

Green Digital Libraries: Progressive Web Apps, Sustainable Design, and Coding for the Greener Good

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Code4Lib 2021

What's Ahead

- Research Motivation
- The Energy Problem Statement
- Sustainable Software Design
- Sample Application
- Research Implications

Research Motivation

“Corporate responsibility is going to be a central concern across industries in the coming decades, with carbon transparency and de-intensification being specific and easily articulated actions and missions through which companies can demonstrate this accountability.”

Hunter Vaughan, Environmental Media Scholar-in-Residence in CMCI's
Department of Media Studies, University of Colorado

“A Materiality of the Virtual”

Hunter Vaughan, Environmental Media Scholar-in-Residence in CMCI's
Department of Media Studies, University of Colorado

“To the user, speed matters... In this paper, I discuss the web performance of 129 library websites, and detail a step-by-step performance enhancement plan.”

Scott W. H. Young (2016)

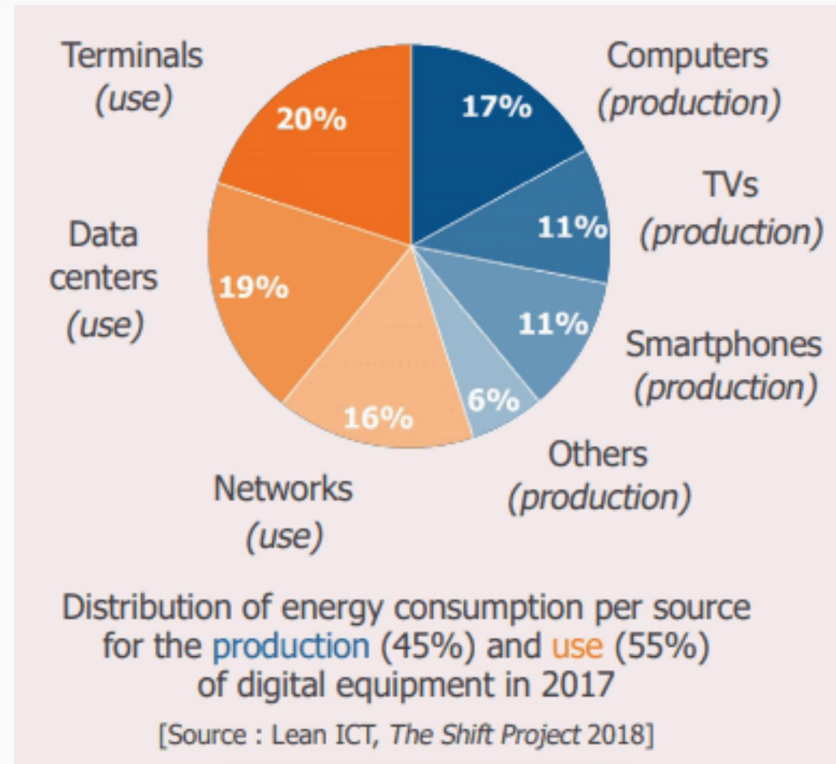
<https://doi.org/10.3998/weave.12535642.0001.401>

What's the Problem?

“If the Internet was a country, it would be the 7th largest polluter.”

Source: Total ICT emissions from [How to stop data centres from gobbling up the world's electricity](#) compared with [Carbon emission by country](#).

Problem Statement - Energy Consumption



[Source: [The Shift Project](#)]

Website Carbon Calculator [Get the badge!](#) [How does it work?](#) [FAQ](#)

How is your website impacting the planet?

Estimate your web page carbon footprint:






Your web page address


[Calculate](#)

By using this carbon calculator, you agree to the information that you submit being stored and published in our public database.

www.websitecarbon.com

Carbon results for
dp.la

Share     



Uh oh! This web page is dirtier
than **72%** of web pages
tested

Carbon results for

loc.gov/collections

Share     



Uh oh! This web page is dirtier
than **54%** of web pages
tested

“Shaving off a single kilobyte in a file that is being loaded on 2 million websites reduces CO₂ emissions by an estimated 2950 kg per month.”

