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Webpage design optimization using genetic algorithm driven CSS

by

Sunyoung Park

A thesis submitted to the graduate faculty
in partial fulfillment of the requirements for the degree of
MASTER OF FINE ARTS

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Program of Study Committee:
Sunghyun R. Kang, Major Professor
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ABSTRACT

In the rapid emergence of globalization, e-commerce, and internet accessibility in remote parts of the world, ongoing feedback and participation from site visitors are essential for attaining clear and effective communication on a web site. This thesis presents a computational experiment for optimizing design of a webpage in an evolutionary manner. Webpage personalization is viewed as a configuration problem whose goal is to determine the optimal presentation of a webpage while taking into account the preference of the web author (designer), layout constraints (web design/editing language: HTML, CSS), and viewer interaction with the browser. The study proposes use of genetic algorithm-driven Cascading Style Sheets (CSS) to assist the process of webpage design optimization. This method will engage visitors to remotely modify and enhance the style (type, layout and color) of web site to fit their aesthetic and functional representation of well-received design. The preference feedback from user will be stored in an application server for automated evolutionary selection process and reinitialized for the next generation of users. Through the experimentation of web prototype and user evaluation test, the implementation of this method is examined and the derived design solutions are analyzed based on web aesthetics, standards, and accessibility.

CHAPTER 1. INTRODUCTION

However compelling the message, however great the copy, the way a web page is designed and presented will have a dramatic impact on success of your site, for better or for worse. When generating the look of a website, one of the main challenges is to take into account the user preference. Traditionally, web developers and designers have dealt with information architecture and usability research to tune their design. As more and more search engines and major news websites become customized and tailored to fit user preference (e.g. Google, Amazon, MSN, etc.), efficient and tasteful organization of information on a web site becomes a shared task between designer, user, and the intermediary—computer.

Evolutionary algorithm, implemented in a web design, can continually seek optimal design solutions, which can adapt to needs of diverse user groups and varying trend in the virtual web environment. Genetic algorithm, in particular, will fully explore wide variety of potential design solutions, which can lead to solutions that would otherwise not be considered using traditional design method.

Genetic algorithm is an optimization routine that works by imitating the paired biological processes of natural selection and reproduction. They are best for solving problems of optimization with a large number of potential solutions, which are difficult to solve using standard methods due to the intractability of these problems. IGA (Interactive Genetic Algorithm) is an extended version of genetic algorithm where the user performs the evaluation. IGA will provide individual layout solutions and lets the user choose the set of solutions that he or she favors according to their personal preferences and comprehension. Then it generated the next set of layout possibilities by operating a crossover or mutation of selection from different users. In this way, user can participates in design process in an intuitive and interactive manner that genetically searches towards most optimized design and functionality of the website.

1.1 Background and Motivation

The idea behind using genetic algorithms for webpage design is motivated by a system created by Karl Sims that uses genetic algorithms for creating 2D textures (Sims, 1991). The motivation behind his work was mostly artistic whereby the artist directly determined the fitness of each solution by visual inspection. His system allowed for random exploration of the texture space with solutions converging based on the likes and dislikes of the artist.

Like with any 2D page layout, webpage layout has also been found to be more of an artistic task rather than a mechanical one. Genetic algorithms seem appropriate for such artistic tasks since, unlike other more brute force algorithms, the genetic algorithm does not attempt to mimic or model any particular process by which solutions are created. Instead, solutions are generated randomly and evaluated after the fact. This method can be quite beneficial to web designers. When asked, most designers could not explain the process by which they generated their page layouts; however, they certainly know a good web design when they see it. The evolutionary mechanism can enhance design process by allowing designers to simultaneously compare and evaluate solutions in a dynamic and intuitive way.

The webpage layout problem has a multidimensional problem space. Genetic algorithms have been proven successful for problems with similarly large dimensional solution spaces. Although the goals of web design and long-established computational search process are different, the basic problem, i.e., the placement and structure of elements, is the same. Thus, there is some precedent in using genetic algorithms for this type of problem.

1.2 Objectives and Hypothesis

The objective of this study originated from my interest in seeking the commonalities between art and natural science. In science, evolution theory asserts that the ones who are fittest to the given natural environment can survive and evolve to the next generation.

Website is a virtual space where complex social interactions and navigations are intertwined much like in the real world environment.

My hypothesis in this study is as following. Genetic Algorithm serves as a highly efficient method for seeking optimal solutions to the complex multidimensional problems using the concept of biological evolution. Therefore applying Genetic Algorithm applied to a web site will work to find these better design solutions while discarding weaker-performing designs, which in result will provide virtual prototyping, evaluation, and optimization of in web design process.

Over the journey of this research, the author hopes to explore the process and possibilities in designing dynamic and agile web site by implementing interactive genetic algorithm (in combination with remote user participation). Ultimately I want to walk away with the understanding of evolutionary mechanisms in virtual web space in comparison to the ones in real world environment. The questions this study is attempting to answer are:

- Will the algorithm actually work in web design?
- Will the designs evolve towards optimal solutions?
- How do we evaluate design solutions?
- Can we expect comparable aesthetics that we would expect from traditional design method?
- What are the benefits for designers, non-designers, and programmers?

CHAPTER 2. REVIEW OF LITERATURE

This literature review discusses the core concept of evolutionary algorithm and its applications in various artistic fields, distinctively in 2-D layout, web and interactive design. The survey makes citation primarily based on the previous studies and materials on evolutionary design and genetic art. Various applications are introduced to exemplify the use of evolutionary algorithm to assist the process of optimization in print, web, and multimedia design. This methodology enables prospective audience to participate in the design process at different levels of interactive construction and manipulation in reaching the optimized final design. This paper will extend the discussion with reviewing materials on interactive genetic algorithm and its influence on human computer interaction. Also, the significance of user role in designing interactive and web media will be addressed. The implementation of this evolutionary optimization method in web media will be summarized with the existing applications, experimental studies, and further research possibilities.

2.1 Introduction

Conventional design process has largely relied on a one-way relationship in which designers create final design and spectators accept and adapt to whatever the outcome is. This traditional design process lacks in satisfying viewers' individual needs and tastes in different forms, at different times, on different devices, at a limited time given for designers. Thus, the new, more dynamic digital environment is needed to automatically generate design outcome to fit personal needs at different levels.

In design process, we constantly face a high degree of complexity and collaboration. Computational support must be provided for designers to explore alternative design solutions. The use of evolutionary algorithms to reduce the burden of designers, and to

enhance the design optimization process is an important research area. The founding studies of Sims' on genetic and evolution art show that the optimization techniques offer possibilities for the automatic generation of complexity in design process (Sims, 1994).

Genetic algorithm is a form of artificial evolution, and its commonly used method for optimization. A Darwinian “survival of the fittest” approach is employed to search for optima in large multidimensional spaces such as World Wide Web. The application of genetic algorithm allows virtual entities to be created without requiring an understanding of the procedures and parameters used to generate them. Sims, the early pioneer in this area keeps emphasizing the idea that the measure of success, or fitness, of each individual can be calculated automatically, or instead, a user can provide it interactively (1994).

Interactive evolutionary process permits procedurally generated results to be explored by simply choosing those that are the most aesthetically desirable for each generation. Over the last decade especially, art and design specialists have actively researched implementation of genetic algorithm in design process. The results of such study promisingly demonstrate generation of ideas with vast amount of design possibilities while allowing user to interactively evaluate the design outcome.

2.2 Genetic Algorithm: Definition and Paradigm

2.2.1 Definition

In order to comprehend the adaptability of genetic algorithm in design field, it is essential to understand first and the foremost the paradigm of genetic algorithm. Since the conception in the mid 1960's, evolutionary algorithms have provided many novel and interesting solutions to problems in wide variety of domains (Rowland & Biocca, 2000). From the design of flywheels and simple autonomous robots to the optimal fundamental principals involved in all these examples are identical and are based on nature's own design

strategy. In a very simplistic sense, this is survival of the fittest. Many reproduce entities and so pass on their information.

Genetic Algorithm (GA) is a specific type of evolutionary algorithm that is a family of optimization routines that work by imitating the paired biological processes of natural selection and sexual reproduction (Syrett, 2005). They are best for solving problems of optimization with a large number of potential solutions, which are difficult to solve using standard methods due to the intractability of these problems. GA is known to be highly ideal method for exploring these kinds of problems, since they tend first to seek partial solutions to a problem, and then use these partial solutions to define discrete neighborhoods for locating fuller solutions. In this way, they avoid the intractability of brute-force methods when confronted with high dimensionality, while still being able to explore a wide set of potential solutions.

2.2.2 Paradigm and Methodology

The process of GA begins by defining a problem space as a set of variables describing potential solutions to a problem and a currency for measuring fitness (i.e., success against that problem). Within this model space, the genetic algorithm will seek to find combinations of variables that create the strongest fitness measures. While there is rarely one right answer to these kinds of problems, there are always answers that are clearly better than others. Genetic algorithms will work to find these better solutions while discarding weaker-performing patterns (Syrett, 2005).

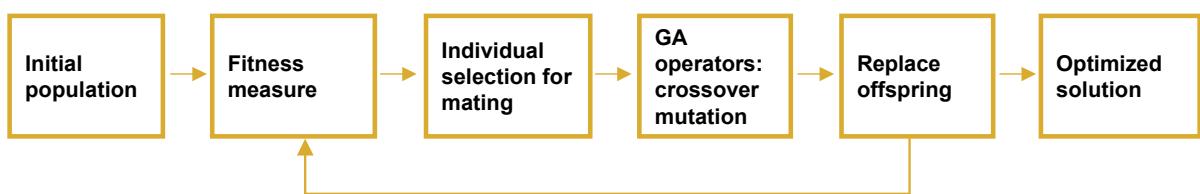


Figure 2.1 Flowchart for genetic algorithm process

After the problem space is defined, the modeler will choose an initial set of candidates to seed the optimization process (Figure 2.1). Once this method is applied to web design process, designer will choose initial set of candidates. These initial designs will then be presented to site users for preference test. It is this test results (i.e. preferred design variables and patterns) that will be randomly go through evolutionary process of crossover and mutation (Figure 2.2).

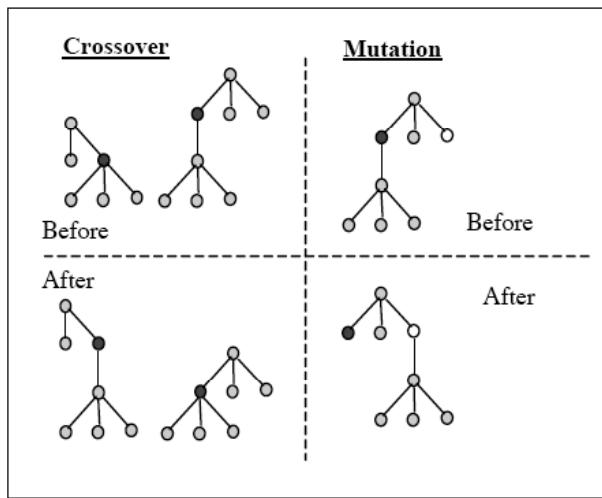


Figure 2.2 Genetic operators: For crossover a random node is selected for each parent and the subtrees from these chosen nodes are swapped. For mutation, nodes from the same tree are randomly chosen, then swapped. (Geigel & Loui, 2001)

These seed candidates are randomly generated or selected using existing domain knowledge. As presented by Syrett, once chosen, the candidates will start a process of iterative optimization with the following steps (Syrett, 2005): expose a set of candidates to a testing environment and collect feedback on their performance; evaluate the fitness of each candidate using a uniform success measure; create a new set of candidates with the fittest solutions having the best chance of passing on their solution to the next generation of candidates; add random mutations into the population using a predefined mutation rate (e.g., 1 in 100 new candidates will experience a mutation), which will allow new traits to enter the population from time to time; And repeat this process until a predetermined stopping point is reached.

This iterative process will tend to continually create stronger candidates until a point of equilibrium is reached, or the external forces shaping the model's performance significantly change. The use of mutation and sex-like reproduction make sure the model is constantly exploring new approaches and adapting changes as they occur.

GA uses two separate spaces: the search space (i.e. coded solutions – *genotypes*) and solution space (i.e. space of actual solutions – *phenotypes*) (Bentley, 1999). Bentley further explains that GA maintains a population of individuals where each individual consists of a genotype and a corresponding phenotype. Phenotypes usually consist of collections of parameters [in context of this thesis, such parameters might be location of a side panel, color and size of the text, background image, etc.].

Each chromosome is encoded with a bit string, and crossover operation swaps some parts of the bit string of parents. It emulates just as crossover of genes in real world that descendants inherit characteristics from both parents. Mutation operation inverts some bits in the bit string at a very low rate. In real world we can see that some mutants come out rarely. Each individual in population evolves to getting higher fitness as it goes generation by generation (Kim & Cho, 2000).

When applying GA to a given problem, the following three major tasks must be performed (Collins, 2003):

- Define a way of coding (i.e. representing) a state in the problem domain as a string of symbols, referred to as the ‘genotype’ or ‘chromosome.’
- Define an evaluation function capable of rating problem states (i.e. chromosomes) in terms of their problem specific behavior (in phenotypic state space) and returning an appropriate fitness score.
- Define a set of selection and reproduction operators suitable for the problem representation used.

Experimental results show that for most GA, evolution makes extremely rapid progress at first, as the diverse elements in the initial population are combined and tested. Over time, the population begins to converge, with the separate individuals resembling each other more and more. Effectively this results in the GA narrowing its search in the solution-space and reducing the size of any changes made by evolution until eventually the population converges to a single solution (Goldberg, 2002).

Theoretical research to investigate the behavior of the various varieties of GA for different problems is growing rapidly, with careful analyses of the transmission of schemata being made (De Jong, 1975; Kargupta, 1993).

Some of the areas that have had solutions successfully optimized by GA are:

- Machine learning
- Strategy acquisition
- Ordering problems
- Control systems
- Fault-tolerant systems
- Scheduling
- Data mining
- Set covering and partitioning
- Signal timing
- Composition of music
- Evolution of engineering designs

2.3 Genetic Art and Evolutionary Design

2.3.1 Background

John Frazer, one of the most earliest and renowned pioneers in the field of evolutionary design, defines design as the imaginary jump from present facts to future possibilities (Bentley, 2002). He adds that design is a series of amazing jumps or creative leaps; but design as seen by the design historian is a smooth progression or evolution of ideas that seem inevitable with hindsight. It is a characteristic of great ideas that they seem self-evident and inevitable after the event. But the next step is anything but obvious for the artist/creator/inventor/designer stuck at that point just before the creative leap. They know where they have come from and have general sense of where they are going, but often do not have a precise target or goal (Bentley, 2002).

As designers we cannot afford profligate prototyping and ruthless experiment, nor can we operate on the time scale of natural design process. Instead, as Bentley suggests, we can use the computer to compress space and time to perform virtual prototyping and evaluation before committing ourselves to actual prototypes. This is the hypothesis underlying the evolutionary paradigm in design.

Computers have been used to produce art almost as long as they have had output devices. Evolutionary art – the use of computers to evolve artistic images – is a much more recent development, relying as it does on several physical aspects of computing such as ‘real-time’ displays as well as development in computer science such as genetic programming (Bentley, 1999).

The use of evolutionary computation to generate design has taken place in many different guises over the last 20 years. Bentley Designers have optimized selected parts of their designs using evolution, artists have used evolution to generate aesthetically pleasing forms, architects have evolved new building plans from scratch (Bentley, 1999). There are

now a number of evolutionary art packages available. This section presents a review of several of these programs.

2.3.2 Approaches

The historical lineage of artificial aesthetic evolution begins with Richard Dawkins, who devised “Biomorph Land”, a program in which the user can guide the “evolution” of generations of graphical stick figures. Dawkins describes his experiments in “Biomorph Land” in his popular work on Darwinian evolution, *The Blind Watchmaker* (1987, p51-74). While the evolution of the Biomorphs is based solely on their graphical appeal, this breeder is well outside the context of art practice. Within *The Blind Watchmaker* it is used to support Dawkins’ argument for the power of cumulative selection, as a digital demonstration of the capacity of the evolutionary process.

Nonetheless, Dawkins’ Biomorphs were to help inspire a succession of artists to take up artificial evolution. During the late eighties and early nineties William Latham, in collaboration with programmer Stephen Todd, created software for synthesizing, mutating and evolving three-dimensional forms — in the artist’s words “ghosts of sculptures” — which he exhibited internationally as cibachrome prints and video animations (Todd & Latham, 1992). His first major exhibition of evolved work, “The Conquest of Form” (1988-89), organized by the Arnolfini gallery in Bristol, toured UK and German galleries and museums including the Natural History Museum in London and the Deutsches Museum in Munich. Despite gaining wide critical attention, Latham has declared himself “dissatisfied” with the art scene and is no longer active within it. After a second touring exhibition in 1991-92, and the publication of a book on his work with Todd (1992), he co-founded software and animation company Computer Artworks in order to develop his work “in a popular form for the mass market.”

Inspired in turn by the work of both Dawkins and Latham, American animator, artist and a-life researcher Karl Sims developed software for the evolution of two-dimensional images around 1991. Sims presented Genetic Images, an artwork using this software, in 1993 at Austrian electronic art festival Arts Electronica, and in an installation at the Paris Centre Georges Pompidou the same year. Running in real time, Sims' work allowed museum visitors to act as a collective “selector” for generation after generation of evolved images. The images themselves showed that graphic objects of remarkable complexity, and some of remarkable beauty, could be generated using evolutionary techniques.

The work of Sims and Latham continues to be influential; the years following publication of their work have seen a number of artists and computer scientists pursue the approaches their work sets out. Projects following Latham's use of procedural/iterative constructive geometry include Australian artist Nik Gaffney's *Mutagen*, a form-breeder which allows both user-driven and autonomous evolution (Gaffney, 1998).

