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Free and Open Source Software is becoming increasingly popular, especially as a tool for international development. One type of open source software getting more notice is Greenstone. Greenstone is a suite of software for building and distributing digital library software and developed by the New Zealand Digital Library Project at the University of Waikato in cooperation with UNESCO and Human Info NGO of Belgium. The National Information Standards Organization (NISO) created *A Framework of Guidance for Building Good Digital Libraries* for developing organizations and donor organizations to ensure the creation of high quality digital libraries. This paper presents an evaluation of the Greenstone documentation manuals for evidence that they instruct readers of various technological ability on the concepts illustrated by NISO's *Framework*. The documentation manuals covered just over half of the principles. A major issue with the documentation is that though it may mention a term or task, it does not explain the importance of it. Improving the documentation manuals could potentially influence Greenstone users to create digital libraries that are of a high quality, and consequently make Greenstone an even more useful tool for international development.

Headings:

Developing Countries

Greenstone digital library software.

International Development

Open source software -- Handbooks, manuals, etc.

DIGITIZING DEVELOPMENT:
DO THE GREENSTONE DOCUMENTATION MANUALS EXPLAIN TO DEVELOPING COUNTRIES HOW TO CREATE GOOD DIGITAL LIBRARIES?

by
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Introduction

Bill Gates once asked, "Do you have a clear view of what it means to live on $1 a day?... There's no electricity in that house. None… The mothers are going to walk right up to that computer and say 'My children are dying, what can you do?'"(Martinson). Though a computer itself cannot inject a vaccine for polio or the measles, feed a child dying of starvation, or serve as shelter to protect one's family from the wind and rain, Information Communication Technologies (ICT) sits in a valuable and relevant seat at the table of international development. Former United Nations Secretary General Kofi Annan succinctly explained that, "If harnessed effectively, information and communication technologies have the potential to improve greatly our social, economic and cultural lives. They can serve as an engine of development in areas ranging from trade to telemedicine, and from education to environmental protection. They are tools with which to advance the cause of freedom and democracy. And they are vehicles with which to propagate knowledge and mutual understanding" (Annan 2).

ICT and library science may seem an odd pairing with international development. The plight of developing countries far away from the U.S. is brought closer to home when one realizes that while America's poor may be better off than originally thought, at least generally, (Rector), there are still some who live in third-world conditions, without clean drinking water and plagued with easily treatable diseases (Easley). Even if a

librarian is not interested in what happens on the other side of the planet, the truth of the matter is that libraries the world over serve diverse populations, worry about budget constraints, and work to serve their community more effectively. The fields of library science and international development converge and reinforce one another, particularly when it comes to digital libraries created with free and open source software (FOSS). Digital libraries and FOSS are becoming more and more popular avenues for serving the community, for the freedoms of use that they offer.

One of the more popular FOSS is Greenstone, developed by the New Zealand Digital Library Project at the University of Waikato, and promoted by the United Nations Educational, Scientific and Cultural Organization (UNESCO) as well as Human Info NGO, the Belgian non- government organization (NGO). Greenstone is a suite of software for building and distributing digital libraries under the GNU General Public License. The creators' aim is to "empower users, particularly in universities, libraries, and other public service institutions, to build their own digital libraries" and some of their targets are developing countries (Greenstone Digital Library Software. Main Page). It runs on Windows, Unix/Linux, and Mac OS-X. Since November 2000, people have downloaded Greenstone-related items for an average of 4,500 times per month, of which 67% are software downloads and 33% are documentation downloads (Greenstone Digital Library Software. Factsheet).

The libraries and institutions in developing countries without Internet access are able to receive CD-ROMs of the software from UNESCO to use on their computers. Collections using Greenstone include Kabul University's Afghanistan Centre with works in Dari, Pashto and other languages, the Agricultural Techniques for Farmers in Vietnam

targeted for its rural populations, Senegal's Digital Library containing theses, dissertations and other local research, and many other collections in Africa, South America, Europe, and even in the U.S. The interface can be viewed in fifty languages, with another fifteen in development. Now that collections based on local knowledge can be published on the Internet, librarians in other countries and their patrons now have access to information that they did not have previously. For example if a student asked his or her reference librarian about the missing people in Argentina during dictatorship of the early 1980s, the librarian could visit Argentina's Secretary of Human Rights website on the subject at http://conadi.jus.gov.ar/gsdl/cgi-bin/library. Given that many people can now access these specialized sites, their continued use now depends on their ability to be sustainable, usable, and useful. Digital libraries are not accessible if users cannot figure out how to use them, if they do not provide information about structure and content, such as in metadata, or if they use an obsolete format. Since these resources are often available to others, what occurs on another continent is relevant on this continent as well.

FOSS often falls short in the area of documentation, i.e. showing/teaching others how to use the software, as will be elaborated on later in the paper. The Greenstone User Survey in 2006 found that "most survey respondents (57%) considered themselves to be basic or occasional Greenstone users or developers rather than intensive (knowledgeable and regular) ones" (Sheble). Survey respondents also highly rated the Greenstone manual documentation – 2.37 out of 3.0 – thus demonstrating the importance of the quality of these documents in digital library creation (Sheble).

Standards of what makes a digital library interoperable, reusable, persistent, verified, documented, and in support of property rights can be found in a publication by

The National Information Standards Organization (NISO), entitled *A Framework of Guidance for Building Good Digital Libraries* (this will be referred to hereafter as the *Framework*) This publication explains through twenty-seven principles what makes a digital collection "good" (defined in detail later). Greenstone's documentation advises its users on how to use the software. Given that it is possible that many organizations in developing countries will want to utilize Greenstone but may not have IT experts, it is important that they are shown or are able to reference how to make a digital collection that will be sustainable, useful and usable. The purpose of this study is to evaluate the documentation of the Greenstone software suite for how well it supports users of varying degrees of technological skill to create and manage digital libraries, according to the NISO *Framework*.