Source: [Danny Van Kooten](https://doi.org/10.3390/su10072494) and Pihkola, H., Hongisto, M., Apilo, O., & Lasanen, M. (2018). Evaluating the energy consumption of mobile data transfer-from technology development to consumer behaviour and life cycle thinking.
<https://doi.org/10.3390/su10072494>

“That is the same amount of CO₂ saved each month as 5 flights from Amsterdam to New York (679 kg CO₂ per flight).”

Source: [Danny Van Kooten](https://doi.org/10.3390/su10072494) and Pihkola, H., Hongisto, M., Apilo, O., & Lasanen, M. (2018). Evaluating the energy consumption of mobile data transfer-from technology development to consumer behaviour and life cycle thinking.
<https://doi.org/10.3390/su10072494>

Environment as User

Sustainable Development Techniques?

- Systems
- Resources
- Code

Systems: routines + architecture

A sysadmin practice
of setting up your
infrastructure

Compression algorithms
+
Evaluating network bandwidth

Minimizing filesize and network use

A simple online web page compression / deflate / gzip test tool

Web Page URL:

Results for: <https://arc.lib.montana.edu/msu-dataset-search/>

Web page compressed?	Yes
----------------------	------------

Compression type?	gzip
-------------------	-------------

Size, Markup (bytes)	6,364
----------------------	--------------

Size, Compressed (bytes)	2,379
--------------------------	--------------

Compression %	62.6
---------------	-------------

A sysadmin practice
of setting up your
infrastructure

Content Delivery Networks

+

Evaluating User Need for a File

Minimizing network and power use

A sysadmin practice
of setting up your
infrastructure

Placement of Data Centers
+
Investment in Green Energy Sources

Minimizing network and power use

[See Green Web Foundation](#)

A sysadmin practice
of setting up your
infrastructure

Using Analytics
+
Applying Local Time

Powering down software during times
of limited use

LOW←TECH MAGAZINE

97%

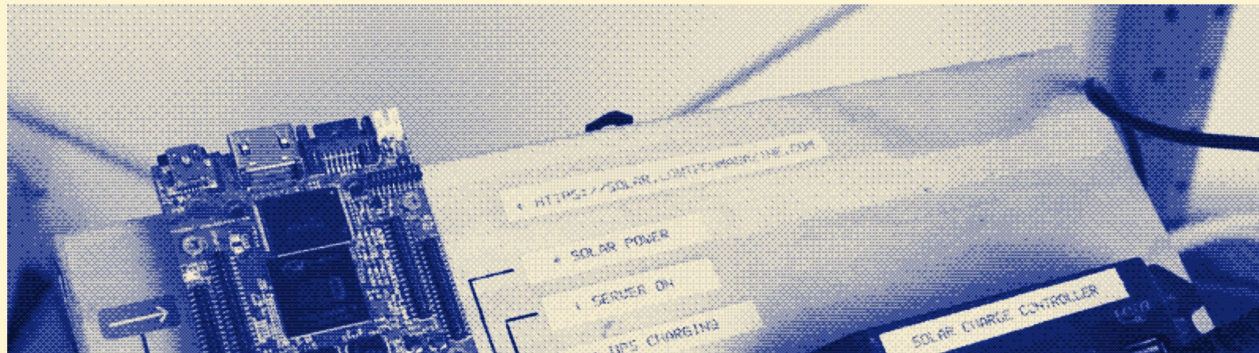
This is a solar-powered website, which means it sometimes goes offline ☀

About | [Low-tech Solutions](#) | [High-tech Problems](#) | [Obsolete Technology](#) | Archive | Donate | 📶

Low-tech Solutions

How to Build a Low-tech Website?

Our new blog is designed to radically reduce the energy use associated with accessing our content.



