RUcore
Rutgers Community Repository

# Born Digital Still Images (Digital Photos):
## Recommended Minimum Standards For Archival and Presentation Datastreams

(Note: This document addresses standards for born-digital still images only. For standards and requirements pertaining to digitization, i.e. the scanning of paper, slides or other analog media into digital images, please refer to the RUcore Digital Surrogate Guidelines.)

**Introduction and Rationale**

Since the inception of RUcore, a significant shift in the field of photography has taken place, as amateurs and professionals alike have migrated *en masse* from analog film to digital formats. Since the first repository specifications for digital photography were drafted in 2006, we've seen digital photography overtake and dominate the field, largely overtaking film as a common medium for the capture of still images.

Of course, new objects will continue to be created using traditional film, and there is no foreseeable end to the creation of objects that originate on paper, film, or other analog recording format, even if those formats are relegated only to niche interest groups. To that end, the repository has established and refined a set of clear and concise standards that serve to acquire and preserve digital facsimiles of analog photographs, books and similar items.

Even so, digital photography brings with it new challenges and different capabilities than our existing core set of scanning digitization standards can support. As a result, an entirely separate set of standards dealing exclusively with digital photography and separate from those that support scanning must be defined and adhered to.

**Emerging shifts to digital photography**

While we have long heard that film's days are numbered, few have truly believed it until very recently. Digital photography has taken more than 12 years to mature, since the introduction of the first mass produced digital camera (the Apple Quicktake) in 1994. For a majority of this period, the switch from film to digital was largely relegated to early adopters, and broadly shunned by professionals who insisted film was here to stay. Within the last decade however, the quality of the hardware available as well as the introduction of professional grade software tools has not only swayed general opinion of digital photography, but has permitted digital photography to become a driving factor in the fate of most corporations in the field. Additionally, a number of very recent events has permanently and irrevocably spelled out that film's days as a dominant medium are numbered:

- **October 12, 2001**: Polaroid, Inc. files for bankruptcy. This is often seen as the watershed event for the decline of analog formats. Development of instant film formats stops, and while the popular Land Camera and a few other versions of Polaroid film survive, a wide array of other formats were discontinued.
  (Since 2001, Polaroid has been resurrected, filed for bankruptcy yet again, and the instant film formats discontinued. At present, private enthusiasts have attempted to revive Polaroid instant film through independent efforts.)

- **2001 – 2006**: Kodak has progressively discontinued a number of film formats, though it has stated it will aggressively pursue the continued manufacture of conventional 35mm and APS film. Additionally, Kodak announced in 2004 that while it "is, and will remain, committed to manufacturing and marketing the world's highest quality film," it is ending production of film cameras.

- **January 7, 2003**: Konica and Minolta, once both strong names in the film and film camera businesses respectively, announce they will merge to form a single company. This is largely viewed as the result of dwindling revenues from analog format sales, as both companies seek to share their digital technologies to strengthen their position in this market.

- **December 2005**: Kodak announces that for the first time, revenue from digital cameras and digital storage media has exceeded revenue from film-based sales.

- **January 11, 2006:** Nikon announces that is has discontinued all but two 35-mm Single Lens Reflex (SLR) cameras: The F6 and the FM10. It also announced it will discontinue the manufacture of all large format analog lenses, and all but nine interchangeable lenses to support the F6 and FM10. In addition, Nikon's photography division announces it will focus almost exclusively on the development of its digital product lines.

  As of 2010, the Nikon F6 and FM-10 continue to be manufactured, although the FM-10 is made by Cosina, and rebadged as a Nikon.

- **January 19, 2006:** Konica Minolta announces it will exit the photography business altogether, discontinuing both analog and digital film camera lines. It will sell its technology to Sony, which has indicated it will continue to support existing Konica Minolta digital camera lines, and develop new lenses compatible with the K-M lens mount.

- **July 22, 2009**: Kodak announces that it has manufactured its final batch of Kodachrome film after 74 years of production. Kodachrome was well known for its longevity and color stability. The last stocks of Kodachrome film have an expiration date of December, 2010.

