Website Engineering in the Real World

Chris Gibson
CECS Student, University of Louisville
902 Lime Spring Way
Louisville, KY 40223
ctgibson@gmail.com

ABSTRACT
The website has become a staple in the business environment, to provide information and services, and connect business-to-business and business-to-customers. Many sites require re-engineering in order to facilitate the needed complexities and frequent changes demanded. For such efforts, it is essential for web management to be adequately applied and evaluated with relevant metrics and measures. This paper presents usability and maintainability as the two primary areas of metrics, which provide useful information for web engineering development in the real world.

Categories and Subject Descriptors
H.3.5 [**Information Storage and Retrieval**]: Online Information Services – *commercial services, data sharing, web-based services.*

General Terms
Management, Measurement, Design, Human Factors

Keywords
Website, Usability, Design, Development, Agility

1. INTRODUCTION
Today, many websites require a dynamic maintenance and re-engineering outlook. Business needs require changes and web sites must present consistency and be current in their web-content. Websites for the spectrum of small to large organizations can have substantial complexity and hence demand careful quality control for changes. As well, a high level of development agility is necessary to keep pace with the demands of the online community. Websites must be designed in such a way, as to meet the needs of this demanding audience while providing a framework that can be easily manipulated to foster design changes on multiple levels.

2. RECENT LITERATURE
The lion's share of research made in recent years in the area of web development is focused around website usability. This phenomenon is understandable as the users' experience on a website is probably the most important factor for consideration in designing and developing such a powerful business tool. Many authors have written books and articles identifying good practices in the realm of web design. Some have sought out metrics to quantify website design to give some level of evaluation of the quality of a website. Much of this work has also been focused on website usability across many elements common to contemporary websites.

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2.1 Truth from an Old Adage
The old adage Keep It Simple Stupid (KISS) seems to be a good way to identify the best practice approach to usability. Removing the user from the complexities of the website and making it as simple and intuitive an experience as possible is at the heart of a good website design. Experts suggest that website design should make it essentially mindless to browse a site and locate information of interest [2]. Reducing the learning curve for website users is done by utilizing standards of conformance whenever possible. Items such as the navigation placement, the use of simple search boxes, and inclusion of a company logo at the top left of the page help the user along in their understanding of the website, and make it more likely for them to revisit and use the website.

2.2 Primary Usability Insights
The role of navigation is of utmost importance in usability, giving users the ability to locate and access information or services of interest with ease. Use of a simple navigation menu at the top or left of a site in combination with a search box simply labeled "Search" can make all the difference in the success of a website [1][2][4][5]. The information architecture also must be structured logically and present the user with their current location within a site [4][6]. Grouping into sub-site areas categorize and segment information can assist in this arrangement, with use of consistent color and styles within a sub-site. The textual content should be provided in readable, standard fonts with proper emphasis for titles, headings and page text [2][4]. Clear and concise wording, as short as possible and the use of bulleted lists whenever possible provide the user with material easily scanned for important information without all the unnecessary fluff and wordiness [2].

These are some of the main points of interest in web usability, all of which have been carefully dissected and explained in detail in a plethora of works in recent years. There is a wealth of knowledge and suggestions covering the breadth of a website in the area of usability, to the extent that it can be difficult to sift through and utilize such knowledge effectively. This investigation sought to do some of the sorting footwork in usability, while contributing input on issues of management, maintenance, and re-engineering. This effort seeks to attach the seemingly unlimited resources and concepts of the design realm

to the demands and limits of the business environment for a real look at how such work is accomplished adequately.

3. DEVELOPMENT OF A WEBSITE

The goal of the investigation was to sort through usability issues and narrow the focus to key elements for consideration for time-conscientious developers. Rapid development and change handling for publishing and maintaining a website using these usability factors provides for much needed web engineering agility. To establish and promote a framework for such demands, a re-engineering effort of an existing company website was undertaken for relevant and practical insights of development.

The company website used in this investigation was re-engineered, focusing in on harnessing the basic usability standards to revitalize the website, and do so to both the users' and the developers' advantage. The original site was found lacking in many of the standard usability recommendations, so a re-engineering effort was necessary to bring the site up to par.

3.1 Specific Usability Goals

The usability of the site is, of course the primary goal. Each page must be easily accessed and viewed and users must easily navigate the site itself. This goal encompasses the structure, layout, design, and useful nature of the information, navigation, and services provided through the website. Consistency among the website with all other media publications, forms and logos of the company as well as internal consistency of the website across pages is a necessary condition for usability.