[Source: [LOW←TECH MAGAZINE](#)]

Resources: media + materials optimization

A software deployment practice

Packaging Fonts

Compressing Videos

Optimizing Images

Optimization for Media (Images and Videos)

✓ Quality: 100%

Lossy minification ⌘L

✓ Zopfli

PNGOUT

✓ OxiPNG

✓ AdvPNG

PNGCrush

✓ JPEGOptim

✓ Jpegtran

✓ Gifsicle

ImageOptim

File	Size	Savings
✓ dataset-search-header-bk108-optimized.png	11,578	20.0%
✓ MSU-horiz-reverse-web-header-optimized.svg	6,287	14.2%
✗ search-24px-optimized.svg	372	
✓ msu-logo-optimized.png	12,438	21.5%
✓ msu-icon-optimized.png	7,477	17.6%
✗ lock-24px-optimized.svg	362	
✓ msu-dataset-search-icon-192x192	14,862	41.3%

+

Saved 19 KB out of 73 KB. 26.6% overall (up to 41.3% per file)

⚙️ ↻ Again

A software deployment practice

Removing all unnecessary characters from source code without changing functionality.

Packaging software releases
Compressing HTML, CSS, Scripts

```
<!DOCTYPE html><html lang="en"
vocab="http://schema.org/"
typeof="WebPage"><head><meta charset="UTF-8"/><meta
name="viewport" content="width=device-width,
initial-scale=1.0"/><meta http-equiv="X-UA-Compatible"
content="ie=edge"/><title>MSU Dataset Search - Montana
State University (MSU) Library</title>...
```

A software deployment practice

Technical SEO

Crawling, Indexing, robots.txt

Structured data

```
<meta name="description"  
content = "... " />
```

Code:
smarter routines +
defensive programming

```
if (navigator.deviceMemory > 1) {  
    await import('./costly-module.js');  
}
```

```
if (navigator.hardwareConcurrency > 4) {  
    await import('./costly-module.js');  
}
```

```
const {level, charging} = await
navigator.getBattery();

// If the device is currently charging
// Or the battery level is more than 20%
if (charging || level > 0.2) {
  await import('./costly-module.js');
}
```



```
@media (prefers-color-scheme: dark) {  
  .day.dark-scheme  
  {background:#333;color:white;}  
  .night.dark-scheme  
  {background:black;color:#ddd;}  
}
```

A software
development
practice

[Intersection Observer API](#)

Lazy Loading HTML attribute

```

```

What is a PWA?

A software
development
practice

over HTTPS

manifest.json (installable)