The work of Baluja et al (1993) attempted to automate the role of the human in the types of systems. They built a neural network that learns the preferences of the user by ‘watching’ the user choose from sets of images. This network can then stand in for the human and work with the genetic program to produce the kinds of images that the human might like. This system tends to have fairly high error rates when guessing human ratings, which is not particularly surprising given the difficulty of the task learning to emulate human aesthetic judgment. Nevertheless, the system has produced a number of very complex and interesting images.

Baker (1993) created two systems that use genetic techniques to produce and modify line drawings. The genotype in this system encodes information about a series of line segments. A drawing program created using this technique allows users to interactively generate interesting line drawings. While they have not yet reported much success with being

able to control the system well enough to create a desired face, they do point the intriguing possibility of practical applications for genetically generated images.

2.3.3 Implications

Clearly evolution art is here, and is being incorporated into serious products. The interactivity, “evolution,” and behavior of the creatures in genetic arts are fascinating. However such works also draw attention to a critical dilemma: How can this art best be analyzed, and discussed? It is one thing to come up with the optimized solution or creation but to evaluate the result is another intimidating task for both creators and audiences, especially when the medium is used as communication artifact such as a website.

One thus raises an equitable question: Can we ever expect evolution in the digital medium to express a level of creativity comparable to what we have seen in the organic medium? In order to even speculate the answer to this question, one should first look into the basic mechanism and paradigm of the evolutionary algorithms.

2.4 Implementation of Genetic Algorithm on Communication Artifacts

The literatures in this section indicate that for some specific objects, there is broad agreement as to what can be described as aesthetically pleasing. Using this information, several authors have attempted to use subjective preference to drive an aesthetic evolution of design artifacts. The idea being to evolve more pleasing pictures, movies, animals, etc. (Rowland & Biocca, 2000) The section is categorized into three implementation types: page layout design, interaction design and web design.

2.4.1 Personalized Document Layout

The digital networked world is enabling and requiring a new emphasis on personalized document creation. Traditional methods of producing document layout and style have become insufficient, since most are aimed at producing static results. Also, as new untrained users start producing documents for a wide audience, the old publishing tools prove too demanding. The new, more dynamic digital environment demands tools that can reproduce both the contents and the layout automatically, tailored to personal needs and transformed for the presentation device, and can enable novices to easily create such documents (Purvis, 2002). In order to achieve such automated document assembly and transformation, Purvis formalized custom document creation as a constrained optimization problem, and uses a genetic algorithm to assemble and transform compound personalized documents.

Grid-based page designs are ubiquitous in commercially printed publications, such as newspapers and magazines. Yet, to date, no one has invented a good way to easily and automatically adapt such designs to arbitrarily sized electronic displays. The difficulty of generalizing grid-based designs explains the generally inferior nature of on-screen layouts when compared to their printed counterparts, and is arguably one of the greatest remaining impediments to creating on-line reading experiences that rival those of ink on paper. (Jacobs, et al., 2003). Jacobs and his collaborators developed adaptive grid-based layout program to format a document. This template authoring system allows user to construct a grid using a set of guides (Figure 2.3). A simple two-column grid is loaded from existing template and the features are constrained to meet the preferred style by user, resulting constraint-based template adapting to different display sizes as the window is resized.

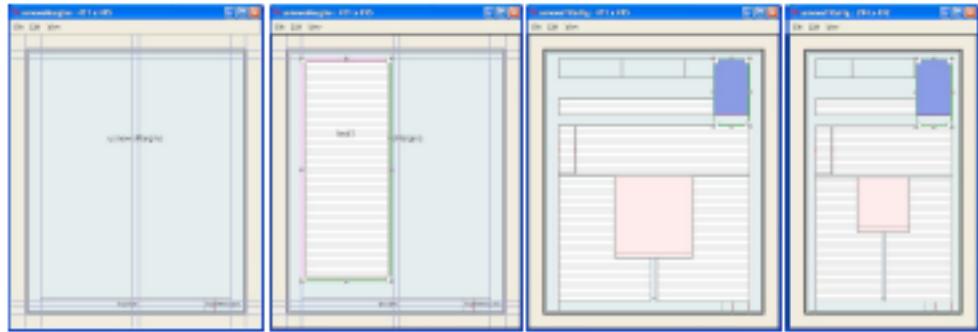


Figure 2.3 Template authoring program (Jacobs, et al., 2003)

Goldenberg (2004), in his thesis, described a Genetic Algorithm (GA) that automatically generates page layouts. This method was found to produce attractive and flexible layouts with relatively small number of iterations and low cost. Visual representations of the layouts are presented and discussed, together with an analysis of the search space and speed with which the GA finds a solution. His paper presents thorough evaluation of methodology and extensive technical details. The range of document types for which this method produces attractive layout is considered as well.

Their paper presented a new approach to adaptive grid-based document layout, which attempts to bridge this gap. In their approach, an adaptive layout style is encoded as a set of grid-based templates that know how to adapt to a range of page sizes and other viewing conditions. These templates include various types of layout elements (such as text, figures, etc.) and define, through constraint-based relationships, just how these elements are to be laid out together as a function of both the properties of the content itself, such as a figure's size and aspect ratio, and the properties of the viewing conditions under which the content is being displayed. The study described an XML-based representation for our templates and content, which maintains a clean separation between the two. They also described the various parts of our research prototype system: a layout engine for formatting the page; a paginator for determining a globally optimal allocation of content amongst the pages, as well as an

optimal pairing of templates with content; and a graphical user interface for interactively creating adaptive templates.

Geigel and Loui (2001) developed a flexible system for automatic page layout that makes use of genetic algorithms for the page layout of digital photo album (Figure 2.4). The system is divided into two modules, a page creator module which is responsible for distributing images amongst various album pages, and an image placement module which positions images on individual pages.

The system makes use of genetic algorithms. The genetic page layout algorithm has been incorporated into a web-based prototype system for interactive page layout over the Internet. The prototype system is built using client-server architecture and is implemented in Java. The system described in this paper has demonstrated the feasibility of using genetic algorithms for automated page layout in albuming and web-based imaging applications.

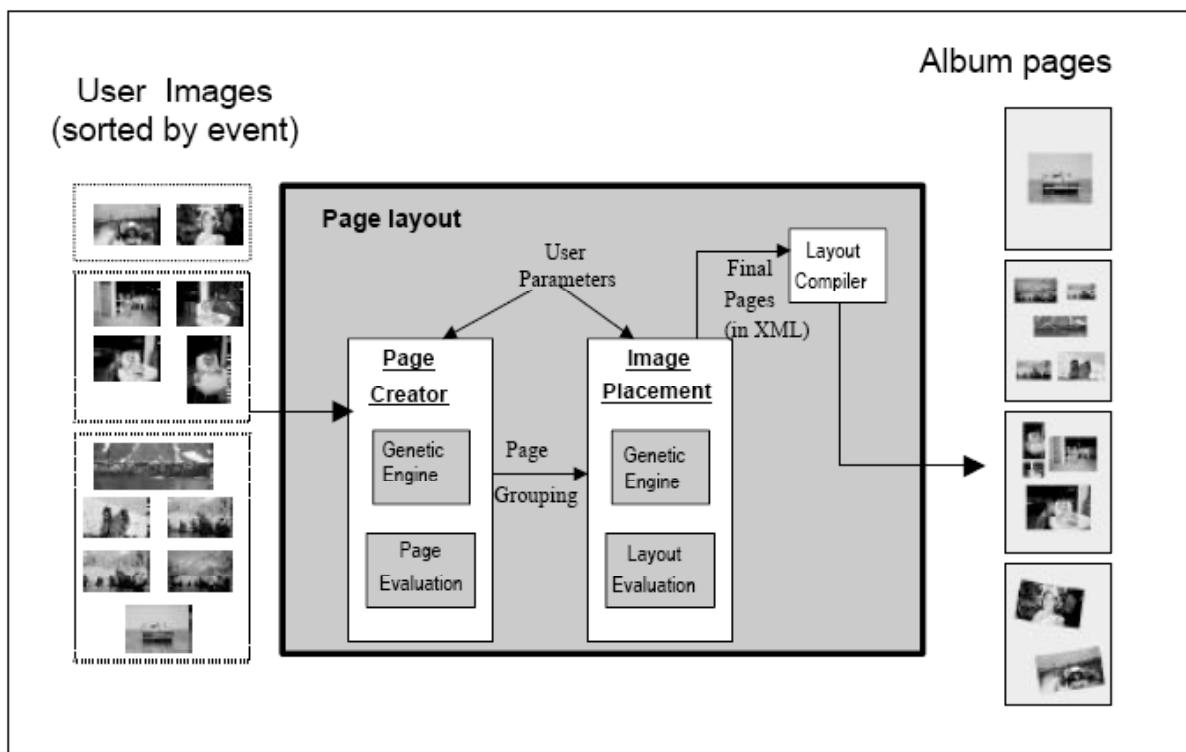


Figure 2.4 Genetic page layout architecture (Geigel & Loui, 2001)

The methodology of the creation of personalized documents using genetic algorithm specifies the document, content components, layout requirements, and desired aesthetic criteria as elements of a multi-objective optimization problem. Basic design criteria (i.e. alignment, balance, legibility, compactness, text and image balance, etc) are encoded as objectives. Combined scores for each design qualities are used as overall measure of how "optimal" the document is. The research findings indicates that the multi-objective approach, when compared to death-penalty approaches, provides much better performance in effectively handling constrained optimization problems. The result also denotes the influence of objectives and constraints over the behavior of the genetic algorithm and the importance of finding the right set weightings for each objective. (Purvis, et al., 2003).

The automatic page layout systems listed above certainly generate a number of interesting and creative solutions to the layout problem. However, they rarely have been judged by users nor the relationship between the setting of preference parameters and layouts produced been investigated. An obvious next step would be to incorporate interactive human factors whereby the validity of the preference and importance parameters can be tested.

2.4.2 Web and Interactive Applications

Personal preference is an important topic for the web industry. Building optimized web site or other online artifacts to fit the individual needs of each user is a challenging task. Since personalization is a critical aspect in many popular domains such as e-commerce, it should be dealt with through a design view, rather than only an implementation view (which focuses on mechanisms, rather than just design options) Rossi, Schwabe and Guimaraes (2001) point out that the main difference between a traditional static page layout media and web applications is that the latter may involve some business logic (application functionality). In addition, users may alter information while navigating web site.

Bauer and Scharl (2000) proposed a methodology for an evolutionary web information systems development. The method suggests suitable development methods and tools for the four sequential phases of web information systems: design, implementation, usage and analysis. The review of existing applications and interface models (e.g. eW3DT, WebMapper, etc.) that interconnects these four cyclical phases are presented with the evaluation on their advantages and shortcomings. The authors emphasize that the notion of evolutionary development and the importance of user feedback needs to be implemented in the web development infrastructure to outcome competitors. The conceptual models in this paper illustrate potential and infrastructural requirements to the implementation of an evolutionary web information systems approach.

Norton examined the application of evolutionary delivery methodologies to a dynamic web development environment. The methodology presented can help build effective design teams by involving participants in all phases of development and harnessing their creativity throughout the product life cycle (Norton, 2001). The paper reinforces the need to approach web development with a pragmatic reverence for its inherent uniqueness. This web engineering method could be useful when applied to the web design process.

Leroy, Lally, and Chen (2003) evaluated the interactions of users with different levels of expertise with different expansion types or algorithms. The relevance feedback and genetic algorithms are described as viable candidates for improving online searching with search engines. The user study provides descriptive data on user and algorithm searching, precision and recall rates, and qualitative descriptive data for different achievement groups—low, middle, and high achievers.

New systematic approaches were suggested by Fan, Gordon, and Pathak (2000), which can automatically generate term-weighting strategies for different context based on genetic programming (GP). The key implications made by this research are adaptive search engines, personalized information retrieval and delivery, and support for knowledge

management. The experiment was conducted to test the implementation of GP on relevance of retrieved documents in comparison with other online information retrieval system and commercial engines. By combining the common statistical clues or features used in the traditional term weighting strategies in an intelligent way, implementation of GP can improve the retrieval performance quite dramatically.

Hotti (2004) developed an easily customizable user interface for a web application called MEDIXINE as his thesis project. To achieve this goal, the author used advanced user interface design methods: user interface templates, Cascading Stylesheet (CSS), XML based navigation, effective layout design and a special file handling mechanism to prevent the customization to be overwritten when software is upgraded. In result, the strength of this new user interface are that it doesn't limit the user interface designers to apply their fancy designs on top of the default user interface. The layout and page structure is defined by one template file and stylesheet so almost all kind of designs can be adapted. (e.g. adding a Flash animation to the header by embedding a file into the template.)

Milani, Suriani & Marcugini (2005) presented a technique based on genetic algorithms for generating online adaptive services. Online adaptive systems provide flexible services to a mass of clients/users for maximizing some system goals; they dynamically adapt the form and the content of the issued services while the populations of clients evolve over time. The idea of online genetic algorithms (online GAs) is to use the online clients response behavior as a fitness function in order to produce the next generation of services. The principle implemented in online GAs, "the application environment is the fitness", allow to model highly evolutionary domains where both services providers and clients change and evolve over time. The flexibility and the adaptive behavior of this approach seem to be very relevant and promising for applications characterized by highly dynamical features such as in the web domain (online newspapers, e-markets, websites and advertising engines). Nevertheless the proposed technique has a more general aim for application environments

characterized by a massive number of anonymous clients/users which require personalized services, such as in the case of many new IT applications.

Building genetically personalized web sites is a challenging but interesting development as discussed in this section. It is a significant step as an alternative design method in growing web community. Genetic optimization approach aims at representing website not only as external services but also in such a way designer and user can reason on their structures to extend them to different domains and roles.

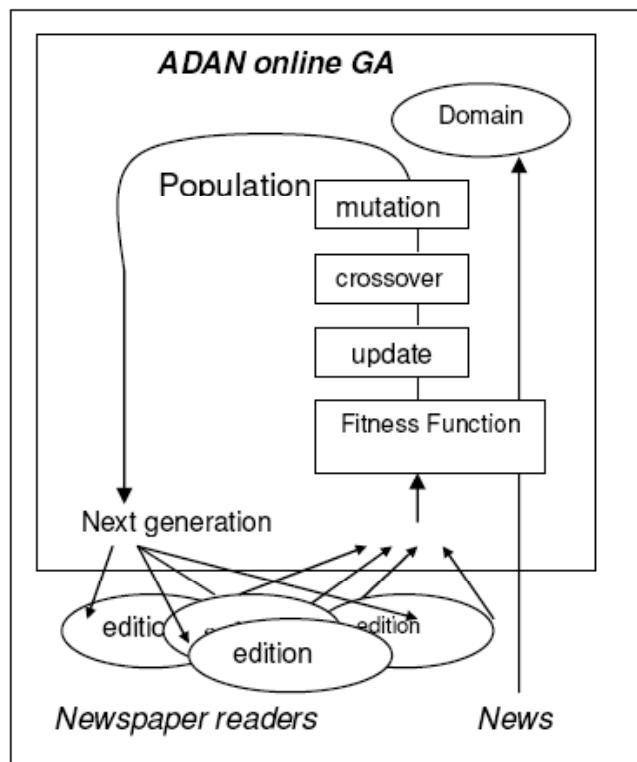


Figure 2.5 *AdaN* (online adaptive newspapers) evolutionary scheme (Milani, et al., 2004)

2.5 Interactive Genetic Algorithms (IGA) and Human–Computer Interaction

Three visible trends that project an image of where these may lead in the next fifty years in computing world are: Computation to Communication, Machinery to Habitat, and

Aliens to Agents (Winograd, 1997). Among many possibilities suggested, Winograd concentrates on the top of the emergence of interaction design. Interaction design draws on elements of graphic design, information design, and concepts of human-computer interaction as a basis for designing interaction with computer-based systems. Successful interaction design will provide the design of effective interactions between people and machinery and among people using machines.

This section summarizes the fundamental concept of Interactive Genetic Algorithm (IGA) and its implementation to existing programs and prototype researches in Human-computer interaction with the aspect of user-centered design. Finally analysis of the exiting approaches in web optimization is presented.

2.5.1 Concept of IGA

Interactive Genetic Algorithm (IGA) is the same as GA except the way of assigning the fitness value. In IGA user gives fitness to each individual instead of fitness function (Kim & Cho, 2000). In this way IGA can ‘interact’ with the user intuitively and dynamically, and also can percept user’s emotion or preference in the course of evolution.

Cooperative systems that leverage the strength of both human and computers have shown to be effective at producing valuable optimization solutions (Anderson *et al.*, 2000). These interactive systems must somehow distribute the work involved in the optimization task among the human and computer participants. Existing systems have implemented the division of labor in variety of ways.

In some interactive systems, the users can only indirectly effect the solutions to the current problem. In interactive evolution, an approach primarily applied to design problems, the computer generates solutions, and the role of the user is to select which solutions will be used to generate novel solutions in the next iteration (Kochhar & Friedell, 1990).

2.5.2 IGA Applications in HCI

Hill and Terveen introduced PHOAKS (People Helping One Another Know Stuff) system, which explores the issues of continuous and remote participatory redesign of web content. PHOAKS is a system that automatically recognizes URLs recommended in Usenet messages and continuously update a large website that summarizes the recommendation data. The functions and mechanisms of PHOAKS are described using the actual website (Hill & Terveen, 1997).

"The Genetic Sculpture Park" is an on-line 3D modeling program developed by Rowland and Biocca (2000). The program allows visitors to engage in a co-operative dialogue with the computer to produce more aesthetically pleasing sculptures (shapes). Their study recounts investigations into evolutionary design methodologies and describes their implementations in a interactive world. In terms of computer-aided design the article examines how such a technique could be used to aid designer in their creation of new objects.