The website should be aesthetically pleasing, while providing all the information in a concise and nicely arranged manner. The site should present reliable information regarding all products and services, promotional offers, current events and other information related to the company, in a consistent and timely fashion.

The site must provide access to all information within one or two hops, meaning that each page should provide navigational elements that will join it to any other page with a maximum degree of separation of two. Navigation should be logical and easy to distinguish, though not detracting from the contents of the page. A search box should be provided and simply labeled "Search" along with the navigation menu.

Primary contact information must be displayed on each page. Pages that are commonly used or visited should have prominent links to them on each of the pages. Images should be clear and relevant for the related content. Design elements may be used to enhance the presentation of the pages, but they should not detract from the presentation of the content. Text should be easily read and links easily distinguished. White space should be used generously to prevent overcrowding of information and other components.

All pages should be designed for view on 800 by 600 pixel resolution monitors and should respect the 216 web-safe colors whenever possible. Side-scrolling, or scrolling from left to right, should not be needed by any user utilizing a browser and computer with monitor resolution set at 800x600 pixels or higher. Page sizes should be maintained under an approximate size of 60 kilobytes or be able to be downloaded using a 56k modem in less than 10 seconds.

3.2 Specific Management Goals

The maintainability and management of the site are also of primary focus and represent the importance for easy updates and monitoring as necessary. This goal includes changes and modifications made to content, navigational elements, style, and design as well as the addition of new pages and features, or the re-engineering of the site as a whole.

The website should be designed in such a way that change handling and new developments should be easily completed. Changes to styles, formats and colors should be able to be done globally across the entire site, or among sub-site pages. Changes to common elements, such as the navigation bar or logos, should also be able to change based on global or sub-site level.

The addition or creation of new pages should be straightforward, and should remove the creator from having to add the common design and styles, excepting only a minimal amount of work. This means that for someone developing a new page, all of the design elements and common components, like the logo or navigation bar, should be easily implemented on the page. The task of building the new page should only require adding the page content and images and not require the rebuilding of common site elements.

The site file structure should be logically arranged, considering each of the sub-site groups. A subdirectory for each of the sub-site areas is expected, containing all of the pages for the sub-site. Images and scripts should be stored globally in appropriate folders, and should not be localized to any specific sub-site. New sub-sites may be added in future development, and should be created in individual folders under the root directory, just as existing sub-site folders are arranged. The naming convention for the sub-site, image, and scripts folders should be appropriate for their associated content.

3.3 Design/Development Process

The design determination initiated as an analysis of the current website, printed publications, and review of other websites in the same industry. Review of the current website was done to extract salvageable elements from the existing design and to begin shaping elements that would meet the goals for the new design. Printed publications were assessed to establish consistency and infuse the new designs with marketing's direction for the company. Other websites in the industry were reviewed for concepts, layout, clarity, ease of use, and presentation of content to give new insights for reaching the goals.

The design and development phase was truly a process of revisions and corrections that proved to optimize the design and layout for the website, enhancing the design's aspects and abilities to match up with the project goals. The layout, color schemes and major design themes found throughout the marketing publications and brochures formed the underlying basis on which the direction of the website design would take. From this basis, an initial concept sketch was developed and refined. Next, each component of the design was taken in isolation, developed by proof-of-concept development, then tweaked and fine-tuned. Then, the component was incorporated within the evolving model and further adjusted to work in tandem with the rest of the model as a whole.

Each element of the site went through this basic incremental process. Some elements required several steps of revisions, back-tracking, going back to the drawing board, or even complete scrapping of the element altogether. This stringent winnowing process was used to ensure that elements individually would fit in well with the model and follow with usability standards. Figure 1 demonstrates this process applied to the menu navigation graphics.

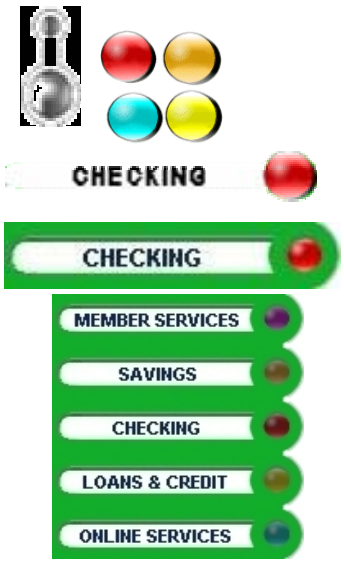

Figure 1. Incremental development of product menu

The completed model was used to develop a template on which the site and its associated sub-sites would be built. At the conclusion of the project, 5 major design revisions and numerous component revisions were required to achieve a very usable, consistent, and aesthetically pleasing site.