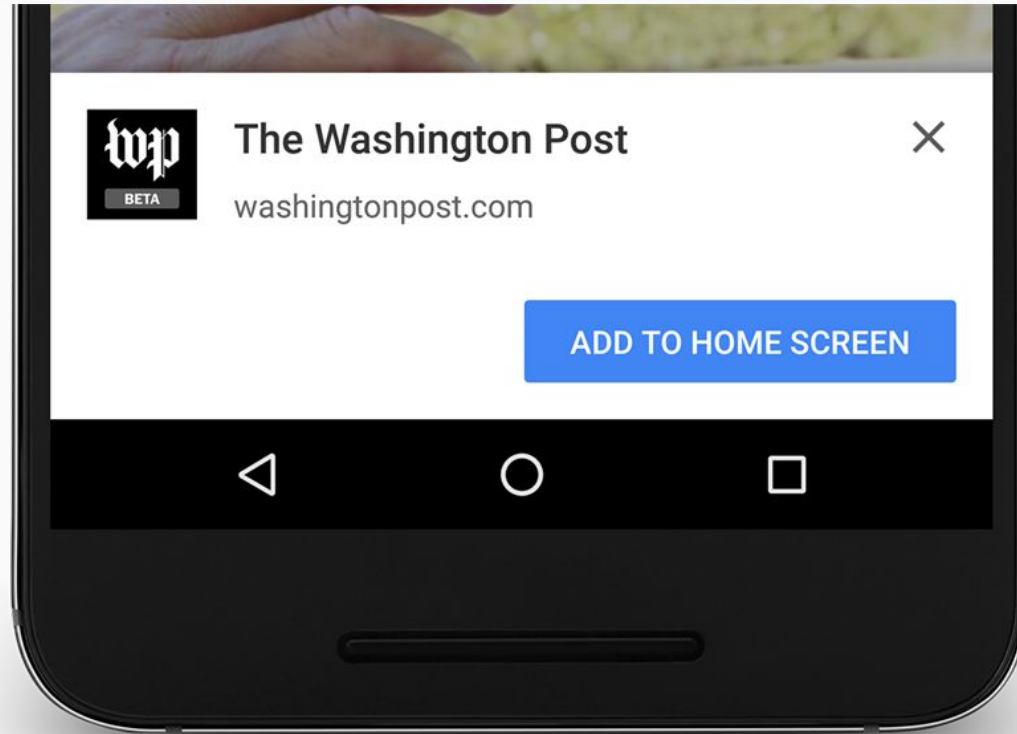
Javascript to cache files for offline

Static data stores (json)

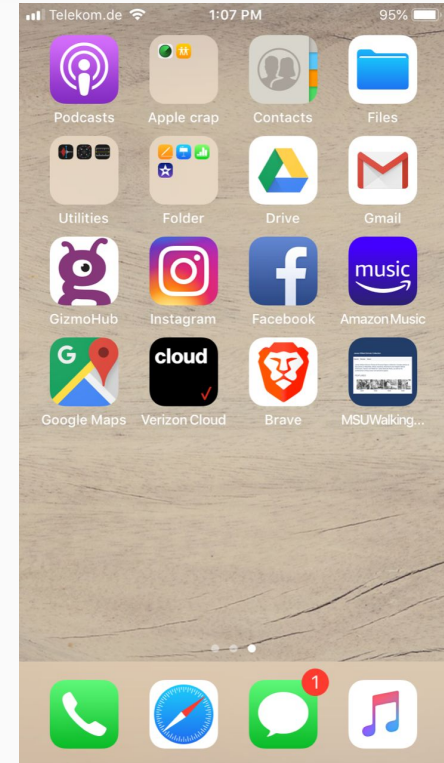
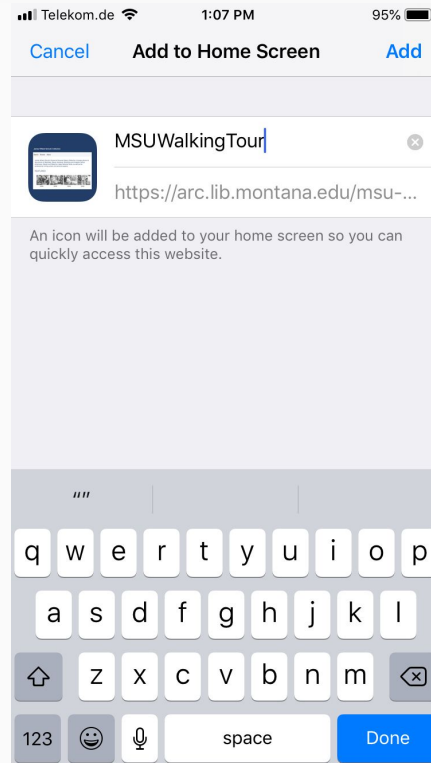
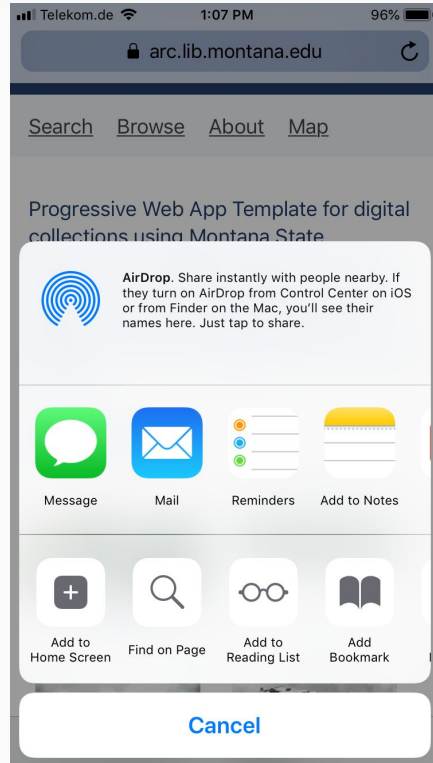
Progressive Web Apps (PWA)

Manifest File
Service Worker
Offline + Installable

Install the Web?