Smart, Rice & Wood (2000) emphasized the need for more empirically supported guidelines to inform design decisions. Guidelines must be based on commonly shared semiology of Web conventions. A semiotics of the Web can help us determine how meaning is derived from Web pages and the Web, and in turn how to better design sites to convey intended and desired meanings. They identified six categories or dimensions of design issues relating to the Web that serves as a beginning of a Web semiotics. Each dimension is explained, with various research issues and questions suggested.

WSDM is an audience driven design method for web sites. The main structure of web site can be derived from classification of the visitors according to their functional requirement (Casteleyn & Troyer, 2002). The presented methodology forces the designer to deeply reflect on the requirements of the visitors, and to resolve any semantic conflict at design time. Implementation of this method seems feasible and would be very useful in association with evolutionary design approach.

Rode's dissertation investigated approaches for facilitating end-user web application development with the particular focus on shaping web programming technology and tools according to end-users' expectations and natural mental models (Rode, 2005). These behavioral studies of active programming strategies could provide a scientific grounding for a software development for non-programmers. The prototype testing and analysis presents a firm knowledge of how the novice developers naturally think about web programming concepts and the viable approaches for making web application development more accessible for non-programmers.

In the above systems, the role of the user in the optimization process has generally been determined by the intuitions of system designers and the availability of interaction and visualization techniques. Experiments have been performed on some of these systems by having users interactively optimize sample problems using the whole system (Anderson *et al.*, 2000).

2.5.3 Existing Approaches in Web Customization

The web is more and more used as a platform for full-fledged, increasingly complex applications, where a huge amount of change-intensive data is managed by underlying database systems (Kappel, 2000). Existing modeling methods for web applications, however, fall short on considering a major requirement posed by a today's web applications, namely customization. Kappel asserts that web applications should be customizable with respect to various context factors compromising different user preferences and device capabilities.

Most existing applications depend too heavily on the web structure as oppose to the design aspect of interface as customizable area. Almost all of the surveyed approaches provide adaptation at the presentation level, many of them also at the hypertext level, but only a few support adaptation at content level. Concerning static and dynamic adaptations, the majority of the approaches allow dynamic adaptation; some of them additionally support

static adaptation. None of the surveyed approaches considers adaptation of adaptation, which genetic algorithm approach can easily achieve adding a further degree of customizability to web development.

2.5.4 Visual Aesthetics and Criteria for Web Design Evaluation

Interactive Aesthetics (IA) enables a remote client, graphic designer, and especially the prospective audience, to participate electronically in the design of the communication artifacts (Bennett, 2002). Bennett proposed the visualization of translation to help audience to comprehend the visual language. She also provided the criteria that should be met when applying IA in order to ensure design process yields a communicable design gestalt.

Harrington *et al.* (2004) described a measure of aesthetics that has been used in automated layout. The approach combines heuristic measures of attributes that degrade the aesthetic quality. The combination is nonlinear so that one bad aesthetic feature can harm the overall score. Example heuristic measures are described for the features of alignment regularity separation balance white-space fraction white-space free flow proportion uniformity and page security.

Despite its centrality to human thought and practice, aesthetics has for the most part played a petty role in human-computer interaction research. Increasingly, however, researchers attempt to strike a balance between the traditional concerns of human-computer interaction and considerations of aesthetics. Thus, recent research suggests that the visual aesthetics of computer interfaces is a strong determinant of users' satisfaction and pleasure.

However, the lack of appropriate concepts and measures of aesthetics may severely constraint future research in this area. To address this issue, four studies were conducted in order to develop a measurement instrument of perceived web site aesthetics. Using exploratory and confirmatory factor analyses the authors found that users' perceptions consist

of two main dimensions, which they termed "classical aesthetics" and "expressive aesthetics" (Lavie, Tali, Tractinsky & Noam, 2004).

The classical aesthetics dimension pertains to aesthetic notions that presided from antiquity until the 18th century. These notions emphasize orderly and clear design and are closely related to many of the design rules advocated by usability experts. The expressive aesthetics dimension is manifested by the designers' creativity and originality and by the ability to break design conventions. While both dimensions of perceived aesthetic are drawn from a pool of aesthetic judgments, they are clearly distinguishable from each other. Each of the aesthetic dimensions is measured by a five-item scale. The reliabilities, factor structure and validity tests indicate that these items reflect the two perceived aesthetics dimensions adequately.

Hoffmann and Krauss (2004) reviewed the current literature on visual aesthetics for the web. This was done by referring to recent contributions of authors in the area of visual aesthetics. Specific focus areas included: authors' perception of the importance of visual aesthetics; how visual aesthetics affect communication; and guidelines and suggestions on how to apply visual aesthetics. The authors also briefly suggest an appropriate research approach when studying visual aesthetics.

Bertelsen, Pold and Søren (2004) proposed the re-orientation of human-computer interaction as an aesthetic field. The authors argue that mainstream approaches lack of general openness and ability to assess experience aspects of interaction, but that this can indeed be remedied. The paper introduces the concept of interface criticism as a way to turn the conceptual re-orientation into handles for practical design, and it also presents and discusses an interface criticism guide.

Bertelsen & Pold (2004) discussed how human-computer interaction can be understood as an aesthetic discipline, and further demonstrated that such a new perspective is a possible basis for operational interface evaluation methods. Today's dominating

perspectives on interactive artifacts focus almost only on technical and cognitive aspects, and consequently the field needs to take cultural and aesthetic level of analysis into account in order to keep up with spontaneity and dynamics of web interface design.

Usability evaluation is an increasingly important part of the web interface design. However, usability evaluation can be expensive in terms of time and human resources, and automation is therefore a promising way to augment existing approaches. Ivory & Hearst (2001) presents an extensive survey of usability evaluation methods, organized according to a new taxonomy that emphasizes the role of automation. The survey analyzes existing techniques, identifies which aspects of usability evaluation automation are likely to be of use in future research, and suggests new ways to expand existing approaches to better support usability evaluation.

2.6 Summary

The literature reviewed in this paper offer a chance to highlight some of the meeting points between artificial evolutionary algorithm and the design of the web and other communication artifacts. As shown in this survey, one can see the Web as an equally adequate environment where genetic algorithm mechanisms can function as effective aid as in for other computing or mathematical problems.

The main contribution of this survey is demonstrating that applying interactive genetic algorithm to the design of web interface can elucidate the most appropriate division of labor between human and computer. As computers become more powerful, the creation of virtual environment such as web site may be limited mainly by our creativity to design, rather than our ability to satisfy the computational requirements. In terms of computer-aided design, the recent studies listed in this paper are small but critical step to see how such evolutionary

techniques could be used to aid the designers *and* end users in their creation, appreciation, and all together collaboration of new and enhanced web environment.

CHAPTER 3. METHODS AND PROCEDURE

This chapter presents a methodology of adapting GA in CSS based web design and procedure of developing this into an online user preference test. First, the principles, guidelines and trends in web design are presented and discussed to determine the variables and limitations in adaptation procedure. Accordingly, CSS variables and Parameters are introduced and the GA terms are defined to help understand the comparability between two entities—web design and genetic programming. The author then discusses how these variables (CSS and GA) can accommodate one another in generating Perl (Practical Extraction and Report Language) code that will lead to the successful design evolution of a web page.

3.1 Web Design Trends and Elements

There is currently a great deal of discussion about what constitutes good web site design. Many comprehensive web design guidelines have been developed for both general user interfaces and for web page design. In this section, the author will explore how these guidelines have shaped the web design methods and trends, and present categorized elements that are essential in web page design.

3.1.1 Web Guidelines and Recommendations

Web designers have historically experienced difficulties following web design guidelines for their lack of consistency and adaptability (Borges, et al., 1996). However, there are some web guidelines that are more straightforward and clear to comprehend and implement. For example, Jakob Nielsen's Alertbox column (March 15, 1997) provides guidelines on how to write for the web, asserting that since users scan web pages rather than read them, web page design should aid scannability by using headlines, using colored text for emphasis, and using 50% less text (less than what is not stated) since it is more difficult to

read on the screen than on paper. Although reasonable, guidelines like these are still not supported with empirical evidence. Furthermore, no studies have derived web design guidelines directly from web sites that have been assessed by human judges. Such shortcomings make the author question the validity of guidelines holds in web design process.

The World Wide Web Consortium (W3C) (source: <http://www.w3.org>) is an international group that develops common protocols for the evolution of the World Wide Web. The W3C was developed by Tim Berners-Lee, an inventor of the World Wide Web, to provide interoperable technologies through the creation of web standards and guidelines. Since 1994, W3C has published more than ninety such standards, called W3C Recommendations. These include recommendations like XHTML and CSS so the web would not fragment into ever-more-incompatible browsers and devices, but would instead work for everyone. The only way we designers and developers can help the web achieve this noble goal is by authoring to these recommendations, while taking care to ensure that the sites still work as best they can in non-compliant browsers. Founded in 1998, The Web Standards Project (WaSP) (<http://www.webstandards.org>) is a solid support group for W3C recommendations.

Such groups and media have remarked the significance of CSS technology over the last decade that it would enable the web to remain open, interoperable, and accessible. If fully supported, CSS would enable designers and perhaps non-designers to create visually engaging and functional webpage far beyond the capabilities of any individual web browser.

3.1.2 Web Design Patterns: A Survey

This survey analyzes popular web sites through elements of their layout: styles, page construction and design elements. The sites are categorized into three types—news, e-magazine, and weblog—by their context. The author then picked three well-known sites that

will exemplify each type and observe the general tendencies and trends in recent web page design. The surveyed sites are chosen because they are text-heavy and have general document layout style, which are suitable to evaluate the page layout elements and variation for this study. The analysis and comparison focus on the three main aspects of web design: layout, type, and color use.

Table 3.1 Comparisons of Web Elements

	Site	Layout	Type Setting	Color	Features/Tools
1. News site	Yahoo news.yahoo.com	2-column, left sidebar navigation (25% width), global navigation tabs on top, more links at bottom	Helvetica, bolded headline, sidebar sub-headings in all caps	Black body, blue hyperlink, gray sidebar sub-head, default blue/silver navigation tap	Color scheme switching option on main Yahoo homepage, icon by heading
	MSN msnbc.msn.com	2-column, left sidebar navigation (20% width), additional links at right side and bottom	Verdana (body), Georgia (headline), Helvetica (sidebar),	Black body, red headline, red hyperlink,	Color scheme switching option on main MSN page, red bulleted headline list, colored bar for section head, boxed sidebar content
	CNN cnn.com	2-column, left picture/ad links (30% width), global navigation tabs on top, additional links at bottom	Arial (body), Arial/bold (headline)	Black body, red section title, blue hyperlink, blue top navigation,	Colored rule over headings, boxed related links, text size adjustment, print/email tool
2. E-magazine	Popular Science popsci.com	2-column, left sidebar navigation (20% width), additional links at side & bottom	Arial (body), Arial/bold (headline), all caps subhead	Black body, orange blurb, black top & sidebar background, white/silver sidebar menu	Blue/orange square bullets for sidebar links, colored bar menu heading, print/email tool
	Reader's Digest rd.com	2-column, left sidebar navigation (20% width), global navigation on top, additional links at side	Verdana (body), Verdana/bold (headline), larger blurb, Arial/bold sidebar navigation, all caps section heads	Black body, red headline, pastel tone (yellow, blue, orange, purple) global navigation & sidebar background	Red bullets for sidebar links, colored bar menu heading, print/email/type size buttons

	Real Simple realsimple.com	2-column, left sidebar navigation/ads (33% width), global navigation on top, related links at bottom	Display font section head, custom font for body & sidebar navigation menu, Verdana for headline & blurb	Light grey global navigation, light blue sidebar, colored subhead in body	Red square bullet points, arrow for dropdown links, print/email/chat buttons, page turning tool
3. Weblog/Wiki	A List Apart (multiple authors) alistapart.com	3-column, logo on left, right sidebar navigation (25%), top global navigation	Verdana for body, Georgia for headline, subhead and top navigation	Amber for hyperlinks	Column rule, dotted line, colored bar, bulleted list, hover images
	Connecting the Dot (single author) iconnectsdots.com	3-column, ads/promo on left right sidebar navigation (20%), top blog title bar	Verdana: bold, all-caps, wide word-spacing	Black top title bar, white background, blue hyperlink, amber sidebar section head	Archive link, online status, RSS feed, comments, trackback link
	Wikipedia wikipedia.com	2-column, left sidebar navigation (16%), top sub navigation tab	Arial: bold, italic	Black body, default blue hyperlinks	Outlined box, rule, square colored bullet, colored bar heading, edit function

1. News web sites

The image displays three side-by-side screenshots of news websites:

- Yahoo! News:** Shows a search bar, news categories like Home, Politics, Science, Health, Travel, and More Popular. A main article about Hurricane Wilma is visible.
- MSN News:** Features a prominent search bar and navigation links for Home, World, Business, Sports, Analysis, Politics, Law, Tech, Science, Health, Entertainment, and Offbeat. It includes a sidebar with "Most Popular" stories and a "STORY HIGHLIGHTS" box.
- CNN.com:** Shows a search bar and navigation links for Home, Weather, Business, Sports, Analysis, Politics, Law, Tech, Science, Health, Entertainment, and Offbeat. It includes a sidebar with "Most Popular" stories and a "STORY HIGHLIGHTS" box.

Figure3.1 Example pages from *Yahoo*, *MSN*, *CNN* stores and updates a lot of

The major portal new sites such as *Yahoo*, *MSN* and *CNN* stores and updates a lot of information on hourly bases. The pages generally look extremely text-heavy and are tightly laid out with small leading and gutter space. Hence, they compensate the crowdedness with using white background and setting up a clear hierarchy in type setting. 2-column layout with

left sidebar navigation is most common for this type of sites. The type styles are properly setup for clear hierarchy between headlines, blurbs, subheads and colored links.

All sites use san-serif font as body copy and most of text for better readability on screen. All three sites use one primary spot color—red or blue—and maybe a secondary color to represent their style. The top navigation tabs in all three sites use dark blue color, which appears to be the most commonly used color for many of general news sites.

2. E-Magazines



Figure 3.2 Example pages from Popular Science, Reader's Digest, and Real Simple

The e-magazine web sites reflect the brand image and tries to set the general look and style of their sites. These sites are not updates as fast as the news web sites, thus, provides more room to be flexible with layout elements. The pages are still quite packed with type but there is comparatively less clutter with arrangement of text and links. The layout follows the standard 2-column style but with a clearer organization. The shorter body content helps readability. Colors are used more versatile in these sites, ranging from jet black, strong primary colors, to various pastel tones. The sites also use the list bullets, rules, icons, color blocks and other visual punctuations to add interest to the layout.

3. Weblogs/Wiki



Figure 3.3 Example pages from A List Apart, Connecting the Dots, Wikipedia

A weblog, sometimes written as web log or Weblog, is a Web site that consists of a series of entries arranged in reverse chronological order, often updated on frequently with new information about particular topics. A wiki is a website that allows visitors to add, remove, and otherwise edit and change content, typically without the need for registration. It also allows for linking among any number of pages. This ease of interaction and operation makes a wiki an effective tool for mass collaborative authoring.

Summary

Even though thousands of different layouts can be achieved using XHTML and CSS, web designers tend to stick to an implicit, internalized layout and design norms. Some very explicit norms, such as W3C recommendations, are well known by increasing number of designers. Some other points are just universally accepted rules (e.g., underlined links, header logo and footer, white background, and san-serif main text font, etc.). What is hence noteworthy is that most pages resemble very much from one to another. Web designers share common print design background and import some of its elements to their webpage creations: a comprehensive use of sidebars and their positioning, footers, graphic header, and typographical hierarchy. Therefore, the difference between one page design and another,

perhaps more so in the information-driven pages, falls in the subtle difference in type, layout and color properties.

3.1.3 Web Page Design Elements

Based on the above survey of the recent web design guidelines and patterns, the study will investigate the following common web design elements of web pages.

- **Type:** font family, size, weight, and text float.
- **Layout:** left, center, right column width, placement, and gutter space
- **Color:** foreground (main text, links), background (top, sides, footer bar)

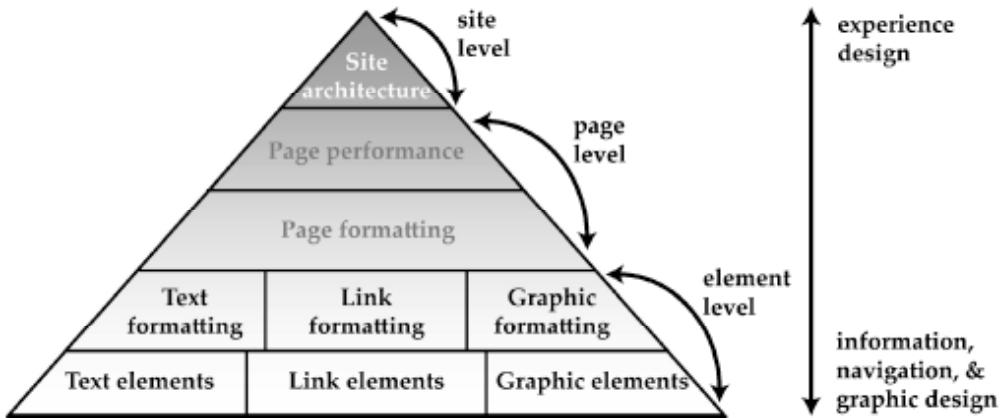


Figure 3.4 Conceptual model of web interfaces (Ivory & Megraw, 2005)

These general elements then can be encoded into the changeable parts in CSS and later implemented in genetic coding. These elements were drawn from examining mainly the information-centric, text-heavy web sites (i.e., sites whose primary tasks entail locating and acquiring specific information) as opposed to functionally oriented ones (i.e., sites wherein users follow explicit task sequences). An information-centric web interface is a mix of text, link, and graphic elements, formatting of these elements, and various aspects that affect its usability, accessibility, and most of all, aesthetics. A web design pattern study done by Ivory and Megraw (2005) presents (Figure 3.4) the significance of these elements. Figure shows that text, link, and graphic elements are the building blocks of web interfaces; all other

aspects are based on them. The author developed measures as many of these element-level features as possible to evaluate the overall style of web page.