I will next review existing literature on FOSS in international development. I will then evaluate the Greenstone documentation manuals, by each principle listed in the NISO *Framework*. I will then discuss the findings and conclude.

Literature Review

This discussion will begin with a review of the literature and definitions of terms. An area of ICT gaining more notice for its development potential is Free and Open Source Software (FOSS). The initial appeal to FOSS over proprietary software is that users and organizations either pay nothing or very little to download and start using it. Free and open source are not interchangeable terms. Software that is "free" is not necessarily software that a user did not need to purchase. While true in many cases, here the term is more political in that it refers to freedoms. The not-for-profit organization

founded by Richard Stallman, the Free Software Foundation, encourages one to think of "free" as in "free speech" not "free beer" (Free Software Foundation 1). The organization defines it as encompassing four freedoms for use:

- Freedom 0 - The freedom to run the program, for any purpose
- Freedom 1 - The freedom to study how the program works, and change it to make it do what you wish
- Freedom 2 - The freedom to redistribute copies so you can help your neighbor.
- Freedom 3 - The freedom to improve the program, and release your improvements (and modified versions in general) to the public, so that the whole community benefits. Access to the source code is a precondition for this. (Free Software Foundation 1).

In contrast to "free," creators of "open source" software gear it towards development and deemphasize the politics. The Open Source Initiative qualifies that the software's license must have free redistribution without obligation to pay royalties, must make the source code available for little or no fee that does not exceed cost of distribution, allow derived works under the same license, does not discriminate against anyone, must not be specific to a product, restrict other software, and must be technology neutral (Open Source Initiative). Even with the philosophical distinction between the two phrases, this paper will refer to both of them as FOSS for simplicity's sake. Propagating one term over the other exceeds the scope of this paper.

Supporters of FOSS believe that it could help developing countries actualize their potential. Many of these countries have received aid from the West for many decades, seemingly without much improvement. Scholar Muhammad Ayish stated: "Frustrated by a decade-long 'experimentation' with Western-prescribed development models, many Third World nations began to see Western dominance of the international economic and

communication system as source of their 'underdevelopment.'" (Ayish 487). Using FOSS allows greater independence for its users in who will not be tied to proprietary licenses, fees, overseas help or training, and who will not be dependent on others for improvements, all particularly salient features to developing countries (UNCTAD Secretariat 9) (May 136) (Barma 4). FOSS allows greater flexibility in bending and conforming the software to the user's needs since its source is not proprietary. This will allow domestic users to develop their technological skills, and potentially create a new local industry with a solid base of qualified technicians creating original software that a developing country could then export (Barma 5) (UNCTAD Secretariat 9). On a practical level, developers can modify FOSS to meet local needs, such as in language. For example, when Microsoft did not include the African language Xhosa, local developers created Xhosa-language packages for Linux (May 136).

The World Trade Organization (WTO) oversees the international compliance of the Trade-Related Aspects of Intellectual Property Rights. Developing nations or transitioning members, as the WTO refers to them, often fail to meet the legal standards due to piracy of proprietary software that is rampant within their borders (May 134). As a result they are then liable to pay the fees for the Intellectual Property Rights (IPR) violations committed within the nation, costing them hundreds of millions of dollars (May 134). Encouraging the use of FOSS amongst its citizens could potentially save these nations millions in extra fees and remain compliant to the regulations of the World Trade Organization.

An additional benefit of FOSS for developing countries in particular revolves around the impermanent nature of digital files, interoperability, and national security.

The United Nations Conference of Trade and Development reports that many governments may wish to store public documents, such as tax data, vote counts, civil information, and/or health records with open code and open file formats, allowing greater transparency (UNCTAD Secretariat 9). If they stored that information with a proprietary software, what would happen if the company/developer goes out of business, no longer managing the software, leaving it behind as technology progresses? Storing that information with open code will allow the users to change and adapt as needed. Interoperability will allow citizens with different software to read the data. That the makers of proprietary software keep its code a secret creates a potential national security risk for countries (Barma 6). Scholar Naazneen Barma stated that they "must be able to rely on systems without elements controlled at a distance" meaning that they should not be dependent on a single software provider from another nation and instead countries should be responsible for the maintenance of their software (Barma 6). Peruvian Congressman David Villanueva Nuñez's open letter to Microsoft Peru in regards to the Free Software in Public Administration Bill, encapsulates these sentiments. He stated,

> • "To guarantee the free access of citizens to public information, it is indispensable that the encoding of data is not tied to a single provider. The use of standard and open formats gives a guarantee of this free access, if necessary through the creation of compatible free software.
>
> • To guarantee the permanence of public data, it is necessary that the usability and maintenance of the software does not depend on the goodwill of the suppliers, or on the monopoly conditions imposed by them. For this reason the State needs systems the development of which can be guaranteed due to the availability of the source code.
>
> • To guarantee national security or the security of the State, it is indispensable to be able to rely on systems without elements which allow control from a distance or the undesired transmission of information to third parties. Systems with source code freely accessible to the public are required to allow their inspection by the State itself, by the citizens, and by a large number of independent experts

> throughout the world. Our proposal brings further security, since the knowledge of the source code will eliminate the growing number of programs with *spy code*.
>
> • In the same way, our proposal strengthens the security of the citizens, both in their role as legitimate owners of information managed by the state, and in their role as consumers. In this second case, by allowing the growth of a widespread availability of free software not containing *spy code* able to put at risk privacy and individual freedoms." (Nuñez).

Other countries that passed or tried to pass similar legislation include Argentina, Brazil, China, India, Malaysia, Pakistan, Philippines, Republic of Korea, South Africa and Thailand (UNCTAD Secretariat 15-16).