- **January 2010**: Canon exits the analog film camera business by quietly discontinuing the manufacture of the EOS 1v. While remaining stocks of new EOS 1v cameras can still be purchased at retail stores, and while most lenses Canon makes for its digital cameras will still work on the film EOS line, all of the cameras Canon currently makes are digital-only.

- As of this year, digital images are estimated to account for 90 percent of all professionally taken photos according to market research firm InfoTrends.

At the same time that film-based companies are seeing the need to adapt or perish in the digital realm, digital cameras have improved dramatically in image quality. While there was once a time where the idea of using digital photographs to preserve images and keep permanent records was laughable, manufacturers are now producing affordable digital cameras – some aimed at entry-level users - that can meet or exceed the image quality produced by some 35mm film types.

These events point to one conclusion: analog film will continue to serve a greatly reduced role in the field of both amateur and professional photography as time progresses. While it is unrealistic to say that film will altogether become extinct, the prevalence of the common traditional formats (35mm, 110) are on the decline. It is very likely that film will be relegated to a limited range of formats for special-purposes applications and niche audiences, while more common general-use and utility-based photography will overwhelmingly shift to digital.

***The need for baseline standards***

The shift to digital photography has not been easy, and has been fraught with many painful lessons on what constitutes acceptable image quality. Indeed, early digital camera models produced

images that were barely acceptable even for computer equipment of the time, much less for print media. Nonetheless, attempts were made by early adopters to use the technology for permanent preservation, and the results are that the digital images produced are unacceptable for viewing.

Indeed, for our purposes, digital cameras are only now being produced that can match the exacting standards that RUcore has laid out for acceptable, preservation-grade images. As the quality has improved, so has the acceptance and adoption of this hardware for general use photography. This is an important turning point for RUcore, as although our repository has a number of professional grade images in our collections, the majority of the photographs we have preserved thus far are often donated family photographs, amateur stills, and images that were generally produced using consumer equipment. As a result, we can expect that in the not-too-distant future, we may be expected to preserve amateur as well as professional digital images that are deemed to capture images and moments that are preservation-worthy.

In preparation for this, it is essential that RUcore adhere to a standard for which we will accept born digital images for inclusion in the repository.

### *Why have a separate standard from those for scanning photographs and documents?*

At first glance, it might seem very easy to take the established standards for photograph and document digitization, and simply apply them as-is to digital photography. Indeed, the two processes share some similarities, and some of the requirements established for digitization should serve as the basis for establishing comparative standards for born digital still images. However, there are a few key differences between digital photography and analog digitization that make a broad application of a single standard impractical. Consequently, the two workflows need to be viewed from different paradigms to fully understand them and appreciate their differences.

### *Perspective is everything: digitization terms redefined*

The best way to understand the differences between digital photography and digitization workflows is to view their intended purposes.

**Digitization,** or simply scanning, is intended to take an object recorded on an analog medium such as film, slides or paper. From this, we use an array of equipment and software to create a digital facsimile, with the intent of making the digital form represent the source object as accurately as possible. Consequently, the workflow, specifications and terminology are centered around this process.

**Digital Photography** on the other hand, is a process where the digital form *is* the primary, original storage medium. With digital photography, there is no physical medium that can accurately be described as the "original." In order for the digital format to take the primary role in recording and preservation, the hardware must be designed differently, and procedures and terminology have to take significantly different characteristics from digitization.

These differences in purpose and perspective result in important variations in how images are acquired and described:

**Resolution: PPI vs. Megapixels:** The most important difference between digitization and digital photography is the issue of resolution. Those familiar with digitization have grown accustomed to expressing resolution in terms of pixels per inch (ppi). This is because for digitization purposes, resolution is a function that expresses how accurately a scan will replicate the original. the higher the ppi, it is presumed, the higher the quality of the resulting digital image will be.

Digital photography, however, limits the relevance of ppi in terms of creating the original photograph. As image sensor sizes can vary greatly from one camera to the next, it is possible for two different camera models to arbitrarily assign widely different ppi values to their images, yet still produce

digital images that are of comparable overall quality. In such a case, ppi only comes into play when a user wishes to print the digital image, in which case this value can be changed at will to suit the user's needs. As a result, the value of importance in digital photography is not how many pixels per inch make up an image, but the overall **pixel count**, or number of total pixels, that are used to represent the image. With current technology, this value is frequently expressed in Megapixels (MP).

