

# Case Study: Global websites – Improving access for global agricultural extension

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# Introduction

ECHO exists to reduce hunger and improve lives through agricultural training and resources. Working through the internet and regional impact centers around the world, ECHO connects small-scale farmers, and those working to eliminate world hunger, with essential resources and each other. These resources include a knowledge-base of practical information, experienced technical support, and an extensive seed bank focused on highly beneficial underutilized plants.

The world wide web promises cost-effective access to its more than 3.2 billion users, with more than 2 billion of these users coming from developing countries. As internet penetration improves in the developing world, agriculture extension stands to benefit from its reach and rapid growth. For every internet user in the developed world there are two in the developing world. More than 95% of the world's population is now covered by at least a second generation mobile data network (International Telecommunications Union 2015).

As internet access has grown in both the developed and developing world, the need for more sophisticated online tools for agriculture extension has become apparent. In 2011 ECHO launched an online collaborative membership community called ECHOcommunity.org. Since that time, more than 10,000 members worldwide have accessed technical resources, participated in online discussion, registered for events, and requested trial seeds from ECHO seed banks.

In 2014, ECHO saw the need to upgrade the capacity of the ECHOcommunity website to provide a solid foundation for its continued growth. The re-design called for the native support of nine languages key to its current areas of impact, and the ability to effectively deliver rich-media resources and communications tools to internet users with varying bandwidth capacities and devices. This document serves to illustrate the lessons learned in the process of improving the global accessibility of our resources. This is not intended to be an exhaustive list of best-practices in website development for a global audience, but rather a look inside the decision making process behind one site.

## Challenges in global accessibility

In the context of the world wide web, the term accessibility usually refers to a standard of inclusive website development based on the idea that information should be equally

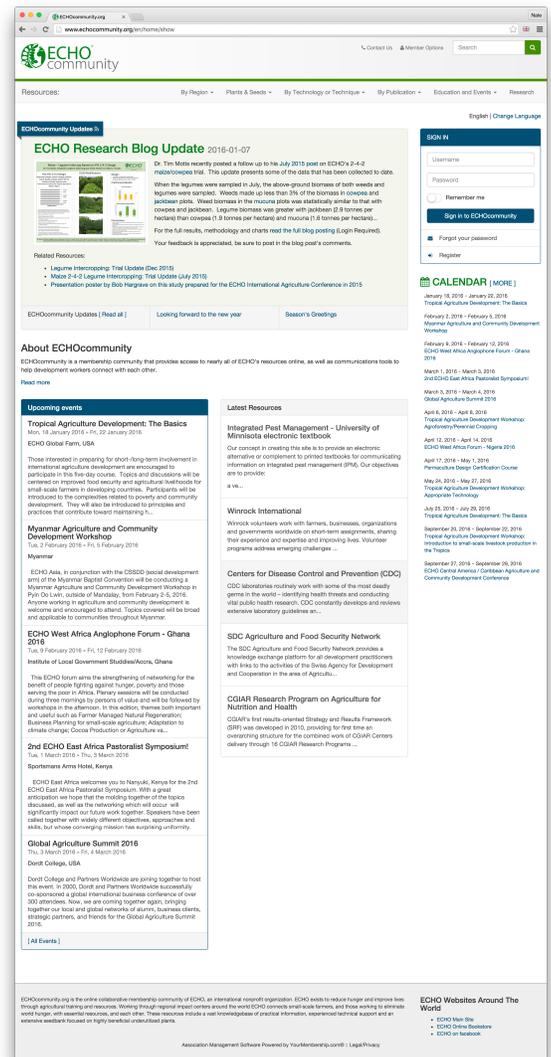
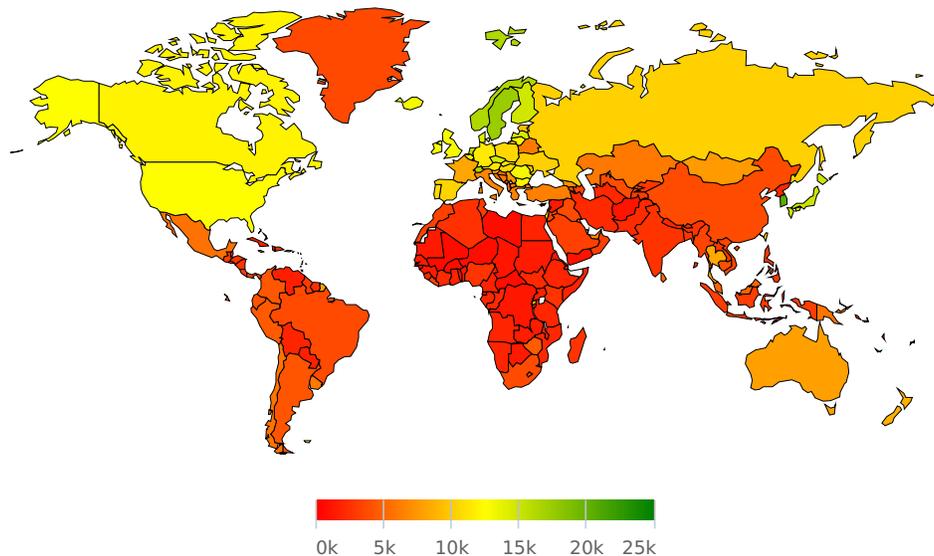


