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FADGI on a Budget: Improving Digital Images for Library Staff and Faculty

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Cover Page Footnote

This paper is indebted to my colleagues in the Digital Scholarship Center at San Francisco State University.

Introduction

For library digitization units performing copy stand photography, the Federal Agencies Digital Guidelines Initiative (FADGI) provides an incredibly useful set of standards for creating high-fidelity digital images of cultural heritage items. As more and more libraries share books and other objects from their collections online that are important, rare, or unique, the demand increases to create digital versions of these objects of a higher quality. Images captured at this high level can serve as digital surrogates in terms of faithfully capturing the marginalia of a text, the colors and condition of a painting, or other interesting and expanding facets of an object, as well as helping to limit access and damage to physical items or providing backup copies in case of future damage. High-resolution digitization also helps prevent these digital files from becoming obsolete in the foreseeable future. FADGI enables photography of mathematically (and visibly) higher quality images. However, understanding the guidelines—much less achieving 3- or 4-star images in FADGI's strict star-tier system—can be difficult for library staff. Many are inexperienced in photography and have only limited resources available to them.[i] Several large-format scanners and copy stands exist now that can achieve FADGI-level digitization "out-of-the-box," but these are often sold for several tens of thousands of dollars and may be out of reach for many libraries that wish to digitize their own unique and rare books or other cultural heritage items.

This article provides an account of potential strategies for experimenting with FADGI in the absence of such equipment, using the experience of the Digital Scholarship Center (DSC) team at San Francisco State University as a case study. While the DSC team has been fortunate in acquiring a few pieces of specialized equipment, we still had to grapple with translating FADGI's highly technical guidelines to our relatively modest circumstances. Our ultimate goal was to achieve a 4-star image with the equipment we already had at our disposal while avoiding image manipulation via photo editing software such as Photoshop. Even with our limitations, the DSC was able to achieve 4-star images of rare books under certain conditions through an iterative experimentation process. In doing so, we refined our studio environment and significantly cut down on the need for timely post-processing labor. Moreover, through engaging with what Don Williams and Peter Burns call "objective and science-based [digital image] literacy," our team gained extensive insights into digitization that greatly improved the overall quality of our work.[ii] Though there will always remain challenges preventing 4-star digitization in many circumstances, even small-scale digitization units like ours can use FADGI to improve their images with the equipment they already have and better understand their cameras, lighting, and environment to ensure that future equipment purchases get them the results they desire.

What is FADGI?

For those unfamiliar with FADGI, it is often meant as shorthand for their star-tier system based on a collection of recommendations, tools for capturing information, and software to analyze that information: FADGI's "Technical Guidelines for Digitizing Cultural Heritage Materials," a DICE (Digital Imaging Conformance Environment) color target, and OpenDICE analysis software. FADGI provides a robust set of recommendations for many parts of the digitization process, along with recommendations for treating born-digital objects. From the standpoint of a

digitization unit in a library, FADGI's Technical Guidelines provide best practices for capturing accurate color, tone response (how accurately light levels are converted to digital pixels), and spatial resolution. Each star tier of FADGI's ranking system represents a higher level of accuracy for each of these elements, with 1-star representing a low conformance to the technical standards described in the guidelines and 4-stars representing a high level of conformance to those standards. To use image resolution as an example: if a 4-star image of a bound rare book requires a resolution of 400 pixels-per-inch (PPI), the Digital Imaging Conformance Evaluation performed in OpenDICE will perform a physical pixel count to determine if the image meets or exceeds 400 PPI. If an image falls short of that pixel count—based on improper distance from the camera's sensor or other environmental factors— and measures 396 PPI, it will receive a score of 3-stars. By performing these conformance tests, a digitization unit can better understand the modifications necessary to make objective improvements to their imaging output.

Equipment

The DSC team already had a copy stand, digital camera, and two lights, which I describe in more detail below. We also purchased several other items as we went, and to replicate our process, I would recommend starting out with the following equipment.