4. MANAGING WEB ENGINEERING

Once the new site was fully developed and released, an evaluation was needed to understand the value and relationship to useful usability factors and management concerns. A wealth of methods and figures can be found for quantifying and assessing a website, however, there must be a distinction made between data and information. The difference is the value of information versus that of data, given that data is a generality, including any identifiable attribute or related measure. Information is a subset of data, which is actually useful for measuring, assessing, and making conclusions or decisions. In this regard, it is important to identify informational metrics and measures in assessing the re-engineering effort made so that useful conclusions can be drawn on the value of a web-engineering project.

4.1 Evaluation Metrics

Useful and informative metrics for website assessment proposed by this research are grouped into two categories. The primary grouping of metrics includes issues related to ease of navigation, consistency, and clarity as addressed in usability. Usability metrics are perhaps the most important measures for assessing websites. This is almost self-evident as usability of a site directly influences user perception of the site, which then dictates the website's use and effectiveness. Table 1 shows some of the usability measures focused on for evaluations.

Table 1. Usability Measures

Metric	Measures
Navigation Structure	Visibility, Average page depth, Number of hops, Consistency
Effectiveness	Page traffic, Clarity, Concise content

The second grouping of metrics is the maintainability of the website, which assess the website from a developer's point of view. Maintainability is nearly as important as usability in that it considers design and development time and the ability to improve the website efficiently and effectively over the life of the site, as well as re-design or replace it as needed. This relates directly to timely and cost-effective requirements placed upon design teams in the real-world business environment. Measures analyzed in this project are summarized in Table 2.

Table 2. Management Measures

Metric	Measure
Development Time	Single page, Entire sub-site
Change Handling Time	Update content or image, Time to release

All useful and informative objective metrics can be associated into the two categories of usability and maintainability. It is also important to acknowledge the area of aesthetics and user preference, though it differs due to the subjective nature of personal preferences among users. Subjectivity can be very difficult to sift through in distinguishing between pure user preference and possible objective measures when venturing into this realm. As a result, the subjective nature of design was not addressed directly in this work, though its existence is important to recognize.

These analysis tools can be used to feedback evaluations to the design and development process iteratively to seek continuous process improvements. Use of a continuous improvement process refines the work done in previous cycles and enhances the overall output on a project. As well, successive iterations typically are easier to process, and are less frequently needed, and require less expensive development time for a company. The new website for the company was evaluated in this manner in the months following its release in order to make improvements in design usability and maintainability.

4.2 Evaluating the Old Site

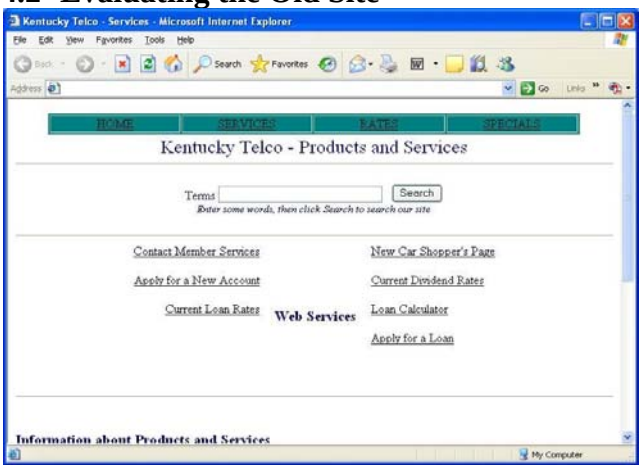

Figure 2. Navigation page for the old website

The navigation structure on the old site forced users to link back to either the home page, or to the services index page to navigate to any other page on the site. This services navigation page is shown in the Figure 2 above. A lack of consistency among pages on the old site, made identifying structure more difficult. The average number of hops to arrive at any given page from any other page on the site is two to three, and it is one to two if linking directly from the main page. Page traffic volumes seem to indicate the difficulty of navigation as many pages were requested minimally, if at all. Consistency of the site was split in two segments. The first were low visibility, low volume pages that were mainly text. The second segment was essentially the main home page which most of the development effort in prior months had been placed, reflecting improved uses of color, backgrounds and use of images.