Figure 1 - A Screenshot of the 2014 ECHOcommunity.org redesign

available to all people. Extensive study has been done on the subject of web design accessibility for those with visual, auditory, physical, speech, cognitive, and neurological disabilities. This study has led to a set of standards endorsed by the world wide web consortium (or W3C) that guide both content creators and the organizations that develop software for the web (Introduction to Web Accessibility 2005). These standards have proven to be useful beyond providing access to people with physical and mental disabilities. By adhering to these standards, web resources benefit from greater portability between systems, longevity, and increased understandability by non-human researchers such as search engines and natural language neural networks. For globally accessible websites, two additional areas of accessibility must be addressed: technological accessibility and cultural accessibility.

Average connection speed



[state of the internet]

brought to you by Akamai

<https://www.stateoftheinternet.com/>

Figure 2 – Comparison of average internet connection speeds by country in 2015 ©Akamai Technologies Inc - Used with permission <https://www.akamai.com/us/en/privacy-policies/copyright-and-other-notice/index.jsp>

### Technological accessibility

Accessibility regarding technological challenge has always been a part of web development as the capabilities of specialized media delivery have, up until recently, exceeded the bandwidth and processing power of the generalized systems that make up the internet. Media must be reformatted, compressed, or otherwise adapted to be delivered to users with varying internet access speeds and for display on a wide range of devices. Websites targeting a global audience, especially those working with the developing world, need to take into consideration that end-users may be contending with technology that is significantly more limited than that which is generally available to others.

### Cultural accessibility

Cultural accessibility encompasses web content, and its organization, in regards to the needs of users in different geographic, cultural, and language groups. Challenges in cultural accessibility include the translation and delivery of content in multiple languages and the

localization of elements such as navigation, dates, and currencies. Furthermore, sociological adjustments must be made to provide this material in a way that is not just appropriate for a given individual, but also effective in its purpose.

## Planning for accessibility

Mistakes made in the initial steps of production can have wide-ranging and long-lasting effects on the accessibility of content on the web. Many times the issues that arise from incomplete pre-production planning do not appear until much later in the implementation, and sometimes cannot be repaired without significant, or even complete, re-design. There can be no more important step in improving accessibility than researching the needs, nuances, and capabilities of end users.

### Maximizing flexibility

In the case of ECHOcommunity it was determined that a custom-designed content management system (CMS) would be necessary to allow for the initial project specifications, and for its expected continued growth. This approach limited our reliance on the capacities of ready-made systems that either had globalization applied as an afterthought, or had been designed for a different purpose such as e-commerce. It is generally accepted that this is not the route most organizations should take, as custom-built solutions do not allow for outside support, either through commercial contracts, or an open-source community. Vendor lock-in is a very serious consideration, and the content management system chosen will determine the total capacity of any given site.