3.2 Cascading Style Sheets (CSS)

3.2.1 CSS Overview

The style of web page design has been dictated by the current state of web technology. Most web designs have relied on what magazine and book layouts usually use: a grid and style sheet specification. It is only in a recent decade or so, however, with the advent of cascading style sheets (CSS) that web designs have been able to break out of that grid structure and become more dynamic and agile.

CSS are a collection of formatting rules that control the appearance of content in a web page. They are very useful for maintaining a web site since its appearance (controlled by properties of HTML tags) can be managed from just one file. CSS Styles also enhance your site's look, accessibility and reduces file size. Another main advantage is reusability. Instead of defining the properties of fonts, backgrounds, borders, bullets, uniform tags, etc. each time you use them you can just assign the corresponding CSS style in the class property.

3.2.2 CSS Attributes

The CSS Style Definition dialog box (Figure 3.5) is a tool that allows web designers to define and edit styles easily and effectively for CSS. It provides eight categories of style definition, allowing for a total of 71 different style options. By setting the value of these properties the document author can control how the browser will display each element. Broadly speaking, properties either specify how to position the element relative to other elements (e.g. text-indent, margin, or float), or how to display the element itself (e.g. font-size or color).

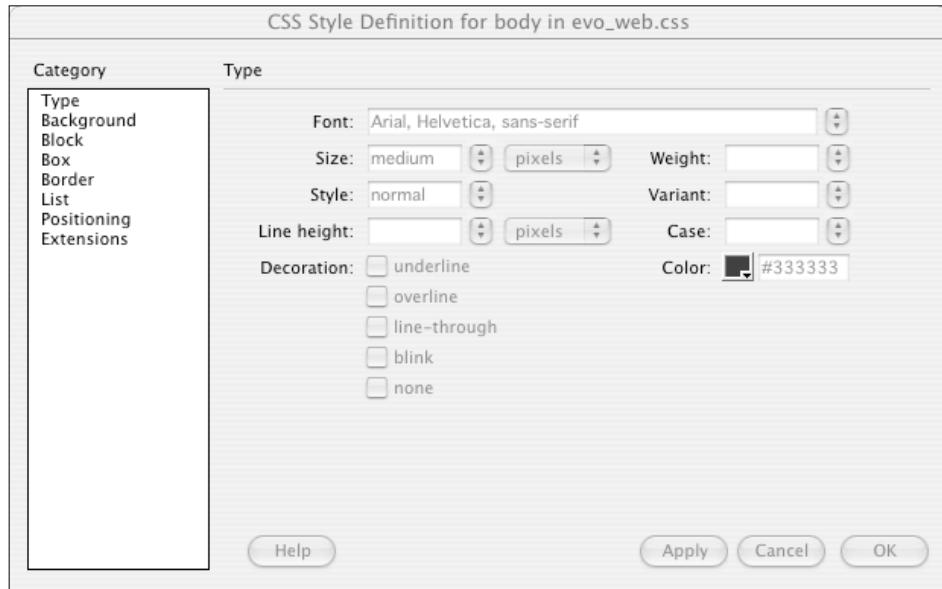


Figure 3.5 CSS style definition window in Dreamweaver CSS Attributes

Figure 3.6 provides another outlook of CSS properties that is more in a summarized list format. It provides an expedient view of the active attributes and their value. Although the author can directly annotate elements in the document with style properties, CSS encourages the author to place this information in a separate style sheet and then link or import that file. Thus, the same document may be displayed using different style sheets and the same style sheet may be used for multiple documents, easing maintenance of a uniform look for a site.

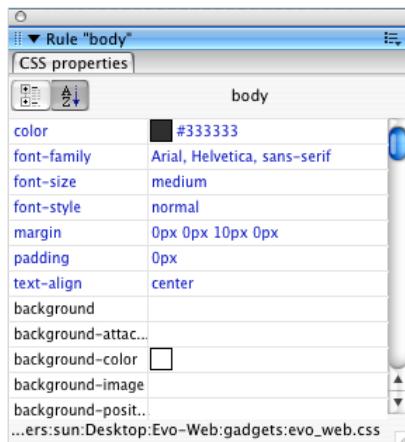


Figure 3.6 CSS properties window

A style sheet consists of rules. A rule has a selector that specifies the document elements to which the rule applies, and declarations that specify the stylistic effect of the rule. The declaration is a set of property/value pairs. Values may be either absolute or relative to the parent element's value.

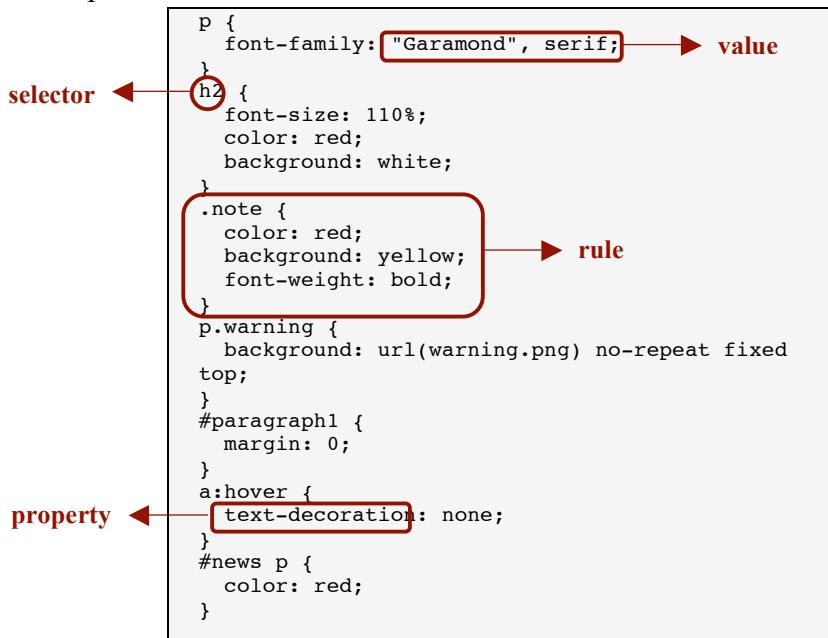


Figure 3.7 CSS terminology

These are seven ample rules, with selectors `p`, `h2`, `.note`, `p.warning`, `#paragraph1`, `a:hover` and `#news p` (Figure 3.7). Property values are specified by, for example, `color: red`, where the property `color` is given the value `red`.

Advantages of using CSS include:

- Presentation information for an entire website or collection of pages can be held in one place, and can be updated quickly and easily.
- Different users can have different style sheets: for example a large text alternative for visually-impaired users, or a layout optimized for small displays for mobile phones.
- The document code is reduced in size and complexity, since it does not need to contain any presentational markup.

In this study, the author will primarily experiment with type, layout positioning, and color properties and their selectors since they are the major elements that affect page layout variations. Also, those are some of the most frequently used CSS properties (Figure 3.8) by web designers. The top five of CSS properties consists exclusively of type selectors. Not many web designers nowadays accept the browser default settings. Color selector appears to be the leading factor in initial response to a webpage design. The layout options follow closely next to the type and color properties.

With its proven flexibility, usability, accessibility, CSS will be a great application for adapting GA mechanism in webpage design. There are a lot more properties than mentioned in Figure 3.8, and taking all of them as GA variables will be an enormous task. For the completion of this study the author will take about 30 most prominent properties from the whole list (Table 3.5). It will certainly give more validity to the test with comprehensive data.

W3C Recommendation of CSS specification was also taken into consideration in deciding applicable design elements for a prototype. Among its capabilities are supports for:

- Font properties such as typeface and emphasis
- Color of text, backgrounds, and other elements
- Text attributes such as spacing between words, letters, and lines of text
- Alignment of text, images, tables and other elements
- Margin, border, padding, and positioning for most elements

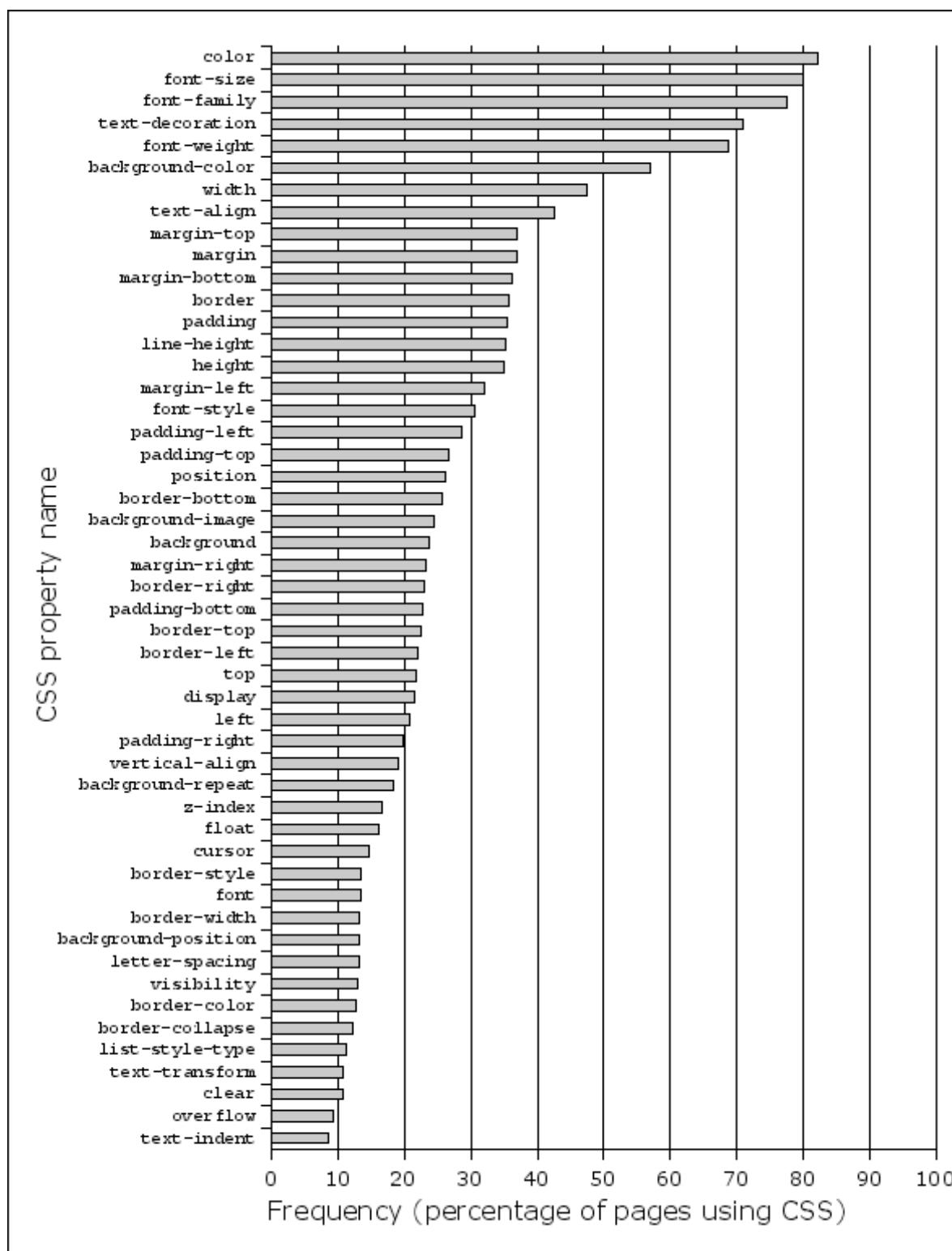


Figure 3.8 Most frequently used CSS properties (<http://triin.net/2006/06/12/CSS>)

3.3 Genetic Algorithm Applied in CSS

3.3.1 Evolution Paradigm: GA vs. CSS

In this section, the author briefly introduces how genetic algorithm work in application of CSS, and illustrates their association. The search process is performed in an iterative manner as illustrated in Figure 3.9.

First, initial CSS properties are determined randomly although there is nothing prohibiting in using some sort of heuristic for this process. Once a generation of page population is established, individual design solutions are evaluated based on the preference votes gathered on prototype web site (fitness function) and well-received page features are chosen for the genetic operators of mutation and crossover. Next, CSS is modified and enhanced resulting in a set of new pages. The process is iterated until a defined stopping criterion is met. This, in web design sense, would be when the pages in a generation start to resemble too much of one another, and when the changes are no linger feasible or meaningful.

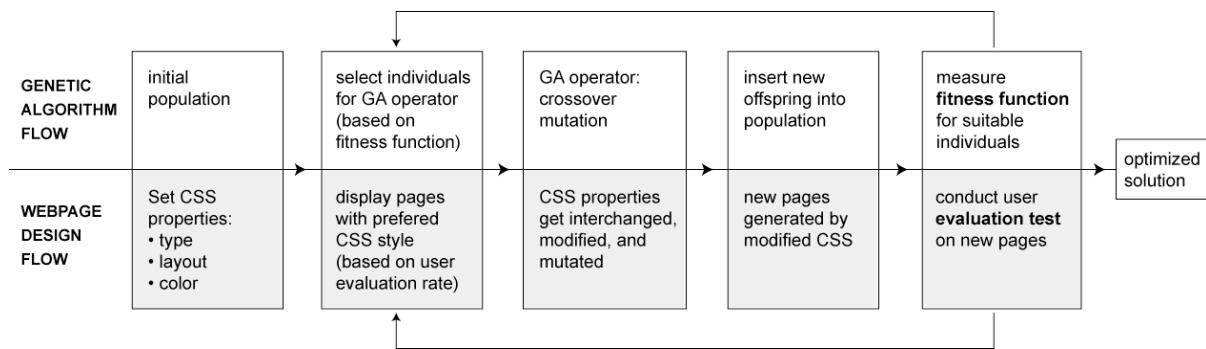


Figure 3.9 Evolution Flowchart: Genetic Algorithm vs. CSS



Figure 3.10 Evolvable Design Parts and Range

3.3.2 Evolvable Design Parts

After reviewing extensive survey of the web design literature and guidelines, the author specified common design features of webpage design, including: the style of text on a page, fonts, colors, consistency of page layout. The Evo-Web prototype page is constructed with 6 major sections (Figure 3.10): header, navigation bar, global navigation, headline, main content, and footer. Then these features were categorized into sub CSS classes, such as section links, related links, story section, page names, to assess individual features; not all features could be assessed in an automated manner due to the time and technical limitations.

3.3.3 Evolvable CSS Properties and Values

Type and Layout Properties

The type and layout properties were kept fairly standard for the general look of a page. The value will be applied to each type class (e.g., in navigation bar, headlines, body contents, etc.) and can independently and randomly be changed through GA operator. Table 3.2 shows type properties with absolute values assigned to them.

CSS selector	Value
font_weight	normal, bold
font_family	Arial, Helvetica, sans-serif Times New Roman, Times, serif Georgia, Times New Roman, Times, serif Verdana, Arial, Helvetica, sans-serif
text_align	left, right, center
float (column)	left, right

Table 3.2 Type and layout properties

Color Properties

The color variations are limited to 256 universal web safe colors. The range for the foreground type colors and background panel colors are separated into 16 groups with 32 possibilities within a group – representing 5 bits in genetic algorithm code (Table 3.3). The foreground and background colors rotate at a minimum of three groups apart so that the colors for text and background do not mix up. For example, if text color lands in a value in Group 3, then the background color will be picked from the range between Group 6 and 16. The color values were carefully assessed and picked to make sure the page samples will allow vast amount of color combinations while avoiding major legibility problems.

Table 3.3 Color distribution groups in RGB hexadecimal value

3.3.4 CSS Code Used in Creating Evo-Web

The Evo-Web pages are designed by Perl code variables that are embed directly into .css code (Table 3.4). All the parts sandwiched by \$ sign (e.g., `$globalNav_font_family$`) will be replaced by random Perl variables while undergoing the guided GA process.