Installability



Manifest (.json)

```
1  {
2    "name": "James Willard Schultz Collection",
3    "short_name": "SchultzPWA",
4    "start_url": ".",
5    "display": "standalone",
6    "background_color": "#213c69",
7    "description": "A digital library template app",
8    "theme_color": "#213c69",
9    "categories": ["books", "education"],
10   "icons": [
11     {
12       "src": "./img/icons/icon-72x72.png",
13       "sizes": "72x72",
14       "type": "image/png"
15     },
16     {
17       "src": "./img/icons/icon-96x96.png",
18       "sizes": "96x96",
19       "type": "image/png"
20     },
21     {
22       "src": "./img/icons/icon-128x128.png",
23       "sizes": "128x128",
```

Service Worker (.js)

```
1 // Hola! This is an over-simplified ServiceWorker for a digital library PWA
2
3 const cacheName = 'diglib-pwa-v1';
4 const staticAssets = [
5   './',
6   './index.html',
7   './app.js',
8   './styles.css',
9   'items.json',
10  'manifest.json'
11 ];
12
13 self.addEventListener('install', async event => {
14   const cache = await caches.open(cacheName);
15   await cache.addAll(staticAssets);
16 });
17
18 self.addEventListener('activate', event => {
19   event.waitUntil(self.clients.claim());
20 });
21
22 self.addEventListener('fetch', event => {
23   const req = event.request;
```


items (.json)

```
1  [{
2    "item": {
3      "recordInfo_recordIdentifier": "42",
4      "identifier_ark": "ark:\V75788\m45d4f",
5      "identifier": "https://arc.lib.montana.edu/schultz-0010/objects/thumb-041.jpg",
6      "titleInfo_title": "James Willard Schultz and Friends: in a Garden, 1939",
7      "abstract": "2 older women and 1 older man sitting in garden in front of house. Not",
8      "extension": "aged persons, friendship",
9      "name_namePart": "James Willard Schultz",
10     "originalMetadata_name": "Unknown",
11     "originInfo_dateIssued": "1939",
12     "originalMetadata_dateIssued": "1939",
13     "originInfo_dateCreated": "2005-09-09",
14     "location_physicalLocation": "Montana State University Library Collection 10 - James",
15     "typeOfResource": "1 Photographic Print, B&W, 7 x 5.5 cm ",
16     "originInfo_publisher": "Montana State University--Bozeman",
17     "accessCondition": "https:\V\creativecommons.org\licenses\by-nc-sa\3.0\us\\"",
18     "subject_topic1": "Montana--History",
19     "subject_topic2": "Indians of North America--Montana",
20     "subject_topic3": "Schultz, James Willard, 1859-1947",
21     "subject_topic4": "James Willard Schultz",
22     "note": "None",
23     "genre": "Still Image",
24     "physicalDescription_internetMediaType": "image\jpeg",
25     "physicalDescription_digitalOrigin": "reformatted digital",
26     "recordInfo_languageOfCataloging": "en",
27     "recordInfo_recordContentSource": "MZP",
28     "recordInfo_recordCreationDate": "2005-09-09 00:00:00",
```

Benefits

Discoverable

Linkable


Installable

Write Once, Publish Everywhere

Sample Application

MSU Dataset Search

Research Implication - energy-efficient, sustainable design




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Access datasets from creators affiliated with Montana State University (MSU)

 Enter keyword, name, or title...

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2018-11-05
[Computational data for selection of Pbe+50Hfx functional for studying Ru-Cl/H-Pr3 complexes](#)
Szilagy, Robert K. , Savio Poovathingal, and Timothy Minton

Green Software Architectures

optimized source code + media

lean HTML/CSS, structured data


systems with compression + caching

serviceworker.js

items.json (static “database”)

Research Implications

Research Implication - energy-efficient, sustainable design


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Most popular ▾

2018-11-05
[Computational data for selection of Pbe+50Hfx functional for studying Ru-Cl/H-Pr3 complexes](#)
Szilagyi, Robert K. , Savio Poovathingal, and Timothy Minton