Page traffic was reviewed on the old site for six months prior to the release of the new website. The traffic on the site shows a huge volume of requests on the main home page, with relatively few for all other pages. The volume of traffic on the remaining pages of the site quickly trailed off. The primary reason for such a disparity between volumes of requests on most pages versus the requests on the main page relates to the fact that users are coming to the site, to access their account only. This is speculated to also be a result of the poor navigation scheme, though to a lesser extent.

The content of the pages were generally well developed. Use of short sentences and paragraphs coupled with use of bulleted lists on most informational pages was done well throughout the site. This was probably the feature of the old site that met up best with web best practices. Another good feature of the old site was the speed of downloads and low page sizes. The old site was designed with the anticipation that the typical member would be connecting from home on a 14.4kbps modem or at best a 56kbps modem. As a result, mainly text-only pages were used, which made for very fast download response times. However, this made for a very unprofessional and unattractive design, and identifies another possible reason for low traffic volumes.

Overall usability was low, where the main home page was the only page with any real design and style. Navigation visibility was almost non-existent, except from the main page or services index page. The primary positive aspects of the old site were very fast download times, and use of concise content.

Maintaining the old site had several obstacles that made making changes and developing new components difficult. Each page was built independently of the others, thus when a change was needed to a site-level component, such as the top navigation, each page would have to be modified separately. This was a time-consuming and arduous task, so much so, that development efforts along this line were avoided almost entirely. This was the primary reason for the disparity in styles for the old site.

Time to create an additional page was small. However determining the appropriate style to use was sometimes a challenge. Total time for this centered somewhere around three hours, given the pre-developed content. If an image was to be included on the page, then another two to three hours was required.

The old site design was difficult to update, and consistency was an ongoing issue in development efforts. As improvements were made to the design on the home page, it became more evident that the site needed a redesign to make it more maintainable, reducing the times for development, especially on a site-wide level. Thus the re-engineering project became evident as a result of the poor level of maintainability of the site as a whole. This was especially evident when improvements to design and navigation were needed, though development times to adjust each page individually were too excessive to engage in such updates under the old design.

4.3 Evaluating the New Site

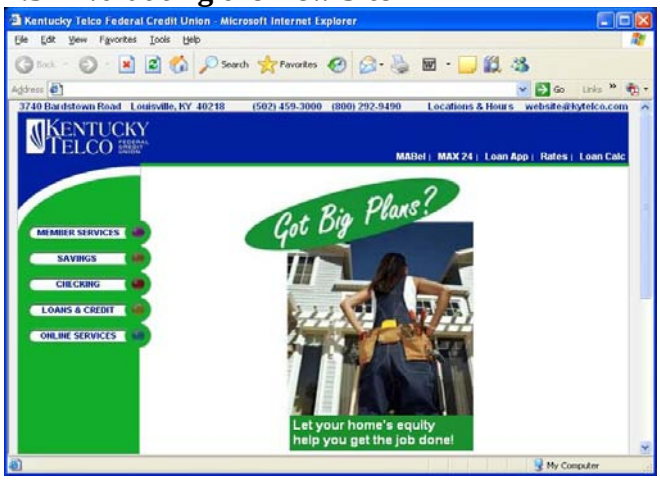

Figure 3. Main page of the new website

The re-engineering project sought to remedy the shortcomings found in the old site. The navigation structure on the new site design centered on drop-down menu based functionality. Instead of listing most of the pages for the site, pages were segmented into product categories, with each menu being a product line, and all associated products pages linked by options under the menus. This menu was placed on the right hand side of every page

throughout the site, making the effective average page depth equal one to traverse from any page on the site to any other page. Top navigation was also consistently positioned at the top of each page for quick access to high popularity pages. Figure 3 shows the new website design with the menu navigation and stylistic enhancements.

Page traffic for the new site was reviewed for six months after release of the new site to allow for the newness effect to wear off. Essentially, this took into consideration a small period of usage on first release as typical members learned the new interface and explored the new site, potentially generating a non-normal volume of traffic. The volume for six months following the initial site release were viewed to account for periods of usage variations and to allow for the normalization of usage to return. Interestingly, the number of hits in the first month was not relatively high or low as was thought a possibility. Instead, the number seemed to be in line with normal usage of the website leading up to the new site release. However, the pattern after release over the six-month period shows an improved growth rate in usage of the site.