There are many open-source projects that can provide both community support and the core features of a modern website that should not need to be re-invented for every application. These projects can represent years of development by experts in a wide variety of fields, thereby reducing development cost and improving the end result. A search of the internet for “open source content management system” returns many results, each with its own strengths and weaknesses.

In order to gain both the benefit of an open-source community, and the level of customization needed, ECHOcommunity.org was built on an open-source framework called Ruby on Rails. Building the CMS on top of a well-known, and well-designed, framework allowed for full customization, while still providing a community from which to source support and pre-built software. Open-source Ruby “Gems”, or software packages, exist for most major functions of a website such as authentication, media management, SEO, and in this case (most importantly) internationalization and localization. By using a combination of custom code, and these pre-built resources, the ECHOcommunity.org redesign was able to be completed in less than 12 months with only one full-time developer.

### Separation of content and presentation

In the initial design of any modern website careful attention should be paid to the separation of content from the design, or presentation, of that material. The widespread adoption of Cascading Style Sheets (CSS) has done much to improve the adoption of this design philosophy. Separating document structure from formatting and presentation elements greatly improves the machine readability of digital documents which can have implications in search engine optimization and accessibility through assistive devices like screen readers. Other

benefits include the ability to easily update the look and feel of a website without individually modifying every document, and improved portability of material between formats and computer systems. For global websites this is imperative, as it also allows for the presentation of a given document in different languages and with variations in localization.

One significant issue that was identified in the re-design of the ECHOcommunity.org website, was the fact that most of the documents were only provided in PDF format. The PDF format is a one-way format that ensures that a styled document will be displayed or printed as intended, no matter what system on which it is rendered. PDF is a valuable format for printing and sharing documents, but has severe limitations where documents need to be modified. ECHOcommunity.org uses single-resource management which allows for any given resource to be displayed in any provided translation with a single URL; this is not possible with PDF, as each file, and in this case each translation, must have its own unique URL. By separating the content from the formatting, PDF files can be dynamically generated from the document. This arrangement provides for the benefits of the PDF format and the flexibility and longevity of text-based document storage.

### Accessible-first design

Andrew Hoffman, a front-end web developer at IBM writes “Coding accessibly is not an extra thing to consider at the end of a project, but simply another thing to consider from the beginning” (Hoffman 2014). Broadly speaking, as the web has developed, accessibility has been treated as a luxury to be added at the end of a production cycle. Over time, the idea of adding accessibility has gone from an afterthought to a priority, one that may even be backed by legal mandate (Legal and Policy Factors in Developing a Web Accessibility Business Case for Your Organization 2012). Designing a website from the ground-up to be compliant with web standards, and with support for all forms of accessibility is a challenge, but one that is significantly less complex than remodeling a site that has not considered accessibility from the beginning.

*We need to change the way we talk about accessibility. Most people are taught that “web accessibility means that people with disabilities can use the Web”—the official definition from the W3C. This is wrong. Web accessibility means that people can use the web. – Anne Gibson (Gibson 2015)*

## Technological options for improving global accessibility

### Speed

Due to variations in internet bandwidth, globally accessible websites – especially those that seek to include users in less developed areas – must make conscious decisions to reduce their bandwidth consumption and improve availability. ECHOcommunity.org has employed several straightforward strategies to improve the speed of the site. This is done in a two-step process that reduces the size of each resource and the distance each resource must travel to reach its destination.

### Reducing bandwidth consumption

There are many technological tricks that can be employed to reduce page size, however each has drawbacks and can be difficult to maintain. The strategy employed in the design of

ECHOcommunity.org is to keep the design as simple as possible, trimming away whatever is unnecessary. Images are a common source of bandwidth consumption. By reducing the number of images used in a site design, a lot of bandwidth savings can be realized with very little effort. Using images sparingly does not, however, mean that a site must be without design appeal. Modern Cascading Style Sheets (CSS) are well supported by internet browsers and allow for significant design flexibility with minimal bandwidth use.