Carbon results for


arc.lib.montana.edu/msu-dataset-search

Share     



Hurrah! This web page is cleaner than 96% of web pages tested

Research Implication - energy-efficient, sustainable design

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MSU Dataset Search

ElementsConsoleSourcesNetworkPerformanceMemoryApplicationSecurityLighthouseGreenIT

Launch AnalysisSave analysisHistoryHelp

☒ Activate best practices analysis

EcoIndex A

EcoIndex 90	Water Consumption (cl) 1.8	Greenhouse Gases Emission (gCO2e) 1.2
Request number 0	Page Size (KB) 0	Dom Size 86

Best practices

Add expires or cache-control headers (>= 95%)	✓
Compress resources (>= 95%)	✓
Limit the number of domains (<3)	✓
Don't resize image in browser	✓ 0 image(s) resized in browser found
Avoid empty src tag	✓ No empty src tags found
Externalize css	✓ No inline stylesheet found
Externalize js	✓ 1 inline javascripts found

Empathetic DevOps

Coding + Social Good

Digital libraries for Everyone.

- lightweight computing practices
- “Green” digital libraries that consume less energy
- discoverable + accessible to any user on limited device

****Thank you****

Jason A. Clark
@jaclark

- Eco Design Checklist
 - collectif.greenit.fr/ecoconception-web
- PWA Universal Builder
 - github.com/lukeed/pwa
- Ecometer Design + Development Rules
 - www.ecometer.org/rules
- Website Carbon Calculator
 - www.websitecarbon.com
- EcoIndex Tool
 - www.ecoindex.fr, [GreenIT-Analysis extension](#)

- Digital Library PWA Template
 - github.com/jasonclark/digital-library-pwa
- Montana State University Dataset Search
 - github.com/msulibrary/dataset-search

References and Follow-up Resources

Progressive Web Apps - Mozilla Developer Network

<https://developer.mozilla.org/en-US/docs/Web/Apps/Progressive>

Sustainable Web Design

Tom Greenwood

(Book published in February 2021)

<https://abookapart.com/products/sustainable-web-design>

Measure the server-side impact of your application with PowerAPI

Cyrielle Willerval

2020-05-14

<https://blog.theodo.com/2020/05/greenit-measure-server-energy-consumption-powerapi/>

Speed Matters: Performance Enhancements for Library Websites

Scott W. H. Young

Weave: Journal of Library User Experience

Volume 1, Issue 4, 2016

<https://doi.org/10.3998/weave.12535642.0001.401>

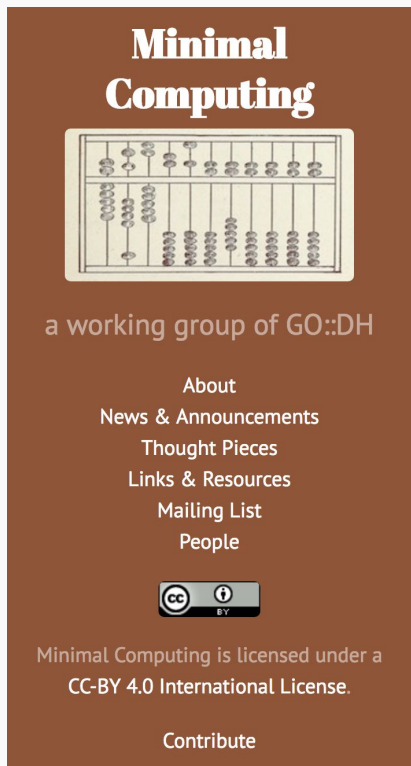
Materiality of the Virtual - Digital Technology and the Climate Crisis?

