent practical situations in different fields of interest some selected buzzwords can be mentioned (Fig. 3).

	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	Smartphone

Figure 3: Buzzwords in industry

Notes: **cb** computer-based, **b** blended, **e** electronic, **m** mobile

To increase the capabilities of operators for modern measuring equipment with software apps and smartpads the operating equipment can also be used for education and training. Some selected examples will be given in the next chapter.

2. Mobile Digital Learning Apps for Smart Photonic Shape, Color, Spectral and Hyperspectral Measurements

Mobile image processing specific paper apps and video apps on smartpads for end users

Highly recognized contributions to current education and training in image processing are provided by professional institutions (in alphabetical order) like AIA (visiononline.org), AMA (ama-sensorik.de), EMVA (emva.org), Fraunhofer-Allianz Vision (vision.fraunhofer.de), SpectroNet (spectronet.de), SPIE (spie.org), VDMA-Industrielle Bildverarbeitung (vdma.org) and by industry (Fig. 4).

Figure 4: Imaging specific ebooks for mobile smart photonic shape, color and spectral measurements

The transformations of analogue paper books, paper pictures and video tapes into their digital versions like ebooks and digital videos for smartpads are **irreversible**. The reasons are their convenience, reliability and affordability. They are efficient and flexible for individual use at work and at home. Clusterpartners of SpectroNet are elaborating valuable educational materials since years (see Fig. 4). A convenient, reliable and affordable conversion of .pdf papers into e-books is done for example by the digital publishing platform Yumpu (yumpu.com/de/browse/user/spectronet.de). To increase the efficiency of individual education and training processes, more than 2000 paper apps and more than 1000 digital videos apps for mobile smart photonic shape, color, spectral and hyperspectral measurements are **open** accessible at the cluster-platform www.spectronet.de (Fig. 5).

Figure 5: Educational material at www.spectronet.de

The digitized open platform contains paper apps, video apps, addresses of experts, institutions and enterprises dealing with mobile smart photonic shape, color, spectral and hyperspectral instrumentations, inspections, measurement engineering and quality assurance. The search and keyword functions in www.spectronet.de are enablers for end users to identify experts, institutions, enterprises and professional contents - convenient, reliable and affordable. Due to its longstanding existence and recognized expertise the www.spectronet.de platform can be recommended for trend scanning and trend watching also. Digitized paper books are **one side** of the educational coin only. The **other side** of the coin is the organization and realization of practical hands-on trainings.

Mobile image processing specific hands-on trainings either in industry and/or shared between industry and universities

Due to the miniaturization of the equipment the hands-on-training courses might be also organized as mobile courses. To cover a multilingual educational support for digital image processing a complete basic knowledge course – elaborated by STEMMER IMAGING GmbH (www.stemmer-imaging.de) is **online free** available in English and German languages:

- English: http://spectronet.de/de/vortraege_bilder/vortraege_2014/machine-vision-technology-forum-silverstone_hw69sjxz.html
- German: http://spectronet.de/de/vortraege_bilder/vortraege_2013/stemmer-imaging---technologieforum-bildverarbeitun_hoaj4wug.html

The multilingual knowledge courses cover planning, illumination, optics, cameras and so on. To keep alive personal contacts for mobile smart image processing specific communication and collaboration services new technological boundary conditions can be used - anytime, anywhere and on demand.

Image processing specific communication and collaboration services with smartphones and smartpads

The transition from stationary communication (phone) to mobile communication (smartphone) is increasing. Typical tools for efficient digital communication and collaboration are Skype and Teamviewer supplemented by content-delivering platforms. An open platform for mobile communication and collaboration in the field of mobile smart photonic shape, color, spectral and hyperspectral measurement engineering and quality assurance is www.spectronet.de.

3. Conclusions

Aim of the paper was the demonstration of the paradigm change in education and training with digital equipment for mobile smart photonic shape, color, spectral and hyperspectral measurement engineering and quality assurance. The transition from stationary analogue methods to mobile digital methods is up to date.

The added values for the users of www.spectronet.de are:

1. **convenient** open sources with more than 2000 digital paper apps, more than 1000 digital video apps and about 1000 addresses of experts, institutions and enterprises dealing with photonic shape, color, spectral and hyperspectral measurement engineering and quality assurance.

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

3. **affordable** sources with open digital .pdf-papers, ebooks, videos and experimental structures for learning - anytime, anywhere at work and at home with efficient modules for mobile smart photonic shape, color, spectral and hyperspectral measurement engineering and quality assurance, independent of the individual conditions concerning time and space and financial resources of the users and learners.

Please feel free to use the search box of www.spectronet.de to get support for your tasks and visions.

Acknowledgements

Recommendable Sources

[1] International Year of Light 2015. *Celebrating Light. 50 Ways Light-based Technologies Enrich Our World*. SPIE Press 2015.
[2] Trends 2015: *Sustainability, Miniaturization, Materials, Modularity, Economy.* PHOTONICS Spectra, January 2015
[3] 2015 Education Directory: *Global Directory of Programs in Optics and Photonics.* www.opticseducation.org