**Unaltered Originals:** RUcore places the utmost importance on the ability to have an archival digital master, that is unaltered or unedited in any way. This requirement ensures that we can refer to this original at any time, should any edits or calibrations we perform on our derivate presentation versions of an object become unsuitable for display as technology changes. Producing such images are relatively easy when digitizing analog formats. The matter becomes trickier, however, when dealing with digital camera equipment.

## Born Digital File Formats: JPG, RAW Image file formats and the unique challenges they present

To be sure, no single digital camera architecture will suit every photography application and so, camera vendors design and construct a vast assortment of digital cameras that vary in size, resolution and capability. A major challenge for dealing with digital photography is the diversity of equipment that is out in the field, and the resulting file formats that they generate.

**Entry-Level Consumer Digital Cameras** pose the greatest issue because they typically output files using the JPEG file format, with very lossy compression. To their credit, such cameras permit beginners and casual users to capture important and even historic moments with a minimum of effort and skill, and a great deal of archived content would not exist without casual photographers using such equipment, where more advanced and skilled photographers are simply not present. However, their ease also presents a disadvantage: entry-level cameras heavily process the images the capture, and the resulting image files are suboptimal for archival purposes without, at the very least, a file format change to an uncompressed TIFF format.

**"Pro-sumer" and Professional Cameras** typically provide the option to process and compress captured images into JPEG files similar to the consumer counterparts, but also tend to provide an option to yield *camera raw image files*. A camera raw image file contains minimally processed data as retrieved directly from the image sensor of the digital camera. Raw files are so named because they are not yet processed and therefore are not ready to be printed or edited with a bitmap graphics editor. Normally, the image is processed by conversion, where precise adjustments can be made before creating a "positive" file format such as an uncompressed TIFF or JPG file. Similar to a film negative, a raw digital image may have a wider dynamic range or contain more color information than can be provided using currently used file formats for presentation and access (TIFF, JPG, etc.), and preserves most of the information of the captured image. The purpose for a raw file is to achieve minimal loss of image data obtained from the sensor, and the conditions surrounding the capturing of the image (the technical metadata). In the field of photography, there is a pervasive, erroneous belief that RAW represents a single file format. In fact there are hundreds of raw image formats in use by different models of digital equipment, and the formats can vary from one vendor to the next, and even among different camera models made by the same manufacturer.

To get around the issue of non-standard and widely-disparate raw image formats, a standardized open file format, developed by Adobe Systems, Inc. and called "Digital Negative" (DNG) was developed in 2004, and is updated regularly with backward comaptibility. DNG is based upon the TIFF image standard, but encapsulates the additional sensor data in most proprietary raw image formats. In addition to Adobe software, the DNG file format is accessible and can be read by over 40 additional 3rd-

party software packages across Windows, Mac and linux platforms. Because of this, RUcore tends to prefer capturing and preserving raw image files that have been converted to DNG, as these represented minimally-processed image files in an open, well-documented format that preserves not only an uncompressed digital image, but a wealth of associated technical metadata.

# Recommended Born Digital Imaging Standards

Taking into account the aforementioned considerations, RUcore strives to adhere to the following recommendations for born digital still image content:

