

## Main Focus

# Drawing with light – From chemicals to pixels

by Jack Holm,  
Convenor of  
ISO/TC 42/JWG 20,  
Joint ISO/TC 42-  
IEC WG: Digital still  
cameras

**P**hotography is core to our life experience. Photographs enable us to communicate and preserve aspects of life, as a complement to language. Digital photography is fundamentally different from chemical photography. Capabilities are varied, user expectations are consequently evolving, and the core metrics and techniques that served photography for over a century no longer always apply.

Today, few have the time to devote to the leisurely exploration of a hobby, and prefer the convenience of digital photography. On the commercial side, digital offers many opportunities, but business models can be difficult to develop and time spent dealing with countless variables can increase overhead and customer confusion.

In the early 1990s, ISO/TC 42, *Photography*, recognized both the possibilities and the challenges of the impending transition of photography to digital, and initiated work in several areas: vocabulary, speed and resolution metrics, and removable media. These efforts recognized that while photography would likely remain core to the modern human experience, the technology on which it is based was about to undergo a radical transformation.

### “What’s in a word...”

Whenever a new technology area emerges, one obstacle to progress is inconsistent terminology. Different terms may have the same meaning, or the same term may be used with different meanings, resulting in communication breakdowns. Building consensus



**“ISO 12234-1 has been almost universally adopted by the digital camera industry, enabling the broad interoperability users experience today.”**

is nearly impossible when, unknown to each other, the parties involved are talking about different things. Communicating the value of new features to potential customers can also be difficult when there is no way to describe the feature in understandable terms.

While an ISO vocabulary standard is unlikely to reach the mass market, it can enable reliable communication within the industry, which will in turn lead to more consistent product behaviour and interfaces.

To address this need, ISO 12231:2005, *Photography – Electronic still picture imaging – Vocabulary*, contains over 200 digital photography terms and definitions, explaining, for example, the differences between “aliasing” and “aspect ratios”, “colour spaces” and “colour encodings”.

### Universally adopted

One of the original concerns with digital photography was the likelihood that, without some form of standardization, different digital cameras would write different file formats that would then be unreadable by other cameras and devices such as computers and printers, at least without special software.

ISO 12234-1:2007, *Electronic still-picture imaging – Removable memory – Part 1: Basic removable-memory model*, specifies the media format, directory structure and file formats (JPEG/EXIF and TIFF) to be used on digital camera removable media, along with an extensive list of camera characterization and image annotation metadata. This standard has been almost universally adopted by the digital camera industry, enabling the broad interoperability that users experience today. Moving forward, work is in progress on a revision of a second part, ISO 12234-2:2001, Part 2: *TIFF/EP image data format*, intended to bring increased capabilities, interoperability and longevity to camera raw formats (unprocessed image data).

Another key standard, ISO 15740:2008, *Photography – Electronic still picture imaging – Picture transfer protocol (PTP) for digital still photography devices*, made it possible to connect cameras directly to printers for “computer free” digital photography. This was considered essential for broad consumer use.

## A taste of colour

Colour is one of the most complex and difficult aspects in both chemical and digital photography, and this fact is somewhat counterintuitive. The human visual system does such an excellent job of perceiving colour that most people think of colour as a physical characteristic of objects like weight, rather than a perception more akin to taste. It is important to remember that our ability to perceive colours reliably is possible because a major part of our brain is devoted to this task.

On the positive side, digital colour reproduction is very flexible. For example, photographic films are designed for

specific illumination conditions while digital cameras can be white balanced to perform correctly under a wide variety of illumination. In the case of camera raw (unprocessed image), white balancing can even be performed after the picture has been taken.

In chemical photography, the complex handling of colour is incorporated into the film. In digital imaging, the need for appropriate colour management is sometimes neglected, resulting in unsatisfactory results. Colour standards are essential in addressing this problem, and are developed in several forums. ISO/TC 42 takes the lead on digital photography specific standards, and collaborates on more general efforts.