Hunter Vaughan

Public lecture, Media Studies in the College of Media, Communication, & Information, University of Colorado Boulder

2020-02-26

[Webcast](#) | [Presentation Slides](#)



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Minimal Computing in Libraries: Introduction

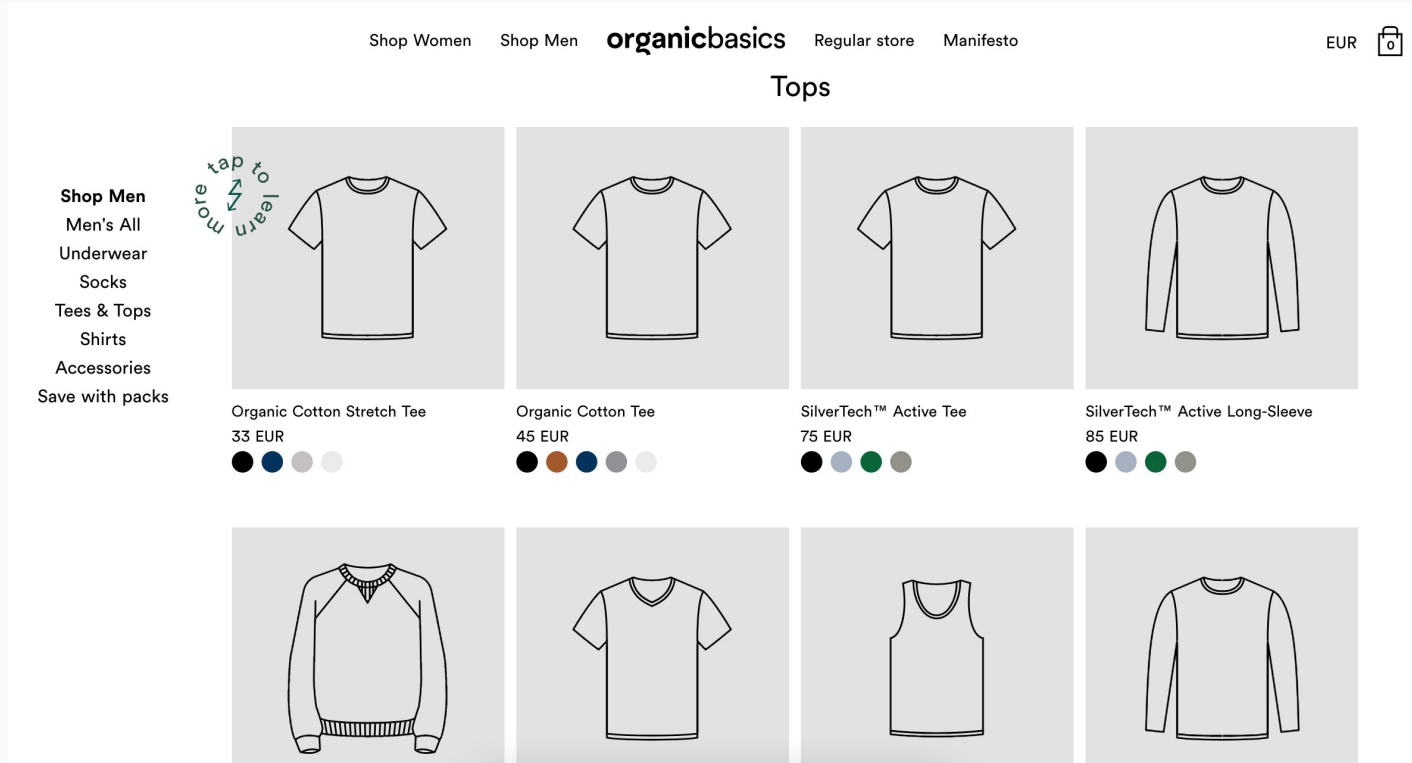
by Stewart Varner - 15 Jan 2017

[The following paper was delivered at the DLF 2016 Forum in Milwaukee as the introduction to the “Minimal Computing in Libraries: Case Studies and the Case” panel]

Content management systems like Wordpress, Drupal, Omeka and even OJS have had a huge impact in digital scholarship. Before those tools emerged, building a website was actually kind of tough. Even if you managed to get access to a webserver, you had to have a little tech know-how to get something online ... and to make it look good was a special challenge.

The rise of the CMS changed most of that and the advent of hosted versions of CMSs changed all of that. No server, no problem. No HTML/CSS skills, no problem. And across the world wide web, millions

Proof of Concept Websites - OrganicBasics



Proof of Concept Websites - OrganicBasics