ECHOcommunity.org also employs a single web font called Font-Awesome (<https://fontawesome.github.io/Font-Awesome/>) to provide universally recognizable icons for the user interface. Since web fonts are scalable, this greatly simplifies support for both high and low-resolution screens, and provides an abundance of content from a single download that is automatically cached in the user's browser. This web font file is approximately the size of two images, but replaces hundreds of round-trips to the web server for individual image files, and eliminates the necessity to create and maintain complex sprites.

By using an image service to automatically resize and optimize images uploaded to the website ECHOcommunity.org has also removed much of the possibility that very large, un-optimized, image files can be accidentally embedded in the website. Inexperienced users, or content producers in a hurry can introduce image files that are inappropriately sized for users with limited bandwidth. Cloud-based services like Blitline (<http://www.blitline.com/>) and Cloudinary (<http://cloudinary.com/>) are not complicated to set up and can reduce administrative overhead, while ensuring that resources load quickly.

#### Reducing transit time

Though the internet is a global high-speed network, the physical limitations of distance between locations still apply. A resource stored on a web server located on the west coast of the North America will take longer to retrieve from Europe than one retrieved from an equally equipped server located geographically nearer to the user. When a web request must cross an ocean, it must also share bandwidth with many simultaneous requests on the limited resource of transoceanic cables. By reducing the distance a request must travel, the number of exchanges it must pass through is reduced, and potential bottlenecks can be avoided. There are services, called content delivery networks (CDNs), that increase the availability of web resources and reduce the physical distance between servers and consumers.

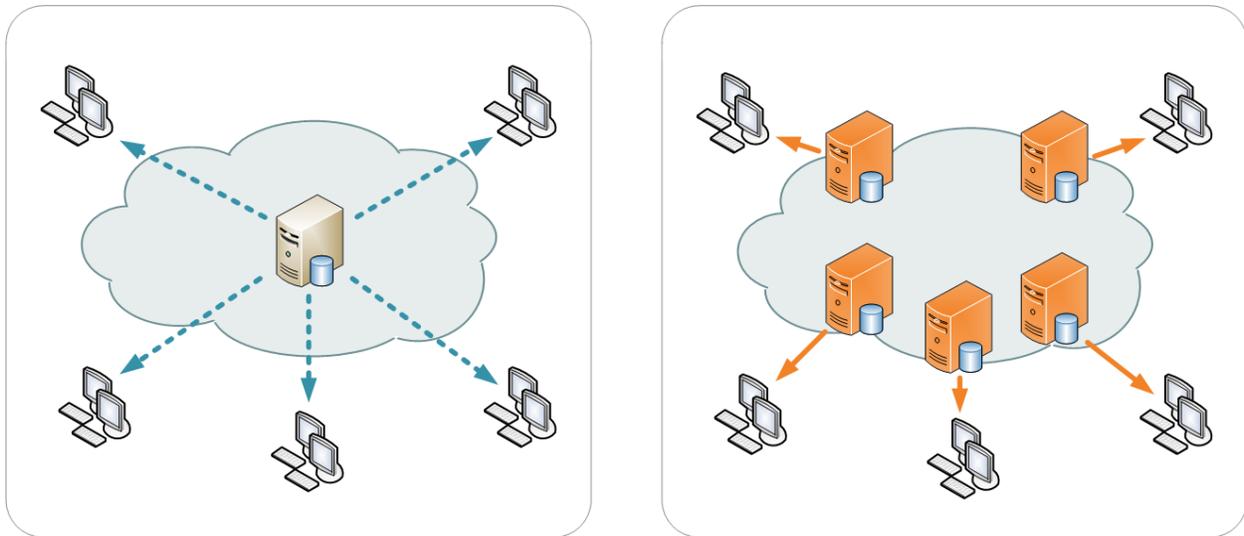


Figure 3 - Single server (left) versus Content Delivery Network (CDN) (right) - By Kanoha (Own work) [CC BY-SA 3.0 (<http://creativecommons.org/licenses/by-sa/3.0>) or GFDL (<http://www.gnu.org/copyleft/fdl.html>)], via Wikimedia Commons