- Digital camera
- 2 lights
- Copy stand (or a way to point a camera straight down at a flat surface)
- Book cradles and weights for holding a book open
- DICE-compliant color target (a calibration tool for matching the colors of a physical object with known values with the colors of a photographed or scanned image).
- Free OpenDICE image analysis software
- Material to block and absorb light (i.e., paper or cloth), if your room has not been treated for reflections

A DICE-compliant color target was needed for the free OpenDICE software to read and accurately measure color and tone values. Shannon Willis and Marcia McIntosh list "purchasing DICE targets and purchasing scanner/camera calibration and profiling software" as the first two of "six essential actions" discussed in their report on FADGI compliance.[iii] The target used for this study was the GoldenThread object-level target. These targets provide a L*a*b*[iv] value for each color and tone so the OpenDICE software can gauge objectively how much a value in a captured image deviates from the base value of the target. Any target that accurately lists these numerical values should work, as these values need to be entered into a spreadsheet for OpenDICE to read.[v]

Our Setup

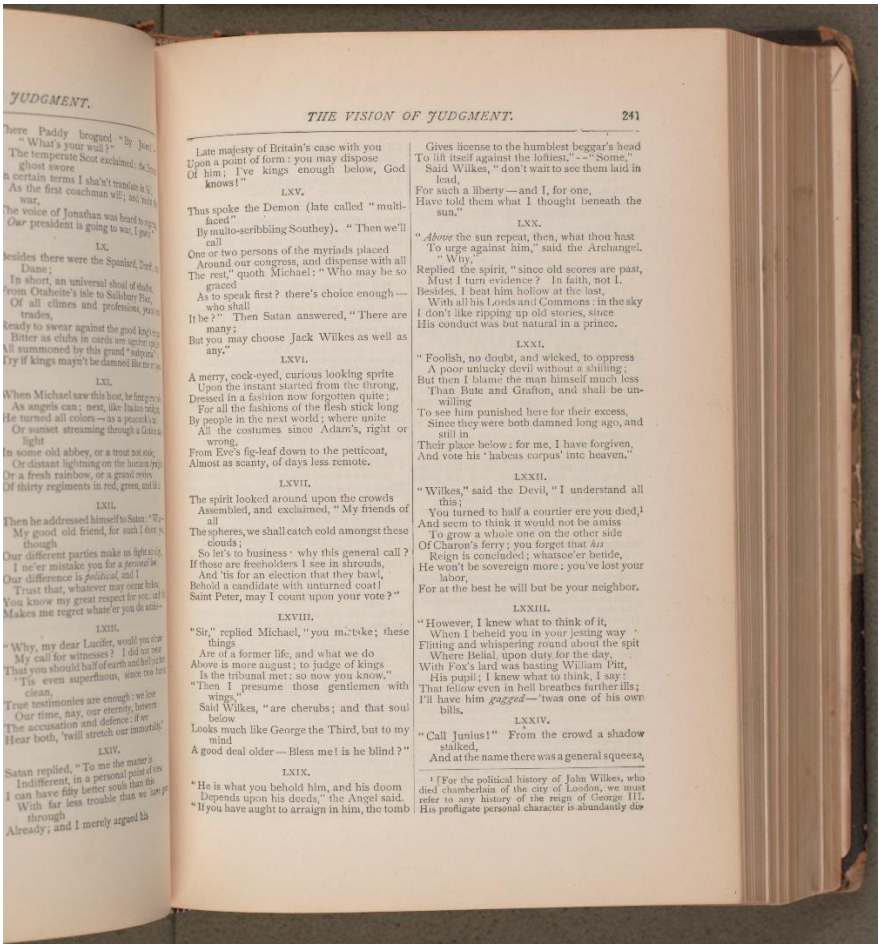
Lighting

For our copy stand work, we use two Profoto Acute 2-D4 halogen lights with white beauty dish reflectors facing 45-degrees down towards the book (see Figures 1 and 2). When digitizing bound materials, this setup ensures that light travels up and down the spine of a book to eliminate spine shadow (see Figure 3). The bottom of each bulb is approximately 35-inches away from the

sides of our copy stand and approximately 55 inches from the floor. We experimented with using diffusion panels with our Profoto Zoom 2 adjustable spotlight reflectors, but, as we learned conceptually as we experimented more with the FADGI process, diffusion lowers detail and reduces color accuracy, which is bad for reproducing text. We tested many angles and decided that 45-degrees provided the best result. The ideal height and distance of the lights will change based on the size of the object being digitized. As always, I would recommend experimenting until your target or object is lit most evenly, and then document your process so you can recreate the setup that worked best for you.

Figure 1: Profoto beauty dish reflector.

Figure 2: Copy stand setup with two modeling lights



THE VISION OF JUDGMENT. 241

Late majesty of Britain's case with you
Upon a point of form: you may dispose
Of him; I've kings enough below, God knows!"

LXV.

Thus spoke the Demon (late called "multi-faced"
By multo-scribbling Southey). "Then we'll call
One or two persons of the myriads placed
Around our congress, and dispense with all
The rest," quoth Michael: "Who may be so graced
As to speak first? there's choice enough — who shall
It be?" Then Satan answered, "There are many;
But you may choose Jack Wilkes as well as any."

LXVI.