Colour standards developed by ISO/TC 42 include:

- **ISO 17321-1:2006**, *Graphic technology and photography – Colour characterisation of digital still cameras (DSCs) – Part 1: Stimuli, metrology and test procedures*
- **ISO 22028-1:2004**, *Photography and graphic technology – Extended colour encodings for digital image storage, manipulation and interchange – Part 1: Architecture and requirements*
- **ISO/TS 22028-2:2006**, *Photography and graphic technology – Extended colour encodings for digital image storage, manipulation and interchange – Part 2: Reference output medium metric RGB colour image encoding (ROMM RGB)*
- **ISO/TS 22028-3:2006**, *Photography and graphic technology – Extended colour encodings for digital image storage, manipulation and interchange – Part 3: Reference input medium metric RGB colour image encoding (RIMM RGB)*.

The RIMM and ROMM RGB encoding standards are widely used in high-end photographic applications.

Colour encoding standards are particularly important in digital imaging because otherwise there is no defined relationship between the numbers in a digital file and the colours a viewer is expected to see in an image.

## Digital speed

An example of a case where the move to digital has required some fundamental rethinking is the development of ISO 12232:2006, *Photography – Digital still cameras – Determination of exposure index, “ISO speed ratings”, standard output sensitivity, and recommended exposure index*.

The purpose of the “ISO speed rating”<sup>1)</sup> is to specify the amount of exposure required to produce the best quality images. With film capture, this is relatively straightforward – if the exposure is incorrect the image formed on the film will be either too dark or too light. Years of experience with this paradigm have led to a strong correlation in users’ minds between exposure and darkness/lightness.

With digital photography, this correlation no longer applies, because it is a simple matter to adjust the darkness or lightness digitally. Some cameras do this automatically, and in camera raw processing applications, the user can make adjustments after the picture is taken. The film exposure mindset is actually a hindrance to the best use of digital capture.

**“The picture transfer protocol (PTP) made it possible to connect cameras directly to printers for ‘computer free’ digital photography.”**

This raises the question of how to determine “ISO speed ratings” for digital cameras. The fundamental answer comes from looking at the quality degradations that occur as the exposure is changed – too much exposure results in clipping, too little exposure results in noise, and a range of exposures may produce acceptable results.

Consequently, ISO 12232 specifies the “ISO speed rating” which corresponds to the minimum exposure that will produce the best quality, avoiding

1) “ISO speed rating” refers to speed rating in accordance with ISO standards.

## About the author



**Jack Holm** is the President and Chief Technical Officer of Tarkus Imaging, a San Jose, California, USA, startup engaged in digital photography technology

development and licensing, consulting, and test and measurement. He is Convenor of ISO/TC 42/WG 20, *Joint ISO/TC 42-IEC WG: Digital still cameras*, ISO/TC 42/WG 23, *Joint ISO/TC 42-ISO/TC 130-CIE WG: Extended colour encodings for digital image storage, manipulation and interchange*, and ISO/TC 42/WG 24, *Joint ISO/TC 42-ISO/TC 130 WG: Revision of ISO 3664:2000*. He is also Secretary of IEC/TC 100/TA 2, *Colour measurement and management*. Formerly, Mr. Holm was a Principal Scientist in the Office of Strategy and Technology at Hewlett Packard, and a Professor at the Rochester Institute of Technology, USA.

## *Main Focus*

---

excessive clipping and noise, as well as an “ISO speed latitude”, specifying the range of exposures that can be expected to produce acceptable results.

In the case of ISO 12232, the industry has yet to fully adopt the standard, due to concerns about user expectations for film-like behaviour. Hopefully the increasing popularity of camera raw will gradually result in re-education and a new paradigm. If this happens, the standard will have been partly responsible for opening up the new possibilities.

### **Addressing industry needs**

ISO/TC 42 has also developed a number of other metrics standards, such as ISO 12233:2000 for digital camera resolution measurements, ISO 14524:2009 for opto-electronic conversion function measurements, ISO 15739:2003 for digital camera noise and dynamic range measurements, and ISO 16067-1:2003, ISO 16067-2:2004 and ISO 21550:2004 for scanner OECF, resolution, noise and dynamic range measurements. The ISO 20462 series specifies methods for the subjective evaluation of image quality (Psychophysical experimental methods for estimating image quality).

In addition, ISO/TC 42 maintains a large body of chemical photography standards and continues to develop standards for image permanence, from chemical photography media to inkjet prints to digital discs.

### **Moving forward**

ISO/TC 42 will continue to support the photography industry and its customers, providing standards to meet immediate needs as well as forward-looking standards to help the world capture the human experience with new technologies. ■