ECHOcommunity employs a CDN, called Amazon CloudFront, to serve all images and other static assets from servers operated by Amazon at edge locations around the world. CloudFront, and other content delivery networks, strategically place datacenters near high-traffic internet exchange points (IXPs), reducing the number of hops a request must make before reaching a server with the needed content. A common, and accurate, illustration is to compare this to regional and long-haul airline travel. By placing a resource at the nearest hub city, a traveler need only take a round-trip regional flight to the hub rather than taking the costly and time consuming long-haul flight to the hub nearest a resource's origin, if such a direct route even exists.

A CDN service provides the hardware and software necessary to transparently replicate, update, and serve resources from the most strategic location based on the client's needs. By utilizing specialized systems and high-speed network connections, CDNs increase both the speed at which resources can be delivered, and the availability of resources when failures occur or traffic volumes are high. Because resources are cached at each edge location, content delivery systems can also reduce the workload and bandwidth used on primary web servers, thereby lowering cost.

Cost, variations in the services offered, and the geographic location of the assets operated by different CDN providers determine the suitability of a delivery network for a given site. For instance, at the time of writing, Cloudfront had no presence in the Middle East, whereas MaxCDN provided one edge location in Tel Aviv, and Cloudflare provided more than five points of presence in that region. Generally, the more edge locations in a given area the faster and more resilient the network will be for local users. One notable gap in coverage for most CDNs (at time of publication) is the continent of Africa.

#### *Reducing transit time for Africa*

*The Internet in Africa is growing fast. Internet penetration levels are about 20% and rising. Mobile subscriptions are just shy of 70%, and mobile broadband access accounts for more than 90% of Internet subscriptions. But*

*the aggregate indicators mask glaring disparities. At the high end of the spectrum, countries such as Morocco enjoy penetration rates above 50%, but at the other end are countries with penetration rates below 2%, and the majority of countries have Internet penetration of less than 10% (well below the 20% threshold that has been found to be critical for countries to reap the economic benefits of broadband investment) (Biru 2015).*

The development of terrestrial networks in Africa has been slower and less extensive than most of the world, and the internet infrastructure has been significantly impacted by this. The African continent hosts very few internet exchange points (IXPs,) or places where lower tier and local internet service providers exchange data. Subsequently, nearly all traffic in Africa flows through submarine cables before reaching locations where CDNs are financially feasible as low market penetration means reduced return on investment for expensive infrastructure. Notable exceptions to this are Egypt, South Africa, and countries participating in the East Africa Backhaul System (EABS). This is not to say, however, that African internet users cannot benefit from CDN services.

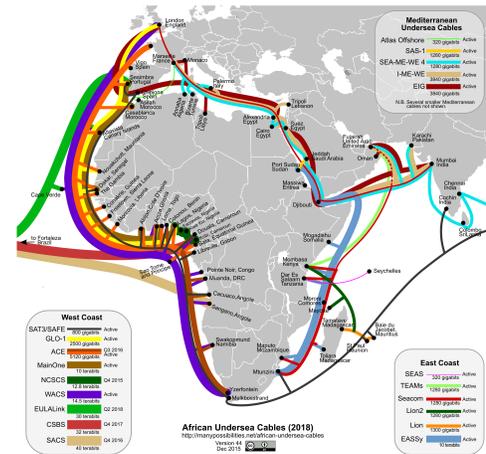


Figure 4 – Projected African Undersea Cables in 2018 - Steve Song

The structure of the Internet is improving in Africa. New submarine cables, and an increase in the number of IXPs is signaling that the growth seen in recent history is will be sustained for some time. By leveraging CDN services at the exchange points for Africa’s submarine cables users see some benefit today. For instance, CDNs in Western Europe serve users in West Africa, this does not eliminate the long-haul connections, but still shortens the distance to a North American resource significantly by avoiding transoceanic links.