The content used was essentially the same as from the old site for most pages, thus it was fairly concise with good use of bulleted lists and short paragraphs. Total page sizes were only slightly larger than the text-only equivalents in the old site due to the addition of images in the navigation structure and linked stylesheets. However, page sizes remained under the 60kb size requirement, maintaining acceptable download speeds. Consistency among pages in design, style and navigation persisted across all pages of the site.

Overall, the usability of the new site was effective and efficient as navigation structure was consistent across the pages of the site with high visibility. The navigation menu structure provided accessibility from any one page to any other page of the site in one hop. The content was concise, and image sizes were small, making total page sizes small and download speed fast.

The maintainability of the new site is much improved considering components can be quickly updated at a site-wide or sub-site level as easily as at an individual page basis. The entire site is built upon one template, making adjustments for each sub-site through use of script files. As well, stylesheets are included in the templates to allow for site-wide and sub-site level changes to be completed by changing the template or style sheet. The general outlook of maintainability on the new site shows a small time requirement for change or additions at the individual, sub-site and site-wide levels.

4.4 Comparing the Old and the New

In consideration of usability, a big factor of improvement was navigation. This component was made consistent across all pages of the site, and changed from purely list-based links to a menu-driven system, associating pages under product-lines. This increased visibility of the navigation and sub-site areas and reduced number of hops required to traverse pages to only one. The consistency of style improved the overall cohesiveness of the site, and increased its professional presentation. Page traffic increased significantly on the site, not only to the home page, but also across the site, increasing volume on a number of pages and span across the pages of the site. The number of hits per page per month on average nearly doubled. Tables 3 and 4 summarize highlighted usability factors.

Table 3. Navigation Comparison

Old Site Design	New Site Design
• Site map on homepage and services list page only • Top navigation style inconsistent • Navigation inconsistent across pages • 2-3 hops between pages	• Menu navigation on each page • Top navigation on each page consistent • Navigation consistent across all pages • Only 1 hop between pages

Table 4. Effectiveness Comparison

Old Site Design	New Site Design
• 60,000 average hits on home page • average of 1,100 hits for next highest volume page • 16 pages with 100 hits or more • 140 hits per page per month • 78% of pages requested per month	• 69,000 average hits on home page • average of 3,200 hits for next highest volume page • 42 pages with 100 hits or more • 270 hits per page per month • 93% of pages requested per month

The maintainability greatly increased from the old design to the new design. The ability to make changes or additions to the site on an individual page basis, sub-site level, or even site-wide through use of templates and stylesheets reduced development and change handling time from an unmanageable amount, to just under a few hours of work. This was the significant improvement the new design brought in relation to maintainability. The time requirements are listed in Tables 5 and 6.

Table 5. Development Time (in hours)

Development	Old Site Design	New Site Design
One Page	3-6	0.5-1
Sub-site or Site	(3-6)*(# of pages)	(0.5-1)*(# of pages)

Table 6. Change Handling Time (in hours)

Change Handling	Old Site Design	New Site Design
One Page	1-5	0.5-1
Sub-site	(1-5)*(# of pages)	0.5-2
Site-wide	(1-5)*(# of pages)	0.5-2

Overall, the usability of the site increased significantly as the improved navigation structure and consistency among pages increased visibility and cohesiveness, and higher traffic across the site was obtained. Maintainability greatly improved, as development times were reduced dramatically on site-wide and sub-site level additions and changes. From these two metrics, and the associated valuable measures, the re-engineering of the website has proven to add much value for both users and developers alike.

5. CONCLUSIONS

It is apparent that web technologies will continue to be a valuable and pervasive means of communication and commerce for small and large businesses and customers alike. For small businesses it is especially important to employee a website effectively to service its customers and be competitive in the marketplace. For such organizations, it is possible to undergo web projects to incorporate into their business strategy, and do so with relative speed while providing improved lines of communication for customers.

Using a useful framework for development can ensure the optimal pursuit of such a project, so developers will focus in on critical elements in the web engineering effort and do so within the constraints of the real-world business environment. Use of relevant metrics allows a company to quickly evaluate an existing site, provide guidelines for re-engineering a site, or a framework, which can be used in initial development of a site. Focusing in on usability and maintainability as the primary assessment and planning factors provide easy and effective tools, which are also easily understood in the presence of cross-functional teams. Utilizing the approach and methods in this case-study investigation indicate promising techniques for ongoing improvement web engineering processes.

6. FUTURE WORK

To continue the work in this field, it would be interesting and of great value to establish a methodology to align usability and maintainability to the profitability for an organization. A proper linkage between the concepts identified in this research and the increase of business to a company would be highly valuable.

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