Table 3.4 Evo-Web CSS

```
*****
/* Evo_Web.css */
*****
```

```
body{
    font-family: Arial, Helvetica, sans-serif;
    color: #333333;
    font-size: medium;
    font-style: normal;
    text-align: center;
}

a:link, a:visited, a:hover {
    text-decoration: none;
}

#wrapper {
    width: 780px;
    margin: 0 auto;
    border: 1px solid #ccc;
    background-color: $$globalNav_background_color$;
}

#masthead{
    background-color: #fff;
    font-family: Arial, Helvetica, sans-serif;
    font-size: 80%;
    font-weight: bold;
    color: #FFFFFF;
}

#globalNav{
    font-family: $globalNav_font_family$;
    color: #ccc;
    background-color: $$globalNav_background_color$;
    padding: $globalNav_padding$% 1% $globalNav_padding$% 1%;
    white-space: nowrap;
    text-align: $globalNav_text_align$;
    border-bottom: 1px solid #cccccc;
    border-top: 1px solid #cccccc;
}

#globalNav a:link, #globalNav a:visited {
    color: $$globalNav_link_color$;
    font-size: $globalNav_link_font_size$%;
    font-weight: $globalNav_link_font_weight$;
}

#globalNav a:hover{
    color: $$globalNav_hover_color$;
}

#navBar{
    float: $navBar_float$;
    width: $navBar_width$%;
```

```

        background-color: #$globalNav_background_color$;
}

#search{
    padding: 5px 0px 0px 10px;
    font-size: 90%;
    font-weight: normal;
}

#search label{
    display: block;
    font-size: 80%;
    color: #666666;
    font-weight: normal;
}

#sectionLinks ul {
    border-bottom: 1px dotted #cccccc;
    list-style: none;
    margin: 0;
    padding: 0;
}

#sectionLinks a:link, #sectionLinks a:visited {
    font-family: $globalNav_font_family$;
    font-size: $sectionLinks_font_size$%;
    font-weight: $globalNav_link_font_weight$;
    color: #$globalNav_link_color$;
    display: block;
    padding: 5px 10px 5px 10px;
    border-top: 1px dotted #cccccc;
    text-align: $sectionLinks_text_align$;
}

* html #sectionLinks a:link, * html #sectionLinks a:visited {
    height: 20px;
}

#sectionLinks a:hover{
    color: #$globalNav_hover_color$;
}

#relatedLinks{
    padding: 10px 10px 20px 10px;
    text-align: $sectionLinks_text_align$;
}

#relatedLinks ul {
    list-style: none;
    margin: 0;
    padding: 0;
    font-size: $relatedLinks_font_size$%;
    line-height: 14px;
    font-family: $relatedLinks_font_family$;
    font-weight: $relatedLinks_font_weight$;
}

#relatedLinks h1{
    font-family: $globalNav_font_family$;
    color: #$relatedLinks_h1_font_color$;
    font-weight: $relatedLinks_h1_font_weight$;
    font-size: $relatedLinks_h1_font_size$%;
}

#relatedLinks a:link, #relatedLinks a:visited {
    color: #$globalNav_link_color$;
}

#relatedLinks a:hover{
    color: #$globalNav_hover_color$;
}

```

```

#content {
    background-color: #ffffff;
    text-align: $content_text_align$;
    width: $content_width$%;
    float: $content_float$;
}

#headlines{
    text-align: $headlines_text_align$;
    float: $headlines_float$;
    margin-$headlines_margin_side$: 20px;
    width: $headlines_width$%;
    background-color: #$headlines_background_color$;
}

#headlines_container {
    padding: 15px 10px 10px 10px;
}

#headlines p{
    font-size: $headlines_p_font_size$%;
    font-family: $relatedLinks_font_family$;
    color: #$headlines_p_font_color$;
}

#headlines a:link, #headlines a:visited {
    font-family: $globalNav_font_family$;
    font-weight: $headlines_font_weight$;
    font-size: $headlines_font_size$%;
    color: #$headlines_font_color$;
}

#headlines a:hover{
    color: #$headlines_hover_color$;
}

#pageName {
    color: #$pageName_color$;
    font-family: $globalNav_font_family$;
    font-size: $pageName_font_size$%;
    font-weight: $pageName_font_weight$;
    padding: 3% $content_padding$% 3% $content_padding$%;
}

#story {
    font-family: $story_font_family$;
    font-size: $story_font_size$%;
    line-height: $story_line_height$%;
    padding: 0 $content_padding$% 20px $content_padding$%;
}

#story_section {
    font-weight: $story_section_font_weight$;
    color: #$story_section_font_color$;
}

#siteInfo {
    clear: both;
    border-top: 1px solid #cccccc;
    background-color: #$headlines_background_color$;
    font-size: 70%;
    color: #666;
    padding: 5px 10px 10px 10px;
}

#siteInfo a:link, #siteInfo a:visited {
    color: #$headlines_font_color$;
}

#siteInfo a:hover{

```

```

        color: #$headlines_hover_color$;
}

#test {
    font-size: small;
    color: #FFF;
    vertical-align: middle;
    font-weight: bold;
    background-color: #CC9800;
}

#white {
    border: 0px dotted #cccccc;
    text-decoration: none;
    color: #FFF;
    background-color: #FFF;
}

#viewing {
    font-size: normal;
    color: #CC9800;
    font-weight: bold;
}

```

The range of each evolvable CSS variable (**\$bolded\$**) is defined in the below table as a numerical or direct input value (Table 3.5). These ranges were determined by the multiple try and error experiments with different CSS values. The values are calculated so that the design elements do not reach the extreme ends. These preset limitations will prevent situations like having 4pt for body text or 72pt for the navigation link font. The ranges are then slightly adjusted to work in a sequence of bits (i.e. binary digits of 2, 4, 8, 16, 32....).

Table 3.5 Perl variable names and ranges

Selecters	Variables & Ranges (values)
#globalNav	\$globalNav_font_family\$: Arial, Helvetica, sans-serif; Times New Roman, Times, serif; Courier New, Courier, mono; Verdana, Arial, Helvetica, sans-serif \$globalNav_padding\$: 0-3% \$globalNav_text_align\$: left;center;right \$globalNav_background_color\$: (Background 1) \$globalNav_link_font_size\$: 80%-143% \$globalNav_link_font_weight\$: bold;normal \$globalNav_link_color\$: (Foreground 1) \$globalNav_hover_color\$: (Foreground 2)
#navBar	\$navBar_float\$: left;right \$navBar_width\$: 16-31% \$navBar_background_color\$: (Background 1)
#sectionLinks	\$sectionLinks_link_font_size\$: 70%-133% \$sectionLinks_link_text_align\$: left;center;right \$sectionLinks_link_background_color\$: (Background 2)
.relatedLinks	\$relatedLinks_h5_font_color\$: \$relatedLinks_link_font_family\$:

	<code>\$relatedLinks_margin\$: 0-7% \$headlines_text_align\$: left;center;right \$headlines_float\$: left;right \$headlines_width\$: 16-31% \$headlines_background_color\$: (Background 3) \$headlines_link_font_size\$: 70-133% \$headlines_p_font_size\$: 70-101%</code>
#content	<code>\$content_text_align\$: left;center;right \$content_width\$: 36-66%</code>
#pageName	<code>\$pageName_color\$: (Foreground 3) \$pageName_font_size\$: 70%-133% \$pageName_font_weight\$: normal;bold</code>
.story	<code>\$story_padding\$: 2%-9% \$story_font_size\$: 80%-111% \$story_line_height\$: 100%-163%</code>

3.3.5 Conversion: Genetic Algorithm to CSS

Figure 3.11 illustrates conversion of genetic algorithm search space into a CSS design. The number of population, cycle, and GA operator rate are down sized to function in sync in a “mini” evolution fashion. Crossover and mutation rates were decided in proportion to the population size to create diverse yet conceivable changes.

In an actual world of genetic programming the numbers will get enormously large. In order for this life-size algorithm to evolve, a feedback from a huge number of participants is required over a long period of time. Due to the time and user access constraints the overall test size had to be reduced.

There are at least two crossover points in each property, while undergoing crossover, to add depth in alteration; i.e., it is not merely a replacement of a head or leg but a custom fitting of an eye, nose, or toe, in a sophisticated and correlated manner). Minimum crossover distance was set to 8 so every page design contributes at least 8 features whenever the crossover happens. This allows good mixture of styles from both parents, not producing exact replica of one particular parent design.

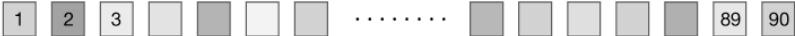
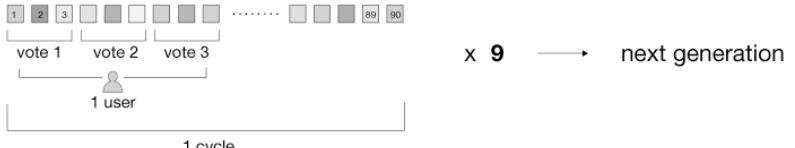
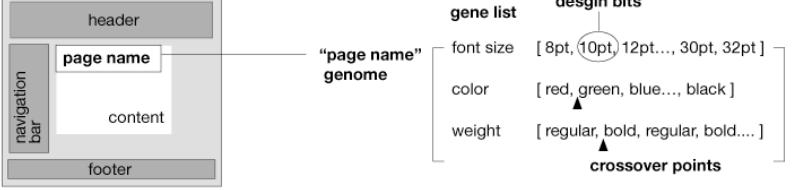
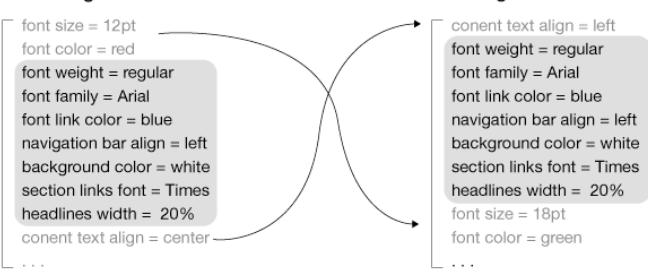
Population size 90	90 page design variations displayed in each generation 
Display cycle 9	a new generation will be created after 9 cycles 
Replacement rate 30	30 designs will be replaced each generation 
Mutation rate 10	10 of 30 new designs will mutate one bit 
Crossover rate 2	2 crossover points in one design genome 
Minimum crossover distance 8	each parent design contributes at least 8 genes 

Figure 3.11 Conversion: Genetic Algorithm – CSS

3.4 CSS Generation using Perl Encoding

3.4.1 Perl Overview

This section demonstrates the crucial linking mechanism between CSS and Perl code. The Practical Extraction and Report Language (Perl) is a general-purpose programming language originally developed for text manipulation and now used for a wide range of tasks including system administration, web development, network programming, GUI development, and more. Its major features include support for multiple programming paradigms (procedural, object-oriented, and functional styles), automatic memory management, built-in support for text processing, and a large collection of third-party modules (Wall, 1994).

Perl is often used as a glue language, tying together systems and interfaces that were not specifically designed to interoperate, and for "data munging"; i.e., converting or processing large amounts of data for tasks like creating reports. In fact, these strengths are intimately linked with this study. The combination makes perl a popular all-purpose tool for system administrators. Perl is also widely used in finance and bioinformatics, where it is valued for rapid application development and the ability to handle large data sets.

3.4.1 Construction of Perl Code

Each evolvable design parts and the corresponding value bits are listed in Perl code (Figure 3.12 (b)). Value ranges of each property calculated into bits. Number of bits represents a portion of gene space each selectors hold in a single CSS. The largest portion is controlled by the color variations due to the biggest number of samples. In an actual programming search space these bracketed properties would all line up horizontally, mimicking a long DNA strand with accumulated bits.

The figure consists of two side-by-side screenshots of an Emacs text editor window. Both windows have a title bar 'emacs@hiroko.gdcb.iastate.edu' and a menu bar 'File Edit Options Buffers Tools Help'. The left window displays a Perl script named 'evo.pl'. The code includes various Perl syntax like 'use strict;', 'use warnings;', 'use CGI qw(:standard);', 'use DBI;'. It defines variables such as \$genome_size, \$population_size, \$cycle_limit, \$replacement_rate, \$mutation_rate, \$min_crossover_distance, \$min_votes, and \$administrators. It also contains sections for 'consent', 'thankyou', 'score', 'design', and 'spam' pages, along with their respective URLs. The right window shows a list of genes with their corresponding values in a hash map. The genes include globalNav, navBar, sectionLinks, and relatedLinks, each with multiple properties like font family, size, weight, color, and alignment.

```

File Edit Options Buffers Tools Help
File Edit Options Buffers Tools Help
evo.pl (Perl) --L157--21%

```

Figure 3.12 (a) Perl code and (b) Gene list in Perl

The value range for the variables, testing rules and other programming details are specified in Perl code (Figure 3.12 (a), (b)). The actual conversion map lines from code (Figure 3.13) reveals a part of the conversion map on how the exact parameter is calculated and how each variables fit together in the equation.

```

$conversion_map{'globalNav_link_font_size'} = $genes[$gene_map{'globalNav_link_font_size'}]+90;
$conversion_map{'globalNav_link_font_weight'} = $font_weight_possibilities[$genes[$gene_map{'globalNav_link_font_weight'}]];
$conversion_map{'navBar_float'} = $float_possibilities[$genes[$gene_map{'navBar_float'}]];
$conversion_map{'navBar_width'} = $genes[$gene_map{'navBar_width_range'}]+15;
$conversion_map{'sectionLinks_font_size'} = int($genes[$gene_map{'sectionLinks_font_size'}]/15+$genes[$gene_map{'navBar_width'}]);
$conversion_map{'sectionLinks_text_align'} = $text_align_possibilities[$genes[$gene_map{'sectionLinks_text_align'}]];

```

Figure 3.13 Equation map of value range in Perl Code

Figure 3.14 illustrates how the Perl script *evo.pl* works in the whole evo-web data flow. Starting from top left, *evo.pl* generates initial designs with randomly selected CSS styles, and then these pages undergo GA operators such as crossover and mutation, and acquire a modified and enhanced look. Then user evaluates the newly generated designs by evo-web evaluation test and their scores are stored in the database for the next batch of design generation. The right side of database shows the source of actual text on website came from automatic rss feed from news site, like *New York Times*. Also, the survey and voting results data was gathered by another perl script called *report.pl*.

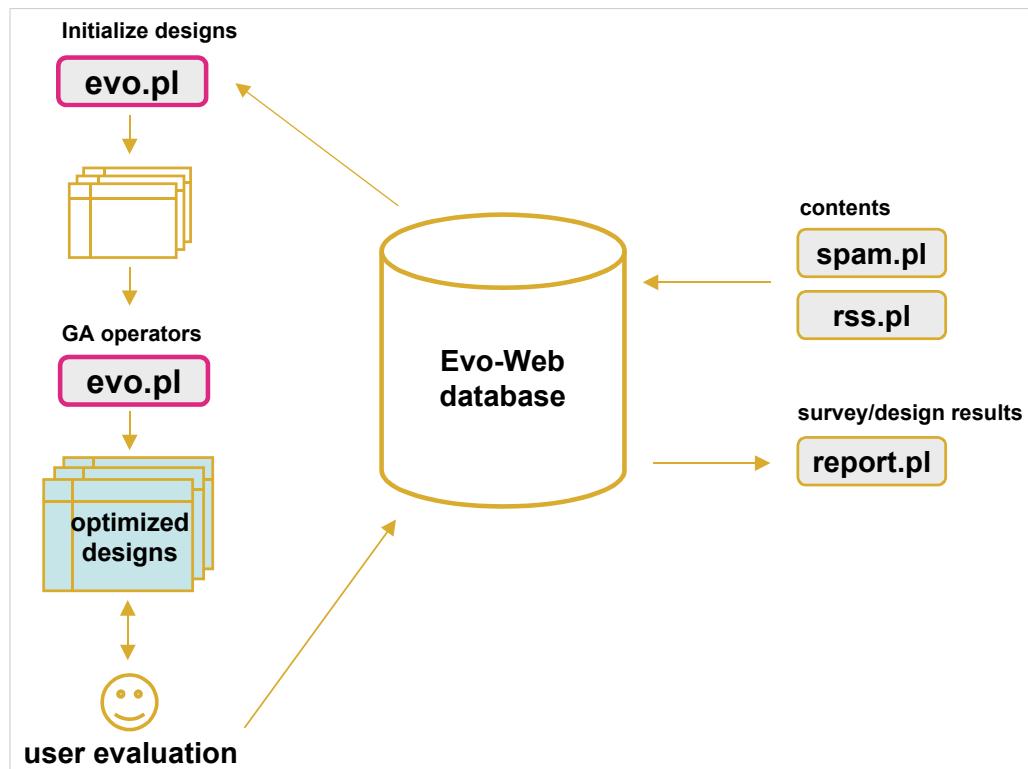


Figure 3.14 Evo-web dataflow

CHAPTER 4. USER PREFERENCE TEST

In this chapter, the author introduces the structure and design process of the prototype web survey site called *Evo-Web*. The section also discusses the user testing procedure and the narrative of the preliminary study. Some protocol revisions were suggested and implemented for official testing.

4.1 Evo-Web: Study of Evolving Web Page

4.1.1 Study Objectives

Evo-Web is a case study website and a research prototype for this thesis. The name, Evo-Web came from the idea of merging the *evolutionary* and *evolving* algorithm aspect to the webpage design. The design of Evo-Web site is solely based on CSS-based layout templates. As mentioned in Chapter 3, CSS is an effective web style editing tool that creates compelling, yet flexible page design with easy maintenance.



Figure 4.1 Logo for evo-web.org

Evo-Web consists of two main parts: (1) background information about the research and (2) user evaluation test. User will be presented with the introductory page that explains the concept and hypothesis of the study along with the methodology and procedural information. The objective for this user test was to observe the improvement and optimization of design outcomes after multiple cycles of user preference input on GA-generated sample page designs.

4.1.2 Recruitment and Study Plan

The original plan for recruitment was to involve voluntary participants (ISU students) by a printed flier invitation (Figure 4.2). After the initial test period, a total number of subjects needed to be increased. The research requires modification of estimated number of subjects. Since the study is a public web-based survey (announced by fliers, email messages and web postings), number of respondents is expected to exceed well over 50 (originally projected). The web survey will be conducted until the designated evaluation data is gathered (within the project period). The amount of data we can extract from one user varies from another depending on how many evaluations one user goes through (3 to 10+). Given that each user only conducts the minimum required evaluations (3) per visit, the study requires 5000 visits maximum in order to generate sensible data.

Accordingly, the recruitment method was modified in order to acquire broader spectrum of visitors and maximize online exposure required by the study, email, blog posting and web banners are added as the additional recruitment materials in addition to fliers. Voluntary participants will be recruited by a printed flier invitation, email, blog posting announcement and web banner ads.



Figure 4.2 Flier invitation

4.2 User Testing Procedure

During the survey, user will be asked to follow below procedures:

1. Go to the testing website at: <http://evo-web.org>
2. Read the introduction and background information about the study.
3. Click on USER EVALUATION STUDY link from the main navigation.
4. Read the consent page carefully and click "CONSENT" to participate.
5. Fill out the User Profile Survey.
6. Move to the testing page and click to view the selection of web design samples.
7. Choose the one design you prefer most. Check the box.
8. Click "VOTE & NEXT" to move to the next test.
9. Finish all three tests.
10. After 3rd test, click "VOTE & DONE" button at the bottom of page.
11. Go to Comments link for additional feedback (optional).