## Resolution Requirements:

- **For entry-level consumer cameras: *Minimum* of 7.0 effective Megapixels (MP),**
  ***or* 5.0 Megapixels if the camera has a "High Dynamic Range" (HDR) capability built-in.**
  - Most entry-level "point and shoot" cameras heavily process and compress photos taken with them, introducing artifacts. Additionally, smaller imaging sensors in these cameras contribute to sensor noise. The high minimum resolution is necessary to help overcome these issues.
- **For "Pro-Sumer," bridge cameras, and professional dSLR cameras:**
  ***Minimum* of 6.0 effective Megapixels (MP)**
  ***or* 5.0 Megapixels if the camera has a "High Dynamic Range" (HDR) capability built-in.**
  - The resolution requirement for non-entry level cameras is lower because it is possible to obtain unprocessed, uncompressed images from these cameras, generally yielding better results even with less image information.
- **Additional considerations for both classes of cameras:**
  - Use of "total" or "interpolated" pixel counts to meet the standard are *not* acceptable, when the effective count is below the minimum.
  - A camera will *not* qualify as preservation-grade if it uses interpolation to reach its advertised resolution.
    - Example: A manufacturer advertises an extremely inexpensive digital camera capable of producing 10MP images, however the fine print indicates the camera is only equipped with a 3MP sensor. This camera is in fact interpolating a 3MP image to 10MP, and is not acceptable for preservation purposes.
- ***Minimum* 8 bits per channel (24-bit color)**
  - The camera should be capable of producing images using the sRGB palette.
- **The equipment *must* be capable of producing images with pixel dimensions of at least 3,000 pixels on one side.**
  - Example dimensions: 3504 x 2336; 3072 x 2902; 3872 x 2592; and 3264 x 2448 are all acceptable.
- **The equipment must be EXIF compliant, version 2.0 or later.**
  - EXIF compliance ensures the camera will embed metadata into the image file that details program modes, exposure settings, lens type, and other relevant information.

## Image Format Requirements:

- **For consumer digital cameras: A direct copy of the JPG output file, without any post-processing.**
    - When possible, this JPG image will be directly converted to a TIFF file, without *any* changes to resolution, image quality, brightness/contrast, levels or other aspects.
    - An edited copy of a digital image is permitted if the edits are the direct result of the photographer's intent to present the image with such modifications for artistic effect. When permissible, an unedited "master" should also be preserved, but will not be made publicly accessible or viewable.

- **For ProSumer and professional cameras: The equipment should be able to produce images in RAW format.**
    - RAW image format ensures that the images produced by the camera are unprocessed, unedited and uncorrected.
    - The camera should either be able to produce image files conforming to the **Digital Negative (DNG)** file format, *or* interface with software that can export a DNG file from the camera's proprietary RAW format.
      Common software packages for this purpose: Adobe Photoshop, Adobe Lightroom.
      Additional listings of 3rd-party software packages can be found at http://www.adobe.com/products/dng/supporters.html
    - In addition to the DNG, a derivative TIFF file will be created and stored as a preservation format, through which presentation JPG, PDF and Djvu or Jpeg2000 images will be created for access by the public.
    - DNG permits the photographer to specify image and lighting adjustments, while not destructively altering the original image.

- **Alternately, the equipment should be able to produced uncompressed TIF images.**
    - Uncompressed TIFs can be used as an archival master, but bear in mind that DNG is the preferred format. Care should be taken when using TIFs to ensure that no image processing occurs to the TIF file, beyond what the camera performs internally. The same considerations will be made for artistic adjustments as in the treatment of camera-produced JPG files.

## Other Considerations:

- **Image quality:** the equipment must be able to produce images with a minimum of sensor noise, and with optimal and accurate color reproduction. Such criteria is subjective, but generally most common photography equipment from major vendors will yield acceptable images as long as they meet the above specifications.
  When possible, a non-exclusive list of tested and known-good cameras will be maintained and made available.
- **Image stabilization:** If you choose a camera or lenses with Image Stabilization (IS), be certain the IS engine is of an "optical" variety, not "electronic" or "virtual." Optical IS uses floating internal lens optics and gyroscopes to ensure a steady image if the camera is moving. Electronic/Virtual IS uses software-based image editing and interpolation to artificially render a steady image.

- **Images taken from cameras not meeting the preservation spec:** It is inevitable that events will occur where images we wish to preserve in RUcore will be captured by cameras not meeting the above specifications. In the absence of better quality images, such images can be accepted by RUcore on a case-by-case basis, in which the RUL Digital Data Curator or the Digital Preservation Task Force will need to evaluate the images and determine the best course of action. It should be stressed however, that the viability of such images cannot be guaranteed and any preservation efforts will be done on a "best effort" basis.