A merry, cock-eyed, curious looking sprite
Upon the instant started from the throng,
Dressed in a fashion now forgotten quite;
For all the fashions of the flesh stick long
By people in the next world; where unite
All the costumes since Adam's, right or wrong,
From Eve's fig-leaf down to the petticoat,
Almost as scanty, of days less remote.

LXVII.

The spirit looked around upon the crowds
Assembled, and exclaimed, "My friends of all
The spheres, we shall catch cold amongst these clouds;
So let's to business: why this general call?
If those are freeholders I see in shrouds,
And 'tis for an election that they bawl,
Behold a candidate with unturned coat!
Saint Peter, may I count upon your vote?"

LXVIII.

"Sir," replied Michael, "you mistake; these things
Are of a former life, and what we do
Above is more august; to judge of kings
Is the tribunal met: so now you know."
"Then I presume those gentlemen with wings,"
Said Wilkes, "are cherubs; and that soul below
Looks much like George the Third, but to my mind
A good deal older — Bless me! is he blind?"

LXIX.

"He is what you behold him, and his doom
Depends upon his deeds," the Angel said.
"If you have aught to arraign in him, the tomb
Gives license to the humblest beggar's head
To lift itself against the loftiest." — "Some,"
Said Wilkes, "don't wait to see them laid in lead,
For such a liberty — and I, for one,
Have told them what I thought beneath the sun."

LXX.

"*Above* the sun repeat, then, what thou hast
To urge against him," said the Archangel.
"Why,"
Replied the spirit, "since old scores are past,
Must I turn evidence? In faith, not I.
Besides, I beat him hollow at the last,
With all his Lords and Commons: in the sky
I don't like ripping up old stories, since
His conduct was but natural in a prince.

LXXI.

"Foolish, no doubt, and wicked, to oppress
A poor unlucky devil without a shilling;
But then I blame the man himself much less
Than Bute and Grafton, and shall be unwilling
To see him punished here for their excess,
Since they were both damned long ago, and still in
Their place below: for me, I have forgiven,
And vote his 'habeas corpus' into heaven."

LXXII.

"Wilkes," said the Devil, "I understand all this;
You turned to half a courtier ere you died,[1]
And seem to think it would not be amiss
To grow a whole one on the other side
Of Charon's ferry; you forget that *his*
Reign is concluded; whatsoe'er betide,
He won't be sovereign more: you've lost your labor,
For at the best he will but be your neighbor.

LXXIII.

"However, I knew what to think of it,
When I beheld you in your jesting way,
Flitting and whispering round about the spit
Where Belial, upon duty for the day,
With Fox's lard was basting William Pitt,
His pupil; I knew what to think, I say:
That fellow even in hell breathes forth ills;
I'll have him *gagged*" — 'twas one of his own bills.

LXXIV.

"Call Junius!" From the crowd a shadow stalked,
And at the name there was a general squeeze,

[1] [For the political history of John Wilkes, who died chamberlain of the city of London, we must refer to any history of the reign of George III. His profligate personal character is abundantly do-

Figure 3: A book lit by one light at the top and one at the bottom. This lighting setup produces even illumination and reduces shadow along the spine of the book.

Camera

We are fortunate to have a Hasselblad H4D 31-megapixels camera, which *is* underpowered when compared to cameras such as the Phase One 150 megapixel model, but takes beautiful pictures, nevertheless. Of course, the more megapixels you have, the sharper the image, which is especially helpful for photographing text that is meant to be read on a computer monitor; however, megapixels are not everything, and zooming far into an image will likely never be the norm for users accessing digital collections. Additionally, a consumer DSLR passing FADGI 3- or 4- stars will provide markedly better results than a 150mp camera with a poor setup.[vi]

We use an 80mm lens, which is around the ballpark focal length for copy stand photography. I recommend somewhere between 50-100mm (i.e., there is no need to buy an 80mm lens if you already have a 50mm one). Wider-angle lenses distort images more, and macro lenses will require the camera to be further from the object, providing lower resolution. With the 80mm, our sweet spot is around f-stop 7.1. You should find the aperture stop that gives you the sharpest image, which might be close to this stop. For shutter speed, generally the longer the shutter speed, the sharper the image. We generally do not use a flash and instead prefer to use the mod

lights at ¾ power, with a .3-.4 second shutter. We also rest a small spirit level on top of the viewfinder to make sure the camera sits perpendicular to the base of the copy stand.