Though FOSS offers many valuable assets, it is not without criticism. One of the main criticisms, that particularly affects this paper, relates to documentation, or rather, the lack of documentation and user support. That FOSS can be difficult to use is often discussed in the literature (Brantley, Armstrong and Lewis 146-163; Manes 134-136; Nichols and Twidale). Users lacking programming knowledge need to factor in hiring a specialist, or take the time to learn the software when computing the cost of their project (Murray 14). This lack of knowledge of computers and software can bring frustration to users who may come across issues and not know if it is a user error or a system error (Schweik et al. 125). Those who are able to successfully use FOSS also tend to be experts (Sen 382). A study on government authorities on use of FOSS, found that they felt using proprietary is easier than FOSS (Ghosh).

Digital libraries, in turn, have been the objects of many evaluation studies (Marchionini 304; Kinman 15-36; Fuhr et al. 21-38; Dalgarno et al. 853-865; Tsakonas and Papatheodorou 1234-1250). Saracevic studied 80 such studies for their construct,

context, criteria, and methodology (Saracevic 350). He found that because digital libraries are very complex entities, there exists a great variety in how they are evaluated (surveys, interviews, focus groups, usage analysis, experimentation, economic analysis, etc.), and what is evaluated (research & development, an aspect of operation, representations, tools, services) (Saracevic 350). Park studied the metadata quality found in digital repositories and found that the most common criteria for measuring quality is accuracy, completeness and consistency, and that it is ensured by using metadata generation tools (Park 224).

Digital libraries create a strong avenue for developing countries to disseminate local knowledge to a broader range of people. Having a digital library, such as an institutional repository, can make an institution better known outside its community (Crow 6). Crow states, "institutional repositories, by capturing, preserving, and disseminating a university's collective intellectual capital, serve as meaningful indicators of an institution's academic quality"(Crow 6). The knowledge of one country can be accessed by another country.

The Institute of Museum and Library Services first created *A Framework of Guidance for Building Good Digital Collections* in 2000. The National Information Standards Organization (NISO) took control of the guidelines in September of 2003, updating it twice to the current edition, published in 2007. Its first purpose is "To provide an overview of some of the major components and activities involved in creating good digital collections" (A Framework of Guidance for Building Good Digital Collection [Electronic Resource] 1). It acknowledges that because digital libraries are complex and every institution is different, "the key to a successful project is not to strictly

and unquestioningly follow any particular path, but to plan strategically and make wise choices from an array of tools and processes to support the unique goals and needs of each collection" (A Framework of Guidance for Building Good Digital Collection [Electronic Resource]). Its intended audience includes cultural heritage organizations planning to create digital collections and funding organizations desiring the development of good collections (*A Framework of Guidance for Building Good Digital Collection [Electronic Resource]* 1). In this paper I apply these Framework guidelines because practicing professionals and scholars collaboratively wrote them, and they represent a holistic view of the best practices for the creation of digital libraries, from metadata to object quality, from how to start a project to creating a collection. Developing countries' digital libraries should be held to the same standard as those in developed countries, and the *Framework* offers a worthwhile model.

Methodology

This study seeks to evaluate the Greenstone documentation for whether or not it explains how to create and manage good digital libraries. I will define "good" later in this section. To evaluate Greenstone's documentation, this study will analyze it with NISO's *A Framework of Guidance for Building Good Digital Collections* (*Framework*). The Greenstone documentation to be evaluated includes From Paper to Collection (*Paper*), Installer's Guide (*Installer*), User's Guide (*User*), Developer's Guide (*Developer*), and Using the Organizer (*Organizer*), which I downloaded from http://sourceforge.net/projects/greenstone/files/ and were the most up to date copies available as of October 17, 2009.

The *Framework* guide was downloaded on October 4, 2009. It is organized by four core areas: (1) Collections or organized groups of objects, (2) Objects or digital materials, (3) Metadata or information about objects and collections, and (4) Initiatives or programs/projects to create and manage collections. Each core area is composed of six principles, or in the case of *Collections* nine principles, that define a specific aspect of creating good digital collections. There are 27 principles in all. To define "good" the *Framework* states the following:

> "The use of the word "good" in this context requires some explanation. In the early days of digitization, a collection could be considered good if it provided proof of concept or resulted in new institutional capabilities—even if the resulting collection itself was short-lived or of minimal usefulness to the organization's users…
>
> [T]he focus of digital collection-building efforts shifted toward the creation of useful and relevant collections that served the needs of one or more communities of users. The bar of "goodness" was raised to include levels of usability, accessibility, and fitness for use appropriate to the anticipated user group(s).
>
> Digital collection development has now evolved and matured to a third stage, where simply serving useful digital collections effectively to a known constituency is not sufficient. Issues of cost/value, sustainability, and trust have emerged as critical success criteria for good digital collections. Objects, metadata, and collections must now be viewed not only within the context of the projects that created them, but as building blocks that others can reuse, repackage, repurpose, and build services upon. "Goodness" now demands interoperability, reusability, persistence, verification, documentation, and support for intellectual property rights." (A Framework of Guidance for Building Good Digital Collection [Electronic Resource]1)

The evaluation will be organized first by each core area and then by each principle within the core. It will consist of explaining the meaning of the core area and will follow with a table of the results. Each table will consist of the core area principle number, whether or not if provided coverage of the principle, and the evidence of each instance of coverage. Coverage as minimal as one sentence mentioning the principle will be sufficient for a "yes" answer. The evaluation continues with defining the principle, and discussing the

Framework's meaning, how well the documentation covers the principle, and how the documentation could be improved, if necessary. Evaluating the coverage will consist of determining the depth of explanation of meaning, importance, and ways to achieve the principle in practice.

To conduct the evaluation, the following steps were taken:

1. Read the documentation.

2. Identify and list each instance of the documentation addressing each principle, answering the coverage evaluation question.