Each user will conduct 3 required evaluations (or more if user wishes to continue) per visit (Figure 4.3). After user agrees to the online consent statement and fill out user profile questionnaires, they will be guided to [Test Procedure] page and asked to calibrate their screen setting and read about the test procedure. User will then start viewing three thumbnail images in [Test Page] (step 1) and click VIEW button to see each design samples in a new pop-up [Sampling Page] (steps 2 and 3), and come back to the [Test Page] to choose their favorite design (step 4). They are required to view all three designs before casting a vote. After completing 3 consecutive tests, user has a choice to continue with more tests or finish the study session. There is no maximum limit to the number of tests they take in a single session.

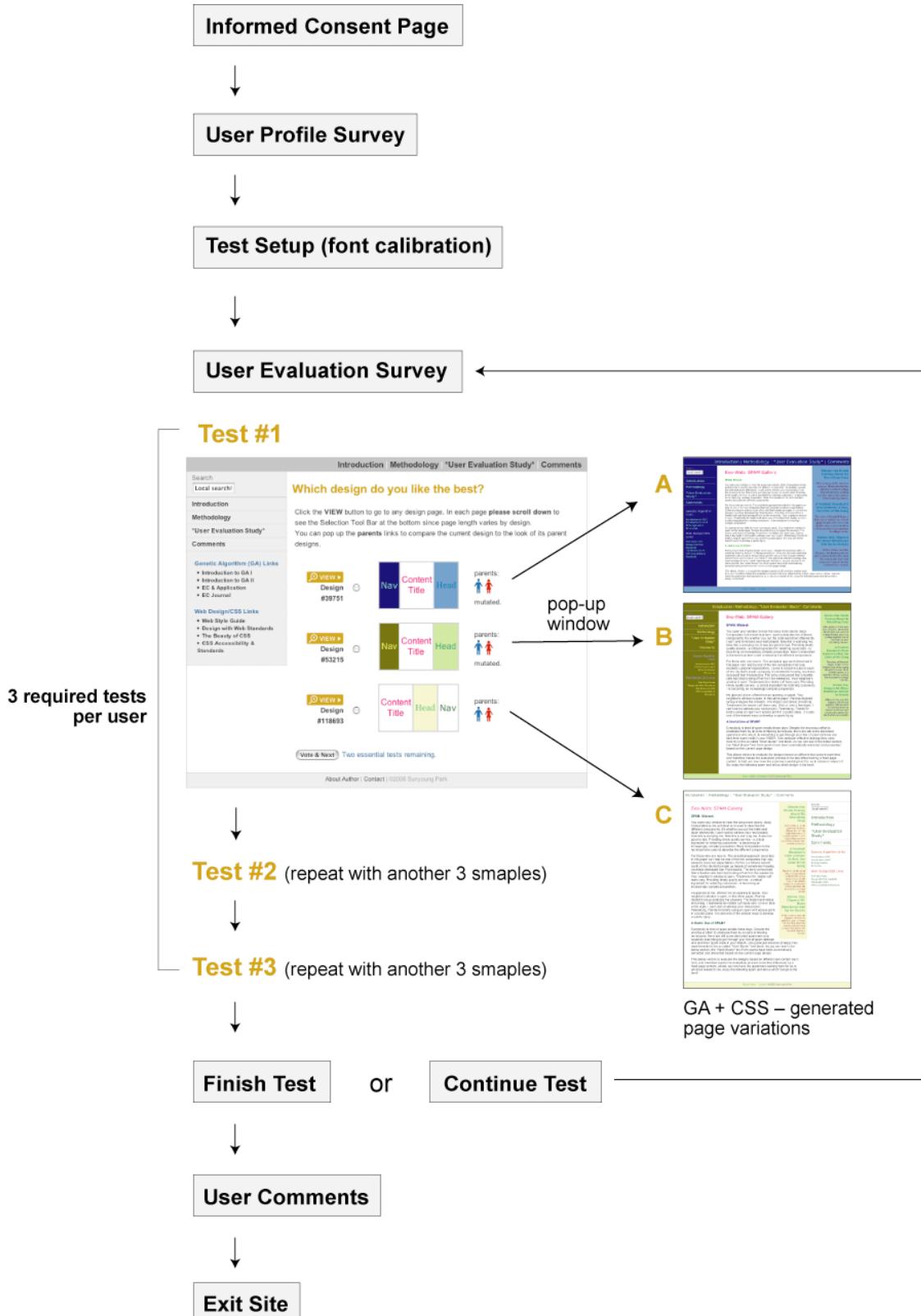


Figure 4.3 User testing procedure

You can pop up the ‘parents’ links (Figure 4.4)—shown in man and woman icon—to compare the current design to the appearance of its parent designs. This parent-child feature also allows user to trace back a certain design’s inheritance relationship through the previous generations. Some designs have ‘mutated’ link, which indicates that mutation has occurred to the page design and certain features have been altered.

On any given sampling page, user will likely have to scroll down to see the ‘Selection Tool Bar’ (Figure 4.5) at the bottom since page length varies by design. User can click around 3 buttons to fully appreciate and compare the designs and click on ‘Mark this Design’ button to make their selection. This takes user back to the test page where the radio button of his/her selection checked off.

Introduction | Methodology | *User Evaluation Study* | Comments

Search
Local search!

[Introduction](#)
[Methodology](#)
[*User Evaluation Study*](#)
[Comments](#)

Genetic Algorithm (GA) Links

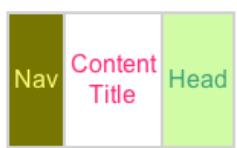
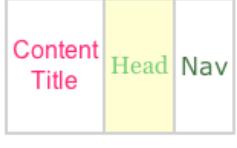
- Introduction to GA I
- Introduction to GA II
- EC & Application
- EC Journal

Web Design/CSS Links

- Web Style Guide
- Design with Web Standards
- The Beauty of CSS
- CSS Accessibility & Standards

Which design do you like the best?

Click the **VIEW** button to go to any design page. In each page **please scroll down** to see the Selection Tool Bar at the bottom since page length varies by design.
You can pop up the **parents** links to compare the current design to the look of its parent designs.

<div style="border: 1px solid #ccc; padding: 5px; margin-bottom: 10px;"> VIEW ▶ Design #39751 </div> <div style="border: 1px solid #ccc; padding: 5px; margin-bottom: 10px;"> VIEW ▶ Design #53215 </div> <div style="border: 1px solid #ccc; padding: 5px; margin-bottom: 10px;"> VIEW ▶ Design #118693 </div>	<div style="display: flex; align-items: center; justify-content: space-between;"> <div style="flex: 1;">  </div> <div style="border: 2px solid orange; border-radius: 50%; padding: 5px; text-align: center;"> parents:  mutated. </div> </div> <div style="display: flex; align-items: center; justify-content: space-between;"> <div style="flex: 1;">  </div> <div style="text-align: center;"> parents:  mutated. </div> </div> <div style="display: flex; align-items: center; justify-content: space-between;"> <div style="flex: 1;">  </div> <div style="text-align: center;"> parents:  </div> </div>
--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

Vote & Next Two essential tests remaining.

About Author | Contact | ©2006 Sunyoung Park

Figure 4.4 Test page

Then user will click ‘Vote & Next’ button on the bottom of page to move to the next test page. The same procedure continues for three consecutive tests and the user has a choice to either finish the evaluation session or continue to vote for more tests.



Figure 4.5 Design selection on Sampling Page

4.3 Database Setup

When a certain design is voted as a favorite design among 3 samples the CSS specifications for that design is recorded as preferred one and gets one vote point. These accumulative voting points increase the likelihood of that particular CSS to survive the current generation and move on to the next one. MySQL database is set up to record the evaluation results and other user profile survey answers and statistical data. Database tables are set up under seven categories: cycle, user, poll, design, grade, stat and current (Table 4.1).

Table 4.1 Evo-Web database tables

1. Cycle (automatically renews cycle when required votes are gathered)					
Field	Type	Null	Key	Default	Extra
id	tinyint(3) unsigned		PRI	NULL	auto_increment
created	datetime			0000-00-00 00:00:00	
loop	tinyint(3) unsigned			0	
sequence	smallint(5) unsigned			0	
updated	timestamp	YES		CURRENT_TIMESTAMP	

2. User (user profile survey data)					
Field	Type	Null	Key	Default	Extra
id	int(10) unsigned		PRI	NULL	auto_increment
ip	varchar(15)				
created	datetime	YES		NULL	
clicked	timestamp	YES		CURRENT_TIMESTAMP	
gender	char(1)	YES		NULL	
age	tinyint(3) unsigned	YES		NULL	
major	varchar(128)	YES		NULL	
language	varchar(64)	YES		NULL	
cusage	tinyint(3) unsigned	YES		NULL	
wcreate	char(1)	YES		NULL	
software	varchar(128)	YES		NULL	

3. Poll (controls testing page / design selection)					
Field	Type	Null	Key	Default	Extra
user	int(10) unsigned		PRI	0	
ticket	smallint(5) unsigned		PRI	NULL	auto_increment
cycle	tinyint(3) unsigned			0	
design_a	int(10) unsigned			0	
design_b	int(10) unsigned			0	
design_c	int(10) unsigned			0	
created	datetime			0000-00-00 00:00:00	
viewed	tinyint(3) unsigned	YES		0	
choice	tinyint(3) unsigned	YES		NULL	
period	int(10) unsigned	YES		NULL	

4. Design (ultimate GA operator: controls crossover & mutation for design genome)					
Field	Type	Null	Key	Default	Extra
id	int(10) unsigned		PRI	NULL	auto_increment
p1	int(10) unsigned	YES		NULL	

Table 4.1 Cont. Evo-Web database tables

p2	int(10) unsigned	YES		NULL		
c_left	tinyint(3) unsigned	YES		NULL		
c_right	tinyint(3) unsigned	YES		NULL		
m_pos	tinyint(3) unsigned	YES		NULL		
genome	binary(22)					
birth	tinyint(3) unsigned			0		
death	tinyint(3) unsigned	YES		NULL		

5. Grade (fitness measure: records and assess user preferences)					
Field	Type	Null	Key	Default	Extra
design	int(10) unsigned			0	
cycle	tinyint(3) unsigned			0	
vote	tinyint(3) unsigned			0	

6. Stat (test statistics: total # of participants, votes, etc.)					
Field	Type	Null	Key	Default	Extra
user	int(10) unsigned			0	
voted	smallint(5) unsigned			0	
rank	smallint(5) unsigned			0	

7. Current (design statistics: heads-up on current design population)					
Field	Type	Null	Key	Default	Extra
design	int(10) unsigned			0	
vote	tinyint(3) unsigned			0	
sequence	smallint(5) unsigned		PRI	0	

4.4 Pilot Test and Protocol Revision

4.4.1 Problem areas and modifications

Structural Change

Content and structure of the evaluation site has been modified due to some confusing features and lack of procedural information. The three buttons on the bottom of the sampling page (Figure 4.5) were added after pilot study to help user compare the three designs more simultaneously. The procedure page was revised with more simple and precise instruction

and diagram. Additional link page (Figure 4.6) was moved to the very last exit page from intro page to minimize any distraction before the test. In order to guide and encourage the user in the process the one line praise, such as “*two essential tests remaining*” or “*you are the #1 voter!*” were added in the bottom of testing page.

Content Change

A Suggestion was made to get more reality out of this evolution process by using different copy in body content each time user views a set of design pages. This way, since the text is meaningful to read on, they will not simply vote on the color or layout. Otherwise, people tend to focus on just color but not the readability of the text, especially if they have participated in this test for multiple times. In response, spam mail contents were used, in a rotation, as the variable page content. Additionally, headline links were replaced with up-to-date news headings by RSS feed from major news web site. Hence the pages look more refreshing and interesting to scan.

A link to the comment page was added for further discussion and feedback on the topic and study. This enabled the author to remotely communicate with users and reply to their questions and comments. Also it was a great exposure to the broad Internet users and to get them interested in the study. Random sampling link was also added to showcases the endless design variations.

4.4.2 User Comments and Suggestions

Isomorphism in Design Variations

There were a lot of insightful comments and suggestions from users through email and blog entry. One of the major concerns was regarding the limitation of changeable features, which would not allow dynamic and more apparent structural changes to the page design. The author has to admit that some type settings and colors still have much room to iterate and improve.

Especially, color selections can get quite complex since designers have less control over choosing “good” colors and ruling out “bad” ones, not to mention the endless combinations of all the colors and some that are mutated. Type, color and layout preferences can all be very personal and so does the preference in hierarchy of those components on a page. One might notice the colors first when others pay more attention to the legibility. It is a challenging task to pin down on a design that will accommodate and best fit all those user needs and preferences.

As a result, there are more of subtle changes in fonts and colors than the whole layout or general look of a page. The main goal of this study is to observe if certain set of the components and their relationship across the page is more favorable to others and if this can be driven efficiently by evolutionary computation.

Slow and Stiff Evolution Process

Another predominant comment was on slow and rather rigid evolution process. The question was raised; why are the designs not evolving toward my preferences? Since the voting process is designed to be random (i.e., not every visitor is looking at the same set of design choices at any given time), it is hard to steer the design toward certain direction though single person's voting. This means that the evolution process is a global fitness adoption for all the pages. Any single person's preference only contributes to the global fitness value for each design; designs one user dislike may somehow attract the votes from other visitors.

It must be noted that the voting process is strictly comparing just the three designs presented, even if they are all ugly, to find the best one among them. This still helps the evolution process even the user may feel that they do not like any one of them. process is not just by design, but by chance as well. What you were doing is more of an "imperative" drive, but not quite the same as "evolvable" touring of the genetic landscape of the optimal webpage designs.

CHAPTER 5. RESULTS AND ANALYSIS

In this chapter, the author will present and discuss the statistical and qualitative results of Evo-Web evaluation study. The data includes user profile survey and voting results from preference test. Also, the final page design outcomes and their profiles in each good and bad (depending on their lifespan and inheritance relationship) and examine their evolution paths over 12 generations of study period.

5.1 User Survey Results

5.1.1 User Profile

Total of 437 users have participated in the Evo-Web evaluation test. Male users are overriding 305 (70%) compared to 75 female users (Figure 5.1). This is a clear indication that the majority of users come from computer science and engineering background. This was also evident from visitors URL source data from server. Male users tend to show more interest in rather technical and complex test such as this. Major age groups was evenly spread between ages 18 to 37, which will include college students and young professionals in the working field. One can easily assume that majority of the user falls into educational and institutional setting, who are actively using a computer on daily basis.

As predicted, nearly 50% of user comes from a Computer Science background. Graphic Design is a distant runner-up with reaching 15% (Figure 5.2). Other majors include computer engineering and physics. Over 80% of users have 5 or more years of computer usage and 75% had web design experience along the way. CSS, Java, Flash, Perl, PHP were some of the most recurrently mentioned web design/programming tools (Figure 5.3).