Environment / The Room

In all of our research on copy stand photography, the practical information that proved most difficult to find was that pertaining to the physical space surrounding the copy stand. Perhaps the need for a well-treated room is self-evident among photographers and presupposed in most instructional materials, but we once again discovered best practices through experimentation. With our Hasselblad and a decent lighting setup, many of our pre-FADGI images seemed acceptable, using our eyes as a guide toward achieving faithful representations of materials. However, often when we thought we had achieved a high-fidelity image, once we viewed that image through a different monitor or on a different day, problems would reveal themselves: whites would turn to grays or become painfully bright—which we did not perceive at the time of shooting. These problems would require additional post-processing, which further degraded image quality and took us away from our goal of avoiding image manipulation. Our extensive FADGI testing showed us how important the room was in creating high-quality images, and we came up with an inexpensive solution to better control our environment.

The Testing Process

Figure 4. An image of a Golden Thread color target being read in OpenDICE.

When we first ran an OpenDICE test—which simply involves taking a picture of an OpenDICE-compliant color target (see Figure 4) and trying to get the numeric representation of each color in the image to match the number written on the physical target—we failed every performance parameter. While we understood little about the parameters at the time, we could see that the whites in our images were often either too bright or too dark compared to the objective tone values of the DICE target, and the blacks were consistently too bright, even after lowering the brightness to adjust for blown-out whites. We did experiment with aperture and shutter speed, as well as light placement, but after a while, it seemed obvious that something outside these elements was causing these discrepancies.

Since the white ceiling in our lab was just high enough to clear the shaft of our copy stand (only about 8 feet from the floor), I hypothesized that we were getting an excess of white reflecting back and forth between the copy stand base and the ceiling. If that were the case, I surmised that if we covered the ceiling with a dark, non-reflective material, our tones would be more accurate, and that did help. After cloaking the ceiling in gray backdrop paper, our numbers in FADGI improved, especially the blacks, which we had trouble getting dark enough in our initial tests. At this point, we experimented with black and gray paper, to see which absorbed light better, raised the height of the paper to see if further reflections could be eliminated based on distance, and angled the paper at about 45-degrees so that light would be less likely to bounce directly into the

lens. Surprisingly, the distance and angle of the paper had negligible effects, but black paper performed slightly better than gray.

Still, our tests continued to fail every FADGI parameter. Color and tone response registered too far from the color target's objective values and, surprisingly, true resolution remained consistently lower than expected based on the camera's distance from the target. We hypothesized that the other surfaces surrounding the copy stand (one of which was an orange wall) might also be contributing additional reflective light of various colors onto the subject. In the hope of addressing this, we created a paper canopy, held up by light stands, clamps, and document clips surrounding the copy stand (see Figure 5). Surprisingly, the tone scale analysis score increased to just shy of 3-stars, and the color registration and, most shockingly, resolution increased to 4-stars.[vii] At this point in the process, one of my colleagues discovered that we could manipulate the tone curve in post-processing to approach the desired tone scale analysis score, so we concentrated on that instead of continuing to experiment with the physical environment (reducing reflections from the vinyl floor would have been an obvious next step)[viii]. After many hours making several tiny changes to the tone curve, we barely hit our goal of 4-stars. It took approximately two full-time staff testing for about 4 hours per day with occasional help from another staff member and a student assistant one month to complete the testing process.