3. Evaluate how well the coverage explains the meaning, importance, and how to achieve each principle. If necessary, a discussion of what could have been included to improve the coverage. The evaluation will work under the argument that the more the documentation covers a principle, then the more information a user can access, then the better the likelihood the user will know how to make a good digital library. This study would complement future studies that specifically test the usability of Greenstone in creating digital libraries, and following studies that test the usability of Greenstone digital libraries by end users.

A discussion of what was covered well, and suggestions of what should be included in future documentation will follow.

Results of the Evaluation

Collections Principles

The *Framework* describes a digital collection as an entity "of digital objects that

are selected and organized to facilitate their discovery, access, and use" (4). It continues that a user's experience of a collection depends on a combination of its objects, metadata, and user interface working together (4). A *good* digital collection follows nine principles ranging from being created following a collection development policy to being interoperable and sustainable.

Table 1

Collections Principles Coverage in Greenstone Documentation

Collections Principle 1	No	
Collections Principle 2	Yes	• *Users* page 18 "The brief description is a statement describing the principles that govern what is included in the collection. It appears under the heading *About this collection* on the collection's initial page." • *Users* page 31 "'Collection title' is the text displayed at the top of your collection's home page. It can be any length. 'Description of content' should describe, in as much detail as possible, what the collection is about."
Collections Principle 3	No	
Collections Principle 4	Yes	• *Users* page 3 "Collections are accessed over the Internet or published, in precisely the same form, on a self-installing Windows CD-ROM." • *Users* page 13-14 "All collections allow you to switch from the standard graphical interface format to a textual one. This is particularly useful for visually impaired users who use large screen fonts or speech synthesizers for output." • *Users* page 47 The entire section "Translate Text"
Collections Principle 5	Yes	• *Users* page 54 "Building and distributing information collections carries responsibilities that you should reflect on before you begin. There are legal issues of copyright: being able to access documents doesn't mean you can necessarily give them to others." • *Organizer* page 12 "*Copyright*: It is very important to know the copyright status of a publication. This window has two parts: one where the original copyright notice is displayed and the copyright level

		can be assigned. This information is for document management with the Organizer, and has no effect on the Greenstone digital library application."
Collections Principle 6	Yes	• *Users* page 71-72 The entire section of "Logs"
Collections Principle 7	No	
Collections Principle 8	Yes	• *Users* page 50, "The Librarian Interface can support different workflows by determining which of the various view tabs are visible. Use the "Workflow" tab to customise what views are available by checking the boxes next to the views that you want to be available." • *Users* page 55, sub section "Logging In" • *Users* page 76, "The software can be used to serve collections over the World-Wide Web. Greenstone collections can be made available, in precisely the same form, on CD-ROM."
Collections Principle 9	Yes	• *Users* page 74, Entire subsection of "Creates access structures automatically" • The entire *Developer's Guide*, which on page ii states that, "It is aimed at those who wish to customise collections and to develop and maintain the software."

Collections Principle 1: A good digital collection is created according to an explicit collection development policy.

Creating a collection development policy allows organizations to focus on their mission by committing to only acquire that which supports its goals. By planning how a digital collection will follow that policy an organization ensures that it is supporting its mission, does not waste resources, and is not likely to suffer from mission drift. The Greenstone documentation does not mention that organizations should plan each digital initiative placed within its overall collection to support its mission. It is not the responsibility of the Greenstone programmers to remind organizations to create items supporting their mission. Though including reminders that doing so improves the sustainability of each digital collection and enhances the quality of it and the overall

collection, and would encourage creators to try make quality collections.

Collections Principle 2: Collections should be described so that a user can discover characteristics of the collection, including scope, format, restrictions on access, ownership, and any information significant for determining the collection's authenticity, integrity, and interpretation.

The *Framework* gives importance to the initial description because it allows end users to locate the collection and understand the contents. The documentation does briefly explain that including a description is important, specifically the "as much detail as possible." It could improve with including specifics on which details are important, such as rights and authenticity, as opposed to the general terms it offers.

Collections Principle 3: A good collection is curated, which is to say, its resources are actively managed during their entire lifecycle.

To the *Framework* curating the entire lifecycle of a collection encompasses active data management, archiving, and digital preservation and doing so ensures that collections can continually be used (9). To actively curate involves enriching the collection through creating, correcting, or enhancing both data and metadata, adding annotations and links, and documenting what has been done (9). The Greenstone documentation seemed to hint that collections should be curated, and does state that the *Developer* guide is for those who maintain collections. The software itself allows users to do so, but does not directly state or elaborate that creators or someone from the organization should actively maintain the collections in this way.

Collections Principle 4: A good collection is broadly available and avoids unnecessary impediments to use. Collections should be accessible to persons with disabilities, and usable effectively in conjunction with adaptive technologies.

The *Framework* also posits that important to this principle is availability, that the collection be widely available for use and easy to access, particularly through the Internet, and does not include being free of charge; usability, that it be easy to use, in terms of finding information, support different operating systems, display non-English language characters, etc; and accessibility, that those with disabilities, be it visual impairments, or loss of hearing or mobility, are still able to use the collection. The documentation does well, as does the general design of the software in supporting these elements. Viewing the collections does not require special software other than a web browser. Those without reliable Internet connections, can create CD-ROMS, which are self-installing. The programmers wrote the software to be usable, including versions viewable with Cyrillic, Arabic, and other non-Latin alphabets. The Greenstone software itself can also be used on computers running Unix/Linux, Windows, or Mac OS systems. On this principle, Greenstone and its documentation excel.

Collections Principle 5: A good collection respects intellectual property rights.

As the *Framework* describes, International property rights laws are huge and complex with important consequences to those not in compliance. The Greenstone documentation definitely introduces this fact. Though it could be improved with more reminders about following copyright and even resources to find more information so that those who download the software will understand the importance of the situation.

Collections Principle 6: A good collection has mechanisms to supply usage data and other data that allows standardized measures of usefulness to be recorded.