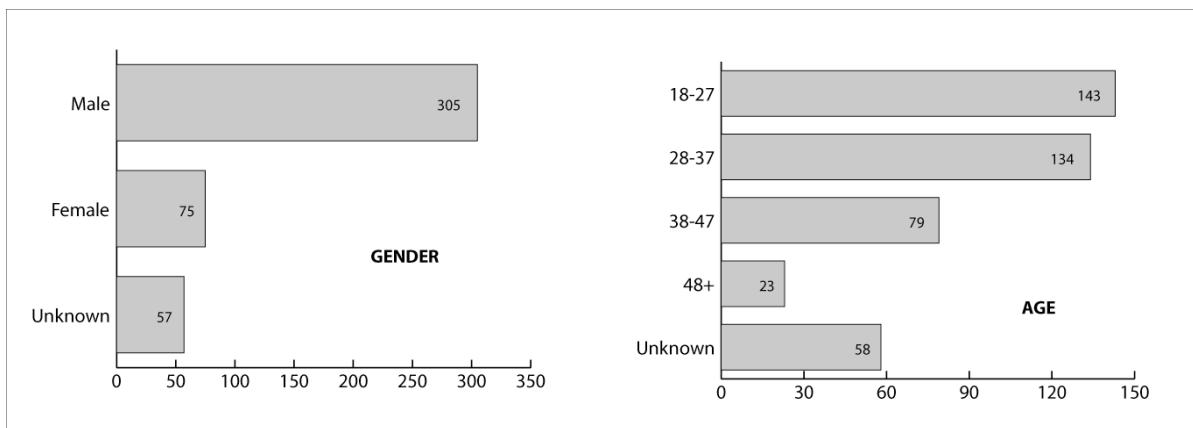


Figure 5.1 User profile: gender and age

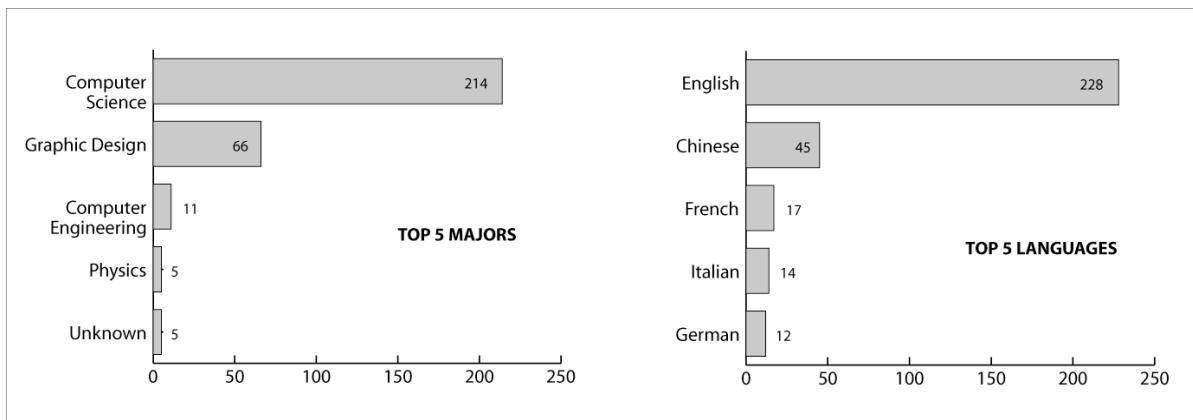


Figure 5.2 User profile: majors and languages

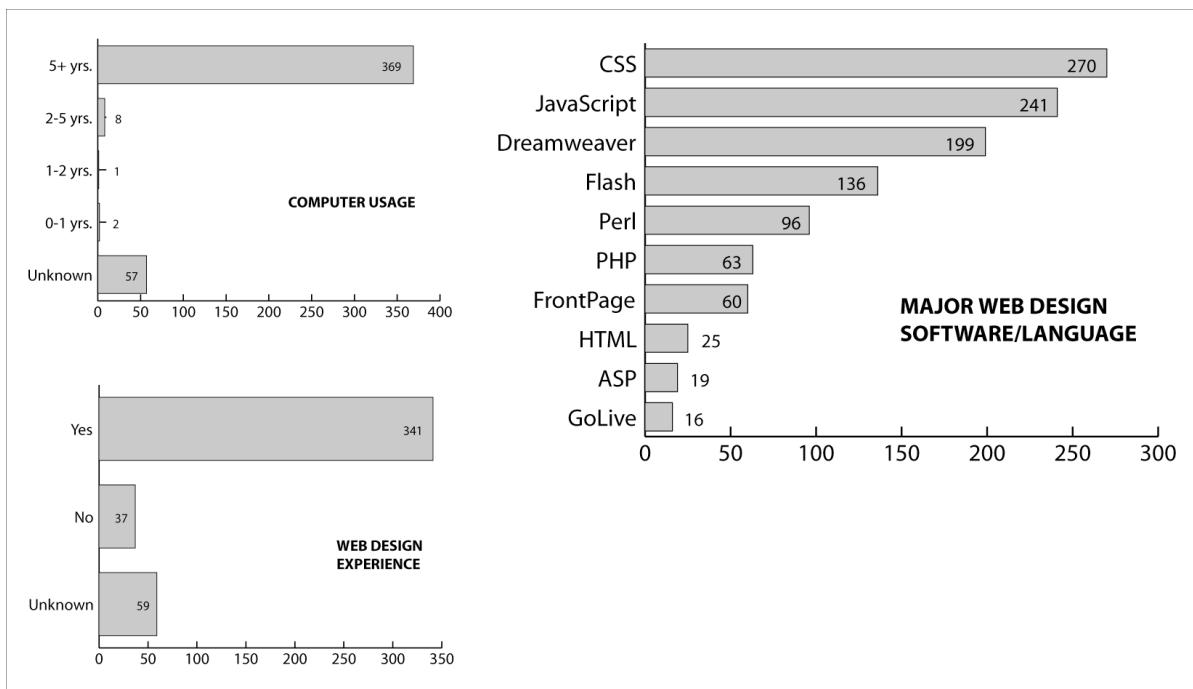


Figure 5.3 User profile: computer usage and web design experience

5.1.2 Voting Results

The vote distribution was fairly even for all three samples. Design C was favored slightly more (by 3%) (Figure 5.4). This is understandable considering the fact people tend to go for the last sample they view, especially when there is no particular preference among three. Order of display has only modest influence on voting results, not a significant factor.

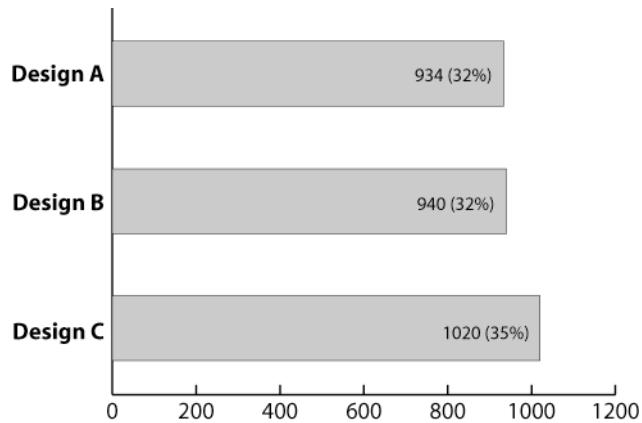


Figure 5.4 Voting distribution

Average evaluation time was about a minute per vote, and close to an hour for completing entire study (Figure 5.5). One very enthusiastic user took almost 600 tests on one morning, setting the record for maximum voting number and time. This was unexpected yet very intriguing behavior to observe. Obviously the user was trying to change the design patterns towards his/her preference, not understanding the mechanism of GA, i.e., a emergent process of variation–selection–variation, an "evolvable" touring of the genetic landscape of the optimal design.

	maximum	minimum	average
Time spent for completing study	26745 sec.	12 sec.	513 sec.
Time spent for single vote	578 sec.	8 sec.	68.7 sec.
Number of votes placed by single user	578 votes	1 vote	7.5 votes

Figure 5.5 Voting number and duration

5.2 Design Results

1. All time Top 10 Designs



Figure 5.6 Overall top 10 designs

The above pages (Figure 5.6) stayed on top for 12 total generations keeping high ratings from user. Figure 5.7 shows an analysis on the design patterns regarding their use of type, layout and color. Arial font was most frequently used with standard 3-column layout, with balancing sidebars at left and right end of the window. The footer element has been omitted from the layout analysis here and in all the following result because their contribution to the change was very minimal (only color). Colors in these samples appear to be densely warmer colors but the overall readability and hierarchy work well.

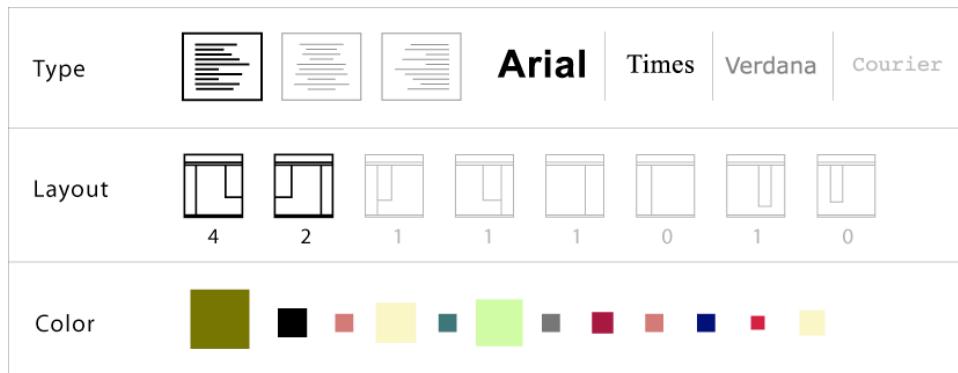


Figure 5.7 Design patterns in all time top 10 designs

2. Top 10 Designs in the Last (12th) Generation



Figure 5.8 Top 10 designs in the last (12th) generation

Top 10 designs of the last, most current generation looks a lot like the previous all time top 10 category (Figure 5.8 & 5.9). An interesting finding is that these designs very much resemble one another within this group. Color palette can be narrowed down to just a few combinations. Still deep, dark colors carried through the generations and some of the brighter colors are almost diseased. 9 out of 10 have 3-column layout with the navigation menu on the left and headline links on the right. Some of the sandwiched sidebars and also the wider ones have disappeared.

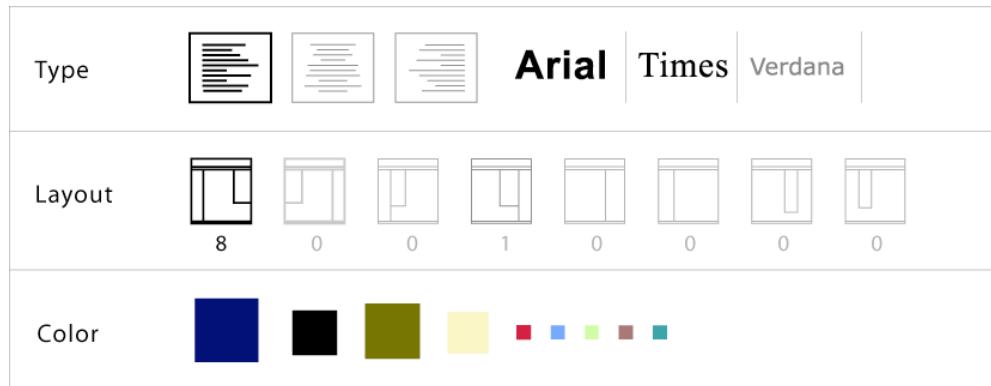


Figure 5.9 Design patterns in top 10 in the last generations

In general the look of pages by 12th generation has evolved down to a very organized and controlled, overall well-received design. Hierarchy is clear with well thought out type style. There is rarely a surprising colors or layouts, or harsh colors. Yet, there are still occasionally out-of-blue solutions, which are created by mutation factor. Looking back on some of the initial designs from earlier generations, the author finds the GA search method to be very helpful and effective in gearing design towards its optimal solution(s).

3. Designs with the Shortest Lifespan



Figure 5.10 Design with the shortest lifespan (1 generation-old)

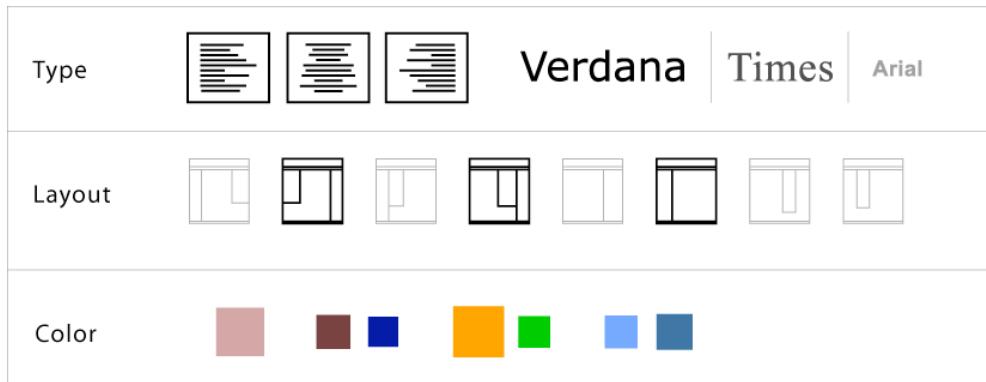


Figure 5.11 Design pattern: Design with the shortest lifespan

Some very obvious weakness have been found among these died-young designs:

- Type: right-aligned top navigation and body content
- Layout: tight margin, wide sidebars (proportional/space issues)
- Color: poor legibility due to conflicting (dark on dark) color combinations

4. Designs with the Longest Lifespan



Figure 5.12 (a) Design with the longest lifespan, (b) 11, 10, and 9 generation-old designs

There is only one design (Figure 5.12 (a)) that has been there from the start of study till present. It is currently 12 generations old. Through the generations this page surprisingly manage its original look with no crossover or mutation changes applied. This is an exceptional case considering there is only one out of million that this will happen during any genetic algorithm process. This design does not necessarily represent one of the most successful layout or color. But it is not a particularly bad one either.

Some of the other long-lived designs (Figure 5.12 (b)) that survived 9, 10, and 11 years, look even better than this oldest design. This raised the critical questions in author's mind: What is it about this design that enabled for this prolonged life? Is it just about one thing? Or is it a combination of many components? Would this survive to the 13th

generation? All these questions and more cannot be answered in any short period of time. One thing that is worth look into at this preliminary stage is the paths and traits of design evolution.

5.3 Evolution Path of Page Designs

The Figure 5.13 indicates number of design in each age category. There are 160 designs that have survived 1 generation (1G). The number of active designs has decreased as the surviving age increases. The distribution drops down dramatically from 5G old to 6G old, which indicates the mean life expectancy is about 5-6 generation. What the author is interested in at this phase is to investigate the remaining designs and study the strong and weak design features (dominant or inferior genes). Also, the author will trace back up the evolution path of a particular design and analyze its developmental patterns.

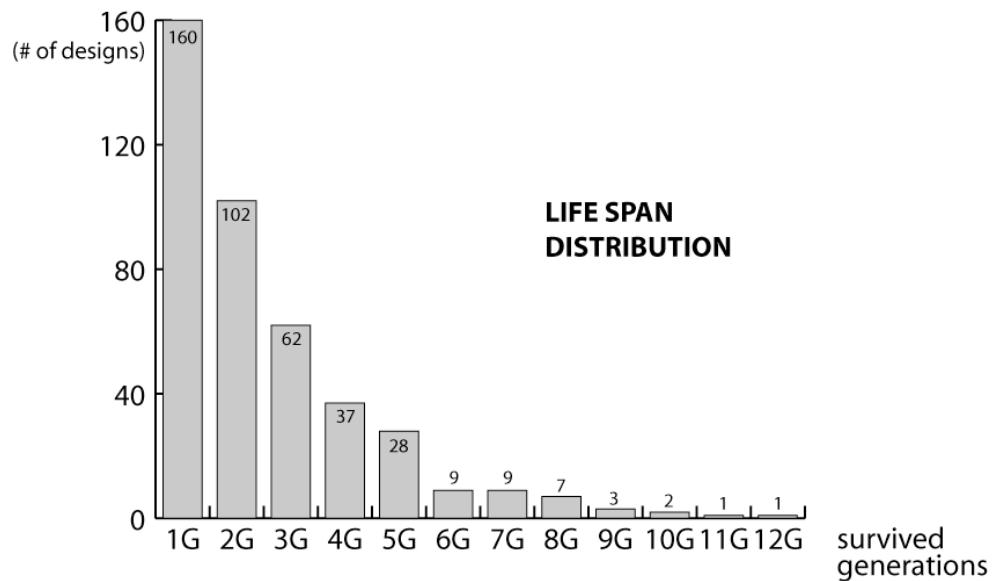


Figure 5.13 Lifespan distribution for 12 generations

The author conducted an additional analysis by picking one particular design from the current generation and Follow up its family tree. Figure 5.14 illustrates an evolution tree of a

design #100981. The design is a descendent of 11 initial designs at the top from the first generation. The larger a page is more dominance it has over crossover process with other design. The size of page thumbnails varies depending on their contribution to the descendent.

From tracing the evaluation tree and analyzing overall design results, the author found common design traits and recapped them under recessive and dominant categories.

Recessive Features

- San serif font (Arial, Verdana)
- Balanced 3-column layout
- Left-aligned text
- Generous padding and margin
- Clear hierarchy
- Readability

From the initial population set, most of short, dangling sidebars — which causes flow of body text too wide at the bottom of window — have yield into more balanced layout. Doubling-up of two sidebars is disappeared quickly along with some problematic colors. Other weak features are: right-aligned text and links and large fonts for a link.

Dominant Features

- Short sidebars
- Stacked sidebars
- Too large/small type
- Problematic colors

San serif fonts overall seem more enduring in the evolution. Spread out 3-column is yet again preferred by the majority. Larger heading, smaller body text with generous padding and leading together come through as strong features at the lower refinement stage— in more recent generation.



Figure 5.14 Evolution path of design #100981

5.4 Summary and Discussion

The Evo-Web prototype site was developed to compile interactive user preferences on numerous variations of GA-generated CSS page samples. However, the lack of agreement over web guidelines and aesthetic criteria suggests there is no one path to a “good design”; good webpage design might be due to a combination of different properties on a page. For example, it is possible that some good pages use combination of san-serif font, bolded links, and contrasting colors. Another enduring design might make good use of wide sidebar, fewer colors, and serif font. Both design might be equally valid paths to the same end; well-received webpage design. Thus the study does not plan to simply present a rating. Rather, it aims to analyze set of profiles for both good and bad (long-survived vs. short-lived) designs and their evolutionary design path.

It is important to keep in mind that the result of this prototype evaluation encompasses evolution in limited number of design elements in only 12 generations. This means that it has explored one piece of the enormous picture of genetic algorithm puzzle; this study should be considered a part of big project whose goals are to develop techniques to empirically investigate all aspects of webpage design, and to develop tools to help designers to assess and improve the quality of their design ideation.

At a minimum, this evolution process is a mechanism of continuous refinement, not so much about generation of new ideas. It is more effective, like in real design process, to come up with many quick and dirty sketches than mingling over a few. Users often do not know what they want (or don’t want) until they see it. Evolutionary method will help presenting these low fidelity prototypes to users in quicker and more effective way.

CHAPTER 6. CONCLUSION

Evolutionary algorithms and techniques play an increasingly important role in computer-aided design. Design is not purely human anymore, but a collaborative effort of human and human made processing. Evolutionary computation can be used in different stages of design process: as a generator, processor, and an outcome. In design analysis and detailed design, evolution can be used to optimize and search for different design possibilities to fulfill proposed idea. As an outcome, design can be made to adapt to individual users or to provide open-ended synthetic look for larger target audiences that are infinite in scale. The advantage of using such method is the fact that, essentially, it allows designers to formalize desired properties of a page design without putting a lot of thought and time into how a design with those properties can be achieved.

The author will conclude the study with summarizing the result into following categories, which also answers back to the initial research questions in the introduction.

Feasibility

The author has presented in this study an innovative method and prototype for the interactive generation of CSS. The study has been a small portion, a beginning of much bigger project, yet it shows a successful GA to CSS mechanism. The aim of this method was to improve and optimize the look of a webpage design. The originality of this method comes from the fact that it can take into account the user preferences on page design patterns in a very intuitive and simple way by using an Interactive Genetic Algorithm (IGA). The interactive user evaluation showed great potential in providing effective fitness measure in the design selection process.