### *Taking advantage of other’s CDNs*

It is not necessary to commit to a full CDN solution to benefit from content delivery networks. Many common frameworks and resources are hosted on such networks, and often both the resources and the services are provided free of charge. The ECHOcommunity.org website uses several web frameworks (Twitter Bootstrap, jQuery, and Font Awesome) that are provided through free CDNs. While these services provide very little control, they have the added advantage of increasing parallel access to resources, a simple strategy for improving page loading speed.

### Scalability

Scalability is the capability of a system, in this case a web site or application, to handle a variable amount of work without significant change to the system (Bondi 2000). The issue of scalability has less to do with global accessibility than it does with good pre-production planning and global citizenship. The scalability of any web site or application should be taken into consideration at the outset of the project to ensure that rapid growth does not overwhelm the system, and that the financial and environmental cost of the system can be reduced when less resources are necessary.

After careful consideration Amazon Web Services (AWS), a scalable cloud-based infrastructure service, was chosen to host the various applications and services necessary for the redesign of ECHOcommunity.org. There is no intention to endorse any product or business in this document; the rationale used to choose one service over another can be applied with varying results based on the needs of a given project. In this case, the AWS products provided a cost-effective integrated tool set with significant growth potential, without requiring any commitment or contracts.

#### Application Hosting

ECHOCommunity.org is a collection of Ruby applications that employ the Rails framework. This application runs on AWS OpsWorks which provides a point-and-click interface for deploying web applications. OpsWorks provides a simple solution that requires very little administration to run a web application on Amazon Elastic Compute Cloud while still providing the opportunity for significant customization. By using a software as a service (SAAS) provider ECHOcommunity.org benefits from continuous updates that provide increased security and redundancy, while reducing the amount of time necessary to administrate such a system.

#### Database Management

Amazon RDS is a managed relational database service that integrates seamlessly with Amazon OpsWorks and other products in the AWS eco-system. RDS was chosen primarily because of the simplicity of integrating it with the other components of ECHOcommunity.org running on AWS infrastructure. Additional benefits include automatic backup and recovery, and the ability to host a variety of different databases, each with their own advantages. PostgreSQL provides ECHOcommunity.org with a high-throughput database with built-in full-text search. The database's full-text search capability removes the need for additional software tools for indexing content until more sophisticated tools such as SOLR are needed, and the capacity exists to support them.

#### Object Storage

In addition to text-based content, the ECHOcommunity.org website hosts a wide variety of rich-media resources. Videos, presentation slides, images, and PDF documents are a few of the objects that are delivered through this web application.

Videos are largely served through popular video hosting sites such as YouTube and Vimeo. Utilizing third-party systems reduces the bandwidth and storage costs associated with large video files, and allows the use of their sophisticated processing, compression, and delivery software. These sites employ content delivery networks, and intelligent streaming for users with low-bandwidth connections. In addition to the technological benefits, the social features of video hosting sites help to promote content and increase exposure and reach.

Other objects are stored in Amazon Simple Storage Solution (S3), a scalable cloud storage system with practically infinite scalability. S3 charges only for what is used, and integrates seamlessly with Amazon CloudFront for content delivery. One requirement of the ECHOcommunity.org re-design was to provide the ability to track and report on resource access. CloudFront and S3 have the ability to provide deep insights into the use of these resources that is difficult to achieve using tools like Google Analytics.

## Device Adaptation

Standards help to define what output should be expected with a given input. Organizations like the National Television System Committee (NTSC) provide guidelines that ensure a user's experience, in this example a television signal, falls within an acceptable range as expected by a content producer. Unfortunately, while standards exist for the rendering of web content, they are, by necessity, not particularly strict. Therefore, the presentation of web content varies greatly depending on the device on which a resource is being rendered. Designing with these variations in mind has more to do with accessibility than aesthetics, as content readability can vary greatly between devices.