The *Framework* gives great importance to the on-going evaluation of collections. With Greenstone, those who maintain the collection and its software, the administrators, are able to keep logs that record use, errors, and initialization, allowing them to know which pages visitors frequent the most and the least, duration of each visit, the IP address of the user, browser type, and CGI arguments. One area for improvement would be a line or two about actually monitoring the collection, so that new users know the purpose of this tool.

Collections Principle 7: A good collection is interoperable.

For a collection to be interoperable, it needs to include the standard metadata for similar collections as well as a description that illustrates how this collection relates to the larger realm of similar collections. Doing so, according to the *Framework*, will benefit the greater world of digital collections by increasing "the use and usefulness" (22). Interoperability also allows collections to be "repurpos[ed]" into newer collections (22). Though the Greenstone documentation manuals reviewed for this paper do not mention interoperability, its website does. It states:

> "Greenstone is highly interoperable using contemporary standards, It incorporates a server that can serve any collection over the Open Archives Protocol for Metadata Harvesting (OAI-PMH), and Greenstone can harvest documents over OAI-PMH and include them in a collection. Any collection can be exported to METS (in the Greenstone METS Profile, approved by the METS Editorial Board and published at http://www.loc.gov/standards/mets/mets-profiles.html), and Greenstone can ingest documents in METS form. Any collection can be exported to DSpace ready for DSpace's batch import program, and any DSpace collection can be imported into Greenstone." (Greenstone Digital Library Software.)

Clearly users can import and export a wide array of documents into and out of

Greenstone, thus supporting interoperability. Including interoperability in its manual documentation, as well as instructions on how to support the interoperability of collections, and its importance would aid in making good digital libraries.

Collections Principle 8: A good collection integrates into the users own workflow.

A collection that integrates into the staff's workflow means that digital collections are integrated into the organization's services, and the actions and tasks can be streamlined to be more effective, intuitive, and less time consuming (*A Framework of Guidance for Building Good Digital Collection [Electronic Resource]*23). As for the end users' workflow, collections should first be in the environment in which the researcher is more familiar, making it more seamless to research the collection for information (*A Framework of Guidance for Building Good Digital Collection [Electronic Resource]*23). Second, according to the *Framework*, there should be a way for end users to contribute to the collection, be it, depending on the collection, tagging information, adding family photographs to a relevant history collection, etc. (23). Contributing should only require minimal steps for an author, for example, to publish work in the collection- at the click of a button. The user manual instructs collection creators how to customize which aspects are easily accessible while working in the librarian interface. The Collector, a different way to modify collections than the librarian interface, is accessed online from any computer by anyone with credentials to log in, and it takes the user through each step. Though the Greenstone creators made the Collector first, the librarian interface second, and recommend using the librarian interface over the Collector (*Users* 54). Greenstone creators intend for the collections to be published online (Greenstone Digital Library Software. Main Page), which is where many researchers look for information, thus

enabling end users to integrate collections into their own workflow. The documentation does a fair job of explaining how to integrate the software into workflows, as well as encourage and enable creators to publish online, integrating information retrieval into the end users' workflows.

Collections Principle 9: A good collection is sustainable over time.

The *Framework* notes that to be sustainable requires planning organizationally, financially, and technically. The organization needs to fully support the endeavor, understanding the long-term obligations, from funding to assigning someone to maintain the collection through server and software upgrades, continued access, data entry and data cleaning, and proving end-user support. Greenstone programmers created the software to include automated tasks, such as linking and rebuilding indexes, as noted in the *Users* documentation. The *Developer* documentation instructs users on how to use the software in-depth, such as the conceptual framework for the software that give a more technical explanation of how the software works. An area for improvement on this principle includes specifically addressing the need for collections to be sustainable. While the software does enable sustainability, users new to digital collections may not understand the need for maintaining collections.

Objects Principles

For a collection to be considered good, according to the *Framework* guidelines, it must contain *good* objects. The *Framework* prescribes six principles that affect how good an object is, ranging from existing in a sustainable format to being uniquely identifiable and able to be authenticated.

Table 2

Objects Principles Coverage in Greenstone Documentation

Objects Principle 1	Yes	• *Users* page 2, "Source documents come in a variety of formats, and are converted into a standard XML form for indexing." • *Paper* page 3, "The output format of a scanned page is a computer file that is usually stored in TIFF or Bitmap format. Compressed TIFF IV is the best format to use."
Objects Principle 2	No	
Objects Principle 3	No	
Objects Principle 4	Yes	• *Paper* page 6, Entire section of "Filename Conventions" • *Developer* pages 11 & 13, "The *OIDtype* option deserves some explanation. Each document has an associated Object Identifier or OID. This is best computed by hashing the contents of the document (*hash*). However, this is slow, so a simpler alternative (*incremental*) is provided which simply numbers the documents sequentially in the order in which they are imported. You can use *incremental* for speed, but use *hash* if you intend adding documents to your collection at a later date (without re-importing)."
Objects Principle 5	No	
Objects Principle 6	Yes	• *Users* page 37, The entire sections "The Enrich View", "Reviewing Assigned Metadata," and "Importing Previously Assigned Metadata"

Objects Principle 1: A good object exists in a format that supports its intended, current, and future use.

The *Framework* contends that this principle enforces that for an object to be sustainable, it must be exchangeable across platforms, broadly accessibly, and in a standard format. Greenstone, though it does not emphasize the benefits of doing so, converts all textual documents into an XML format, and recommends its users to save image files as TIFFS, both preferred methods of the *Framework* as listed on pages 28, 29, and 30.

Objects Principle 2: A good object is preservable.