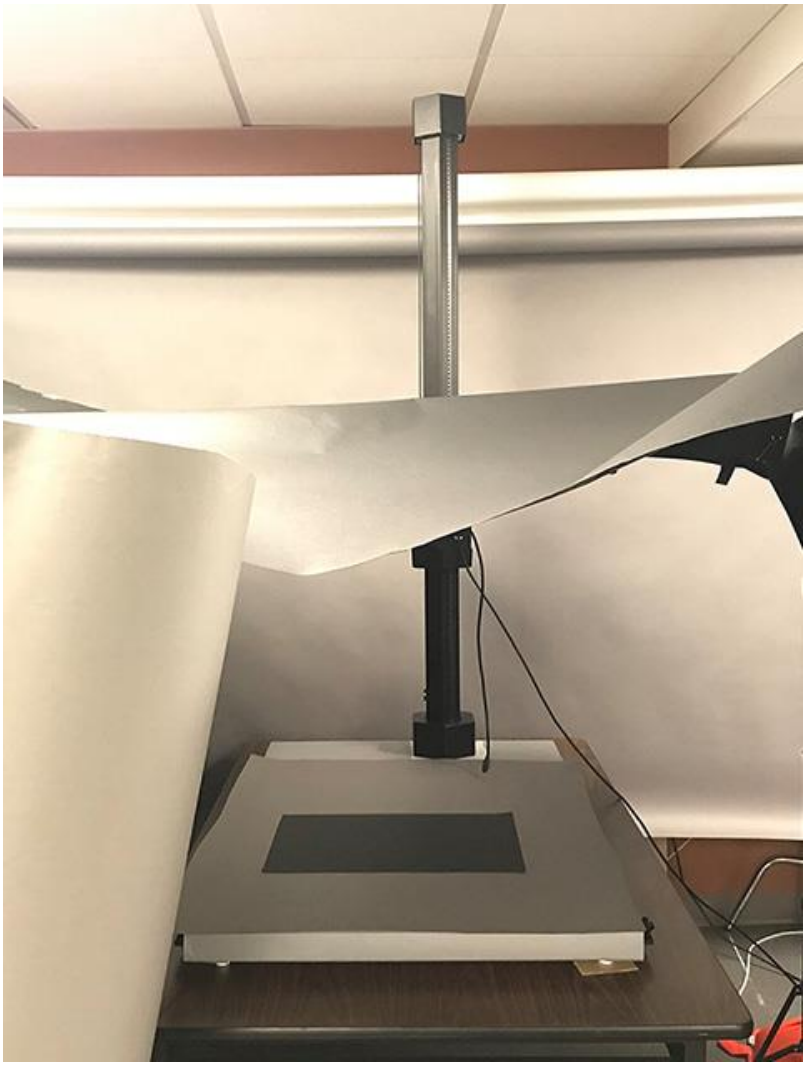


Figure 5. Our paper canopy in an early stage of development.

Shortly after this success, we moved to a carpeted office and set out to achieve 4-stars without post-processing and to plan a more permanent alternative to the paper tent we created. We purchased an 8’ x 8’ portable photo booth, which had a glossier interior than anticipated. After a little more research, instead of backdrop paper, we chose duvetyne fabric as the material for covering the walls and all parts of the metal frame because of its high opacity and matte finish—we also covered our white copy stand base in the same material. With those adjustments in place, we again achieved 4-stars for color registration and resolution and got very close to hitting 4-stars for tone response without post-processing manipulation. We reached this milestone just before we had to shutter due to COVID-19, but I believe that a few pieces of metal were not completely covered by the duvetyne, or perhaps a black or duvetyne rug could have helped correct tone without having to manipulate the tone curve in software.

Conclusion

Given our relatively modest starting point, our DSC team was very proud of what we were able to accomplish on a budget as well as the expertise we developed. It is my hope that readers from

other organizations without the means to purchase equipment capable of achieving FADGI-level digitization with minimal intervention will find our process helpful. More specifically, I would like to emphasize two takeaways for those working in digitization labs who are not professional photographers: 1) that you can improve your images greatly by using a color target and objective analysis software and 2) improving your environment will make an enormous impact on your images, even if you are using a point-and-click camera or are unable to run FADGI tests. Dialing in your lighting setup and camera settings will further improve your images, which FADGI can help you do through trial-and-error. I think FADGI is often viewed as an intimidating set of standards, but I have come to see it as simply a challenging calibration tool. While achieving the higher star tiers is dependent on a certain level of equipment which some of us cannot afford, it is, after all, only a set of guidelines: we can aspire to get as close to these standards as our equipment will allow, and make smart purchases based on what we learn from FADGI to continue improving.

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[i] Shannon Willis describes a similar "gap in [librarians'] imaging and photography knowledge" in her presentation describing best practices.
Willis, Shannon. "I Am Not a Photographer: One Librarian's Journey Toward Understanding FADGI, Image Quality, and Digitization Best Practices." Presentation at the 2017 Texas Conference on Digital Libraries, May 25, 2017: http://hdl.handle.net/2249.1/82149

[ii] Williams, Don & Burns, Peter. "Refining the Theory-to-Practice Path for FADGI Still Imaging." Archiving 2020 Final Program and Proceedings, pp. 39-42. Society for Imaging Science and Technology. https://doi.org/10.2352.issn.2168-3204.2020.1.0.39.

[iii] Willis, Shannon & McIntosh, Marcia. "Cost and Feasibility of FADGI Compliance for the Digital Projects Unit: Final Report." September 30, 2017; Denton, Texas. https://digital.library.unt.edu/ark:/67531/metadc1020928/: accessed April 18, 2022), University of North Texas Libraries, UNT Digital Library, https://digital.library.unt.edu.

[iv] The CIELAB color space that is intended to more accurately represent the perception of the human eye.

[v] The manual gives instructions for using the ColorChecker SG target, as an example of an alternative to the GoldenThread target.

[vi] For best results, make sure your camera sits perpendicular to the copy stand.

[vii] You will find that the FADGI parameters are interrelated.

[viii] More post-processing: lowering the Contrast in software to -15 gave us better results and it is okay to add a little sharpening.