With the increased use of mobile devices for internet access around the world, developers must now account for an increased, and unpredictable, number of screen sizes and resolutions in their designs. Mobile broadband penetration increased 12-fold between 2007 and 2015, reaching nearly half the population of the world. Nearly one-third of people living in rural areas have access to the internet through mobile devices (International Telecommunications Union 2015). Global websites for agricultural extension must adopt a solution to these challenges in order to reach their target audience. Two design methodologies have emerged in response to this challenge: adaptive design and responsive design.

Adaptive designs employ distinct layouts depending on the screen size, or device type, used. For example, there could be a specific layout for mobile phones, tablets, and desktop computers. This type of design gives the designer a high level of control over how content is displayed, but requires a separate process for each layout and foreknowledge of the viewport size. Mobile versions of websites and native device applications such as iOS or Android apps are both forms of adaptive design.

Rather than tailoring disconnected designs to each of an ever-increasing number of web devices, they can be treated as facets of the same experience (Marcotte 2010). This is the philosophy behind responsive design. Responsive web sites utilize one layout which continuously changes based on width of the viewport, with the goal of providing an optimal experience for every screen size, without foreknowledge. Responsive design can be technically daunting, however many frameworks such as Twitter Bootstrap (<http://www.getbootstrap.com>) and Zurb Foundation (<http://foundation.zurb.com/>) provide turn key solutions with excellent documentation for implementing responsive web design. ECHOCommunity.org employs a responsive design based on the Twitter Bootstrap framework. This design was chosen in order to improve access for all devices, while keeping labor and costs low.

## Search Engine Optimization

Search engine optimization (SEO) is the process of improving the visibility, and understandability, of web content for search engines. SEO is an ever-changing field, and much of the discussion around optimization is beyond the scope of this document. However, SEO does have an important role to play in the accessibility of globalized web sites, especially as user behavior on the web today typically begins with a search engine.

According to Netmarketshare, Google accounts for more than half of all search engine use worldwide (Desktop Search Engine Market Share 2015). Globally accessible web sites should be aware that though Google holds a dominant position, specific cultural groups may

use another search engine almost exclusively. Baidu, Yandex and Naver are search engines with significant market share in China, Russia, and South Korea respectively. Fortunately, the differences between these tools are not significant for basic optimization.

According to a June 2015 report by Ascend2, 72 percent of marketers worldwide said relevant content creation was the most effective SEO tactic (Ascend2 and Research Partners 2015). Good content can, however, be undermined by being inefficiently or incorrectly exposed to search engines.

ECHOcommunity.org is a membership community that requires users to log-in in order to access many resources. Resources hidden behind paywalls and login requirements are equally inaccessible to search engines. This issue is partially solved by providing a description, preview, or abstract of restricted content to users who are not logged in. In addition, by providing insight into the content of a resource, users are provided with incentive to take the step of registration or login.

Another search engine optimization challenge experienced in the redesign of ECHOcommunity.org was related to the multi-lingual nature of the website. By providing a detailed site-map, and by following proper language meta-tagging conventions, search engines can better understand the underlying structure of a site. This understanding can have a significant impact on search engine page ranking for users in other languages. Improvements in SEO are partially responsible for a nearly immediate 25% increase in traffic at ECHOcommunity.org when the redesigned site was released.

## Cultural options for improving global accessibility

### Language

Other than internet access, there is no greater barrier to global accessibility than language. While tools such as Google Translate exist to automatically translate web pages and documents, the accuracy of these resources is not yet comparable to human translators. As human translation can be costly and time consuming, the question remains if the accuracy is “good enough.” In its first three years of existence, ECHOcommunity.org utilized machine translation for all but a few key documents; through experience and feedback from members it was decided that this was not an adequate solution.