The *Framework* clarifies that "the object will not raise unnecessary barriers to remaining accessible over time despite changing technologies" and that it must be able to migrate and to emulate (*A Framework of Guidance for Building Good Digital Collection [Electronic Resource]*48). By migration, it means that it can transfer across media (i.e. CD to DVD), software, and formats (JPEG to JPEG2000) (*A Framework of Guidance for Building Good Digital Collection [Electronic Resource]*). By emulation it means to reproduce "on contemporary systems the computer environment in which digital objects were originally created and used) (*A Framework of Guidance for Building Good Digital Collection [Electronic Resource]*23). The documentation does not specifically mention preservation, though the software does prohibit users from doing so. It uses TIFFs and XML which can be easily migrated to other formats; it can be published online or on a CD-ROM, or even a DVD-ROM. Specifically stating how Greenstone can be used to preserve objects is an area for improvement.

Objects Principle 3: A good object is meaningful and useful outside of its local context.

The *Framework* advises that objects become more meaningful when they can be understood outside of their initial, digital contexts. For this to occur, metadata needs to make the object self-explanatory, such a title, format, and rights. Using metadata according to a standard scheme increases the object's portability and interoperability, so that if used in a different collection, it can easily be mapped to the new collection. The Greenstone documentation does not address this issue of object interoperability. While it does allow users to use objects from a previous collection in a new collection, it does not

emphasize the issue of complete metadata, other than the general goal to make it is descriptive as possible (*Users* 31).

Objects Principle 4: A good object will be named with a persistent, globally unique identifier that can be resolved to the current address of the object.

Greenstone documentation certainly supports the *Framework['s]* principle to have unique identifiers. The documentation includes examples on how to create a unique identifier. But it could be improved with supporting the globally unique aspect of the principle, which the *Framework* recommends to include an organization-unique prefix to each object identification number.

Objects Principle 5: A good object can be authenticated.

Users need to trust that the object they are looking at is the object it claims to be, that it has not been altered in an unauthorized way. The *Framework* points out that digital objects, unlike their tangible counterparts, cannot rely on physical clues to alert the observer as to whether or not it is "real." Instead, the object's digital provenance, or it "origin and change history," must be provided (55). The Greenstone documentation does not address authenticity or digital provenance. Though a user who does know about such issues could include digital provenance with an object using Greenstone, it may not be obvious to an unaware user.

Objects Principle 6: A good object has associated metadata.

The *Framework* wants objects to have both descriptive and administrative metadata, as well as structural for compound objects. It also recommends to include the

metadata at the point of creating the object, as well as to embed it to increase portability. While Greenstone enables users to include metadata and frequently discusses how to include it at the collection level and object level and explains the structural metadata, it does not adequately explain the importance of it, such as it increases its authority, identification through Internet searches, and management. Though, the manual implies the importance of metadata with the frequent mentions of it.

Metadata Principles

Along with good objects, a collection must also contain good metadata that allows users to understand the object and trust its provenance. The *Framework* defines metadata as "structured information associated with an object for purposes of discovery, description, use, management, and preservation" and acknowledges three types of metadata: descriptive that enables users to find objects and distinguish it from another; administrative that records the objects file and rights management, as well as preservation; and structural that retains the objects order by illustrating the inner relationships of the object, such as the chapters of a book (58). Creating metadata is a multistep process, possibly created by different authors. The *Framework* describes the process in which the beginning stage of creation, the object's authors, contributors, source, is provided by the original author; the organization stage needs catalogers to record the object's subjects, publishing history, and access rights; and in the final stages of access and usage, the user adds evaluative information, such as reviews and annotations (58).

Table 3

Metadata Principles Coverage in Greenstone Documentation

Metadata Principle 1	Yes	• *Users* page 20 "[the user] would have been asked to select what metadata sets should be used in the new collection. Three standard sets are pre-supplied: Dublin Core, the DLS metadata set mentioned above, and a set that comprises metadata elements extracted automatically by Greenstone from the documents in the collection." • *Developer* page 19 Entire subsection "Document metadata"
Metadata Principle 2	No	
Metadata Principle 3	No	
Metadata Principle 4	Yes	• *Organizer* page 4 "In the Organizer, each document may be assigned metadata from the following set of attributes: … xii. Copyright notice [and] xiii. Copyright code (from a list of standard rights permission schemes)"
Metadata Principle 5	Yes	• *Developer* Entire section 2 "Getting the Most Out of Your Documents"
Metadata Principle 6	No	

Metadata Principle 1: Good metadata conforms to community standards in a way that is appropriate to the materials in the collection, users of the collection, and current and potential future uses of the collection.

The *Framework* acknowledges that the metadata needed for one type of object from one sort of institution easily differs from the metadata appropriate for another type of object from a different institution. Using standard metadata schemes allows interoperability and usability. It also highly recommends that institutions create a specifically local "application profile" that maps what should be done in unclear circumstances. This application profile also encourages institution-specific standardization across different metadata schemes of different collections. Greenstone

developers encourage this by automatically including Dublin Core, a widely used metadata scheme, with the software. They also encourage institution-specific standards by allowing users to create new collections based on the metadata schemes of previous collections. Users are also able to add categories or combine schemes to create a template specific to the collection. Though it encourages and implies, the documentation could be included with explanations of why an institution should try to comply with community standards.

Metadata Principle 2: Good metadata supports interoperability.

Similar to collections, interoperability in metadata means that it make the object meaningful outside of its original context. Metadata that supports interoperability also enables researchers to locate the item in what the *Framework* calls a "distributed networked environment" (76). For example, a stereograph card within its original collection of other stereograph cards is obviously a stereograph card. But if that card depicts a family in Yosemite National Park is copied and moved into another collection emphasizing National Parks, containing photographs, stereograph cards, negatives, and other formats, it is no longer as clear that it is a stereograph from the 19th century and not a stylized, born-digital photograph from 2004. In this example, metadata that would support interoperability would have included an entry along the lines of "format: stereographs." To highlight the issue, the *Framework* describes an instance in Harvard's Teddy Roosevelt collection, in which a photograph with the president on a horse is simply titled, "On a horse." Outside of its Teddy Roosevelt collection at Harvard, this metadata hides the true meaning – who is on the horse? Though the description made

sense in its original collection of solely Teddy Roosevelt items, outside of that context it is unclear. The Greenstone documentation does not specifically address the issue of metadata and interoperability, though the software does support it, as already addressed in the collections section, and because it automatically includes the Dublin Core metadata scheme, a standard for digital collections. Its documentation would better serve its users by including information on how to create metadata that supports interoperability and why a user should take the extra steps to do so.

Metadata Principle 3: Good metadata uses authority control and content standards to describe objects and collocate related objects.

Using metadata according to a controlled content standard allows enhanced cross-collection searching, accuracy, and continuity. As with metadata schemes, the *Framework* acknowledges that depending on the institution, some data dictionaries are more appropriate than others. Instead an institution should add to existing thesauri and dictionaries with local-specific, carefully documented vocabularies. Simpler is better for the untrained authors and creators. Though it regularly mentions "metadata" throughout each manual, the documentation does not specify that authority control and content standards exist and are important.

Metadata Principle 4: Good metadata includes a clear statement of the conditions and terms of use for the digital object.

Users need to know what is in the public domain, what is copyright protected, and how to obtain permissions for restricted items. The *Framework* also recommends that whether or not the resources has been published or not should be included, and that the

organization should maintain contact information for the rights holders (81). While the above shows the Greenstone documentation mentions that metadata should include the objects' conditions and terms, it does not directly state or emphasize that the user needs to include that information. Novice users may not understand the need to include that information.

Metadata Principle 5: Good metadata supports the long-term curation and preservation of objects in collections.

Long-term curation and preservation stems in part from administrative metadata that encompasses technical, record keeping, and structural information. This type of metadata describes the digital object, such as its file size, format, when and how created, the object's context, sampling frequencies, page numbers and orders, and more (83). Section two of the *Developer* manual describes how the software through plugins automatically extracts certain types of information from documents during collection building, such as structure and file size. More description on the types of metadata that would support preservation, and thus sustainability of collections would improve the manuals.

Metadata Principle 6: Good metadata records are objects themselves and therefore should have the qualities of good objects, including authority, authenticity, archivability, persistence, and unique identification.

The *Framework* reasons that because metadata provides an object's provenance, integrity, and authority, that meta-metadata also needs to be authenticated and assure the user of its integrity (85). Organizations should also include information stating which institution created the metadata, standards of completeness and quality (85). While the software itself does enable users to include meta-metadata, the documentation manuals

do not include any references that this should be done to improve the authenticity of the object, and therefore the collection, as well.

Initiatives Principles

Besides containing good objects and metadata, good collections are created according to established initiatives within the organization. The *Framework* uses the term "initiative" to refer to both the programs and to the projects contained in each program because both require similar planning for sustainability (86). It laments that although organizations may include digital collection building within its mission, they often times have not incorporated that into the organization's funding and structure (86).

Table 4

Initiatives Principles Coverage in Greenstone Documentation

Initiatives Principle 1	Yes	• *Users* page 40-41 Entire section of "Designing Your Collection's Appearance" • The entire "From Paper to Collection" particularly page 7 "Scanning costs" section
Initiatives Principle 2	Yes	• *Paper* page 14, entire section "Intensive OCR"
Initiatives Principle 3	Yes	• *Paper* page 2 – Questions (listed in full under Initiatives Principle 4 • *Developer* page ii "[This manual] is aimed at those who … maintain the software."
Initiatives Principle 4	Yes	• *Paper* page 2: o "What is the goal of your collection? o What is your target group? o How big is it—local, regional, or global? o How many documents are you making available? o How many pages? o How much graphics content? o Does the material split into parts that will be consulted by a limited audience and parts that need to be disseminated widely?

		○ Are the documents already available electronically? ○ If so, in which formats? (Note incidentally that PDF files are not automatically equivalent to digital full-text form, as they often contain only page images.) ○ What is the copyright status of the documents? ○ Who owns the copyright? ○ Are there other organizations with the same target audience? ○ Are you willing to collaborate with other groups? ○ What budget is available for the whole project? ○ What human resources are available (in person-months) for coordination, editing, scanning and programming? ○ How many computers are available for this project? ○ How many CD-ROMs do you want to distribute? ○ Will they be free, or for sale?"
Initiatives Principle 5	No	
Initiative Principles 6	No	

Initiatives Principle 1: A good digital initiative has a substantial design and planning component.

Adequately planning for a project greatly affects its success. Planning should include specifying the target audience, performing a needs assessment to ascertain the needed functions, and developing short and long term goals, constraints, selection, digitization, copyright issues, metadata, maintenance, dissemination, and evaluation (87). Greenstone documentation does an excellent job covering this principle. The From Paper to Collection guide gives an informative overview of the digitization process, beginning with picking the appropriate scanner for an organization, OCR software, and training

needs for staff, that also includes recommendations for the type of worker and how long the average worker can work attentively to the task. The introduction lists typical steps for a digitization project, including (but not exclusively) selecting the documents, securing copyrights and permissions, tagging chapters, organizing, building the actual digital library, then disseminating it over the Internet or CD-ROM. It includes costs of different types of scanners, OCR software, the steps of scanning, the possibility of outsourcing, and how much it costs to scan. Three examples of different sized organizations with different scanning needs are outlined to illustrate to those new to digitization how to plan for their own project.

Initiatives Principle 2: A good digital initiative has an appropriate level of staffing with necessary expertise to achieve its objectives.

The "Intensive OCR" section covers only the staffing requirements and issues for this stage, noting that attention to detail is critical, that staff often leave the job after several months, most are tired after working six hours, etc. The documentation gives excellent specific information regarding what an organization initiating a digitization project should expect from staff, such as scanners and quality assurance checkers. It could improve with more specific information on the value of assigning someone to maintain the collection- duties required to maintain, approximately how much time is needed per week or month to maintain, etc.