In order to expand the global reach of ECHOcommunity.org the main content pages, some key resources, the navigation, and user interface of ECHOcommunity were translated into nine languages: English, Spanish, French, Chinese, Kiswahili, Thai, Burmese, Khmer, Vietnamese, and Indonesian. These languages were chosen as a starting place due to their use in areas geographically adjacent to ECHO’s regional impact centers.

The choice of which languages to support is usually determined by which languages will provide the best return on investment. There is no recommended list of languages that a site should support, as every business and organization has different needs and goals. For example, at time of publication Amazon.com supported 10 languages with additional variations to suit 13 locales (Amazon.com 2015). The combined populations of these locales only cover about half of the world’s population, however their combined gross domestic products indicate that they represent nearly three-quarters of the world’s spending power. For a retail site, this makes sense, especially since other business factors may reduce the value of providing services in

certain regions. For comparison, social media hub Facebook supports more than 40 languages (Facebook.com 2015). Facebook has a distinct advantage over Amazon.com in that there is very little to translate and maintain, since most content on Facebook is user-generated.

Before investing in translation, a hypothesis should be formed and tested as to which languages are necessary; this research should be revisited periodically to ensure that a site's target audience is being served. Web analytics tools such as Google Analytics can provide demographic data for visitors including their location and browser language settings. Measurement tools were developed along with the translation management features of ECHOcommunity.org to analyze traffic on the site and highlight resources that are requested in languages not yet supported by that resource. By studying this data, investment in future translation can be informed by demand, improving both efficiency and value.

No matter how many resources are translated there will always be gaps in language coverage. In order to provide the best experience for users when a resource is not available in their preferred language ECHOcommunity.org employs fallbacks. Human translated messages show what translations are available, as well as the full text in its original language. The option for machine translation is made available, but nothing on the site is machine translated without user permission in order to build trust.



Figure 5 - A human translated language fallback menu.

### Challenges in character encoding

When ECHOcommunity.org originally published documents in Khmer and Burmese character support for these languages was so poor that the documents were hand written, scanned, and published as images. Today, very few character sets cannot be represented in the UTF-8 encoding. By utilizing Unicode, and specifically UTF-8: Latin, Greek, Cyrillic, Asian and many more characters can be accepted by web forms, stored in databases, and rendered in web browsers.

### Localization

Translation is the act of transforming content from one language to another, such as French to Thai. Localization, on the other hand, means adapting content so it is appropriate for local markets. Localization employs sociology and anthropology to ensure that content is not misunderstood, and can be applied by the user. While localization includes reformatting dates and currencies, it is also the analysis and manipulation of all kinds of content.

### Design considerations for translation and localization

There are some design considerations that must be made when translation and localization are employed on a website. Colors and icons can have different meanings in various cultures; and images may convey unintended meaning based on the viewer's social, religious, or political context. Employing feedback from end-users can greatly reduce the friction that design decisions may cause, and should be solicited early and often.

Differences in word-length and reading direction can cause content to change size and orientation considerably between translations. Responsive design helps to mitigate these issues by eschewing fixed-width design and prioritizing text readability.

Text in images should almost universally be avoided. It is much easier to localize captions than to provide alternative images for each translation. Website designs using images with text are usually more resource intensive, harder to translate, and cost more to deploy and cache. Google in particular has excelled in building global-scale products, and part of this has meant designing minimalist interfaces:

*“Google realized early on that it had to invest in languages if it was going to succeed in local markets. But what has also served Google well is that it builds products to scale. That is, it creates ‘world ready’ designs that are text-based and almost entirely free of visuals.”*

*- John Yunker, co-founder of Byte Level Research, a boutique research and consulting company dedicated to the art and science of web globalization (Sawers 2011).*

## Conclusion

Over the past 40 years it has been demonstrated that the internet has the power and potential to transform societies. This transformative power is being leveraged in virtually every industry. As agriculture extension is increasingly provided through the internet, making resources accessible to those in the least developed world will only grow in importance.

Informed pre-planning and shared experience result in the conservation of resources and create a platform from which innovation can arise. By focusing on accessibility, in all of its forms, online resources are provided greater impact and value.

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