Initiatives Principle 3: A good digital initiative follows best practices for project management.

Included in project management is (1) a planning stage: setting goals, identifying what needs to be done to implement and achieve goals, estimating time and resources,

breaking project down into sub-tasks; (2) implementation stage: monitor completion of tasks, review and update project plan; and (3) a review stage- document project's progress, evaluate, articulate findings and lessons learned (*A Framework of Guidance for Building Good Digital Collection [Electronic Resource]*89). The documentation manuals do not articulate that users should follow any sort of project management plan, though it is implied. It offers pre-project planning questions that should be answered, and I will discuss it further in Initiatives Principle 4. It also makes a statement assuming that there will be someone to maintain the collection on page ii of the "Developer." Including a section on recommending a project management would be helpful and enable users to know the entire process for creating digital collections.

Initiatives Principle 4: A good digital initiative has an evaluation component.

Digital collections should not be published and left alone. Instead, throughout the process, from creation to publishing careful planning needs to occur. The *Framework* states that they should be evaluated in order to "identify and refine project goals, assess progress toward project goals, determine the quality of project results, measure the impact of the project, show accountability, and demonstrate the value of the project to funding agencies" (91). The Greenstone documentation manuals offer excellent questions for initial planning, as shown above in the evidence. But it does not offer an evaluation plan after that. Since it provides logs that enable creators or the maintainers to collect statistics about who uses the sites, which pages they visit and for how long, for example, it seems that the documentation should and could easily include information on an overall evaluation plan, from start to finish and beyond.

Initiatives Principle 5: A good digital initiative markets itself and broadly disseminates information about the initiative's process and outcomes.

A digital collection can hardly be useful if nobody uses it. And nobody would know about it if its existence were not announced to the targeted community beyond the creating organization. The *Framework* recommends theses tactics to spread the word about a collection in trade publications, meetings between library, archive, and/or museum professionals, Facebook, YouTube, and even entering it in a relevant Wikipedia page (93). The Greenstone manuals do not direct its readers to advertise their collections. Giving suggestions for how to let others know about an organization's collection, such as those mentioned in the *Framework* would be instructive and enlightening. It would make collections more usable when people know there are there for them to use.

Initiatives Principle 6: A good digital initiative considers the entire lifecycle of the digital collection and associated services.

Planning for one or many digital collections involves more than the digitization process. It should also include how the collection will be maintained after completion, its sustainability. The *Framework* advises that initiatives should address the following issues: projecting its use overtime, updating it and its website will need, how to maintain master objects, periodic object checks for accessibility and usability, and how to include the project into the established workflow of the organization (95). As I have previously discussed, Greenstone would benefit its users if it instructed them on post-digitization projects, such as project evaluation, and recommended processes for the effective maintainability of an established collection.

Discussion

First and foremost, the Greenstone documentation manuals are guides of how to use the software. When I evaluate it for its coverage of the NISO *Framework* principles, as an indication of how well it instructs its readers to create good digital collections, it covered sixteen guidelines and did not cover the other eleven.

A prevalent finding is that the manuals often refer to subjects, and seems to assume that the reader has knowledge in that area. Metadata is a prime example of this. The manuals refer to it countless times, offering a definition, such as the one on page 2 of the *User:* "In most collections, descriptive data such as author, title, date, keywords, and so on, are associated with each document. This information is called *metadata.*" And while a demo collection comes with the software that includes some examples, the manuals do not adequately explain the importance of the "so on" metadata, which we can also guess might be the technical, record-keeping and structural metadata needed for preservation and curation, explicit statements of the conditions and terms of the digital object, and authority control of terms for continuity, usability, and interoperability across collections. It does not explicitly state that objects and consequently collections are greatly improved when they have informational metadata; they simply imply it through the frequent inclusion of the term. They do not emphasize or instruct their readers that end users need to be able to trust the validity and authenticity of an object, that because they are not able to pick up the actual object to evaluate it, the provenance of the digital version must be communicated. The documentation does not discuss that metadata must be complete so that the object has meaning outside of its context. Mentioning "metadata" repeatedly implies its importance but does not explain why or how. Incorporating a

comprehensive section on the powerful uses of metadata would greatly enhance the usefulness of the manual documentation. In this study I found that Greenstone's Documentation manuals offer some guidance in over half the principles the *Framework* proffered, but could improve with more explicit statements of the importance of including certain items.

Conclusion

Greenstone is becoming more widely used, particularly because UNESCO promotes its use in developing countries. Because of globalization and the Internet, what happens in one country does not necessarily stay there. Students and researchers can now access the local knowledge of a country thousands of miles away. In order to remain relevant to their communities and those outside of it, the organizations creating digital libraries and collections need to publish in a way that is, sustainable, useable, and useful.

Also, just because Greenstone does not have a direct financial cost to download, there is a cost to digitize documents, pay the workers, etc, and may therefore need to seek financial assistance from other organizations. Donor organizations need to know that their money was spent well and appropriately, and hold their recipients accountable. If the recipients do not create a digital collection that will be used or stand the test of time, their money will have been a waste. Since many of recipients probably do not have an IT expert on staff, it is vitally important that they have access to documents that show them how to create a good digital library.

This study's results are significant because it has shown that Greenstone's documentation manuals cover just over half of the principles that make a digital library good, i.e. objects, metadata, and collections that are interoperable, reusable, persistent, authentic, verified, documented, and in compliance with intellectual property rights. The authors of the Greenstone manuals could greatly enhance the quality of their manuals, and influence the quality of the collections made based on those manuals, if they made included more direct statements emphasizing the importance of doing certain tasks, instead of implying importance or assuming the reader understands. Because Greenstone users in developing countries possess vastly different technological skill levels, they cannot assume everyone knows the value of certain tasks. With some changes, Greenstone could be an even more effective tool for international development and library science/ICT.

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