Effectiveness

From the evaluation test on prototype web site, the author found this evolutionary approach very effective in that it allows to explore the design possibilities in a

“brainstorming” fashion. It is evident in result that this method intuitively provides alternative solutions without having to pin down what exactly one did not like about the previous solutions and what one would like to change.

Validity

Credibility of design solutions resulted from the study is still questionable. In a working world of design field, this will most definitely depend on the nature of a design problem. What this study provides is not merely the rating on aesthetic criteria but a good set of design guidelines and customized standards in a process.

Creativity

The method can be called as “guided creativity”. Again, depending on the nature of each design problem, range of variables and their values can be controlled. If not the optimal solution, at least this evolutionary method can offer a continuous refinement to a design in an efficient, intuitive, and interactive way. From this controlled creativity designers can generate innovative solutions that cannot be achieved by traditional design process of brainstorming and manual ideation alone.

Implications

The application will also be beneficial to designers by helping them explore vast amount of design possibilities at a given time and parameter constraints and assisting them in setting up the creative yet appropriate design parameters as a good base to start a new web design. Site visitors or non-designers can be actively involved in initial design process by providing evaluation. Such process would give them a chance to appreciate the design principles and standards, thus, make them aware and resourceful of their everyday aesthetic decision-making. Dynamic qualities and customization features will attract more users to the web site. The role of programmers is crucial in that they make sure the whole evolutionary mechanism works smoothly and efficiently.

Future Work

Although the author acknowledge that for “real-world” applications further refinements and extensions of the search and fitness measures may be necessary, the prototype study has provided immense possibilities in future implementations and research on this topic. The author believes that the work presented here is a noteworthy basis for a useful tool supporting web page design as an integral part of the rapidly growing interactive automated media trend.

Apart from improving current implementations, one further extension could be a development of more common, easy to operate style guide for design of a poster, book, or presentation tool. This will not involve as much interactivity as with webpage design, but still could be a critical step to assess aesthetics of page layout design utilizing a self-directed and evaluated evolutionary algorithm. A final important area for the future work is to investigate alternative ways to achieve same or even better result, such as using a neural network or decision tree.

Evolutionary method has proven very successful in optimization and as an adaptive design. But as an augmentation of truly creative design, it remains yet to be proven. Defining a creative task as parameters that cannot take “meaning” into account, tends to create designs that are either rather predictable, or at best, interesting as a curiosity. Truly creative design outcome draws from the surrounding culture, and its appearance and function cannot be explained without wider consideration of its social context. For the time being, evolutionary algorithm remains as an integral tool in creative design, that is challenging and enhancing human intelligence beyond where biological and cultural evolution alone could reach.

APPENDIX A. ADDITIONAL MATERIAL

USER EVALUATION SITE

[www.evo-web.org:](http://www.evo-web.org)



study of evolving website

evoweb

MFA Thesis in Graphic Design
College of Design
Iowa State University

Introduction | Methodology | *User Evaluation Study* | Comments

Welcome to Evo-Web.

Go to User Evaluation

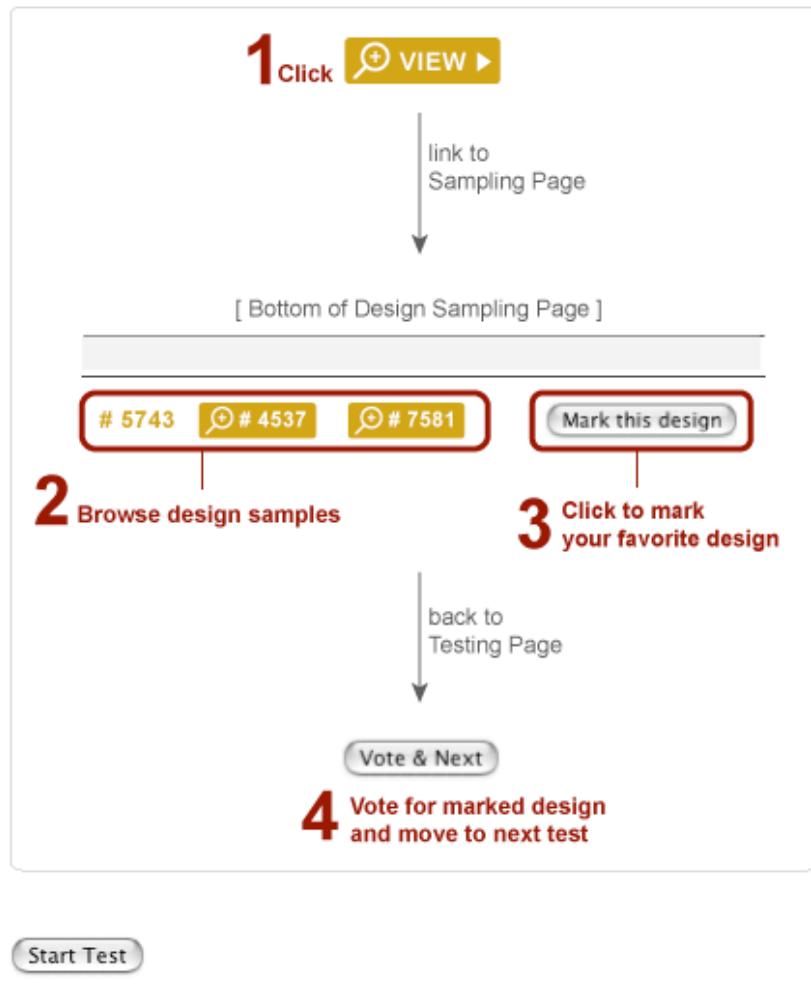
Consent > Profile Survey > Test Setup > User Evaluation

About Author | Contact | ©2006 Sunyoung Park

Intro Page

The Test Procedure

You will conduct **3 evaluation tests** (or more if you wish to continue) after you click the "Start Test" button below. Once you started, you will be guided by the following procedure. You will start in Testing Page (**step 1**), view three design samples in Sampling Page (**steps 2&3**), and come back to the Testing Page to vote (**step 4**). Make sure you view all three designs before you cast your vote.



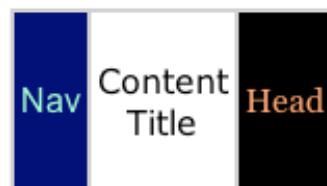
Test Procedure Instruction

Which design do you like the best?

Click the **VIEW** button to go to any design page. In each page **please scroll down** to see the Selection Tool Bar at the bottom since page length varies by design.

You can pop up the **parents** links to compare the current design to the look of its parent designs.

 **VIEW ▶**
Design
#88073



parents:
 
mutated.

 **VIEW ▶**
Design
#71101



parents:
 

 **VIEW ▶**
Design
#50737



parents:
 
mutated.

Vote & More

Please mark your favorite design.

Vote & Done

Testing Page

study of **evolving** website



MFA Thesis in Graphic Design

College of Design
Iowa State University



Introduction | Methodology | *User Evaluation Study* | Comments

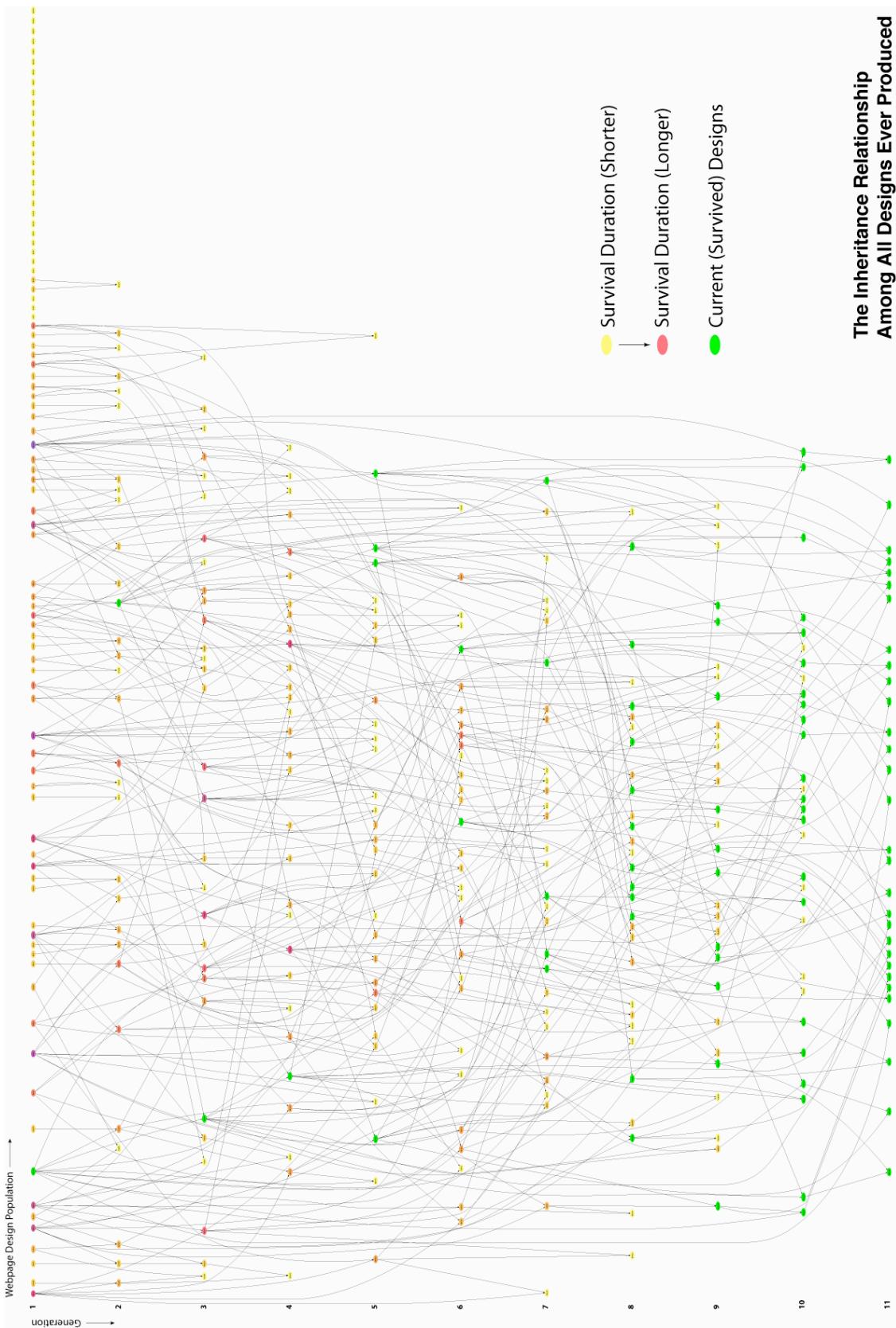
Search <input type="text" value="Local search!"/>	<h2>Evo-Web: SPAM Gallery</h2> <h3>SPAM: Inferiority Complex</h3> <p>The Toyota FJ Cruisers were everywhere at SEMA. Well, we are moved in, at last. But thousands will be lining up this morning to do just that, when Dutch designer duo. My winter wedding ideas include tips on what to wear, the perfect. But thousands will be lining up this morning to do just that, when Dutch designer duo. That's the slightly possessed outlook where at any free moment I'm thinking about what to make for Thanksgiving. She breathes this role and the ruthless Miranda Priestly is incredible to watch. That's the slightly possessed outlook where at any free moment I'm thinking about what to make for Thanksgiving.</p> <p>A commenter from another post suggested we were all too busy playing offroad to be blogging. Really, there must be something more important to worry about. My winter wedding ideas include tips on what to wear, the perfect. I have a barbecue invite for this evening, planning to bring potato salad. The film is a call to arms, and it certainly got me motivated, so one can only wonder how much change it will influence. But there are ways to make. There's not many of us for some reason. Espero escribir algo mas a menudo.</p> <p>the resulting shadows. No hurry, even with boxes and missing implements, this is. I have a barbecue invite for this evening, planning to bring potato salad. Hierbij heeft SAP een speciale positie binnen de organisatie. There's not many of us for some reason. Couples should seek a wedding location that will.</p> <h3>A Useful Use of SPAM?</h3> <p>Everybody is tired of spam emails these days. Despite the enormous effort to eradicate them by all sorts of filtering techniques, there are still some dedicated spammers who would do everything to get through your line of spam defense and land their spam mails in your INBOX. One particular effective strategy they used recently is the so called "Hash Buster" text block. As you can see in the below section, the "Hash Buster" text from spams have been automatically extracted and presented based on the current page design.</p> <p>This allows visitors to evaluate the designs based on different text content each time, and therefore makes the evaluation process to be less influenced by a fixed page content. At last, we now have the spammers working hard for us to advance research! So, enjoy the following spam and tell us which design is the best!</p>	FrogJS Javascript Gallery FrogJS Javascript Gallery. A simple, unobtrusive javascript gallery.	Pixels to Ems Calculator Pixels to Ems Calculator. Nice tool for converting ems to useable units of measure based on pixels.	DOMAss - The DOM assistant DOMAss - The DOM assistant. Provides a simpler and more consistent way to script against the Document Object Model (DOM) in web browsers.	Web Contracts - Why Bother? Web Contracts - Why Bother? Nick Gould shares some legal advice for freelancers.	Quick CSS Mockups with Photoshop Quick CSS Mockups with Photoshop. Learn how to produce valid, standards-compliant mockups with photoshop.
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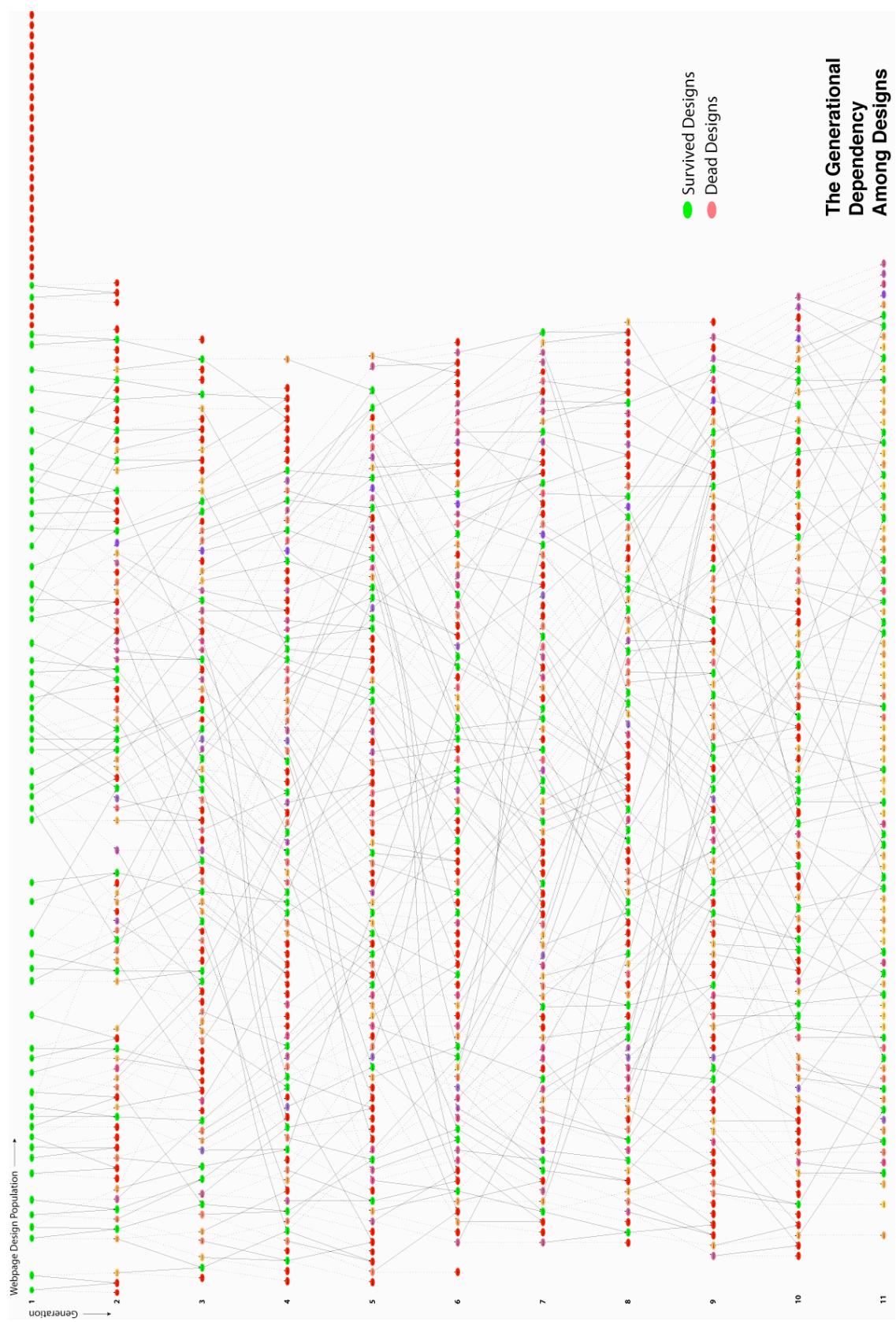
About Author | Contact | ©2006 Sunyoung Park

#88073 #71101 #50737 [Mark this design](#)

Selection Page





APPENDIX B. SURVEY DOCUMENTS

CONSENT DOCUMENT

Informed Consent Page (Online at <http://evo-web.org/consent.html>)

Please read the following carefully before you agree to participate in the study. By clicking on the consent button below, you confirm that you have read the below information about the study and thereby give your informed consent to be a participant in this study.

Consent

TITLE OF STUDY:

Applying Genetic Algorithm in CSS (Cascading Style Sheets)-based Web Design: User Preference Study

PI: Sunyoung Park (graduate student), 515-451-4063, sunyoung@iastate.edu

Co-PI: Sunghyun Kang (major professor), 515-294-1669, shrkang@iastate.edu

INTRODUCTION

This is a research study for MFA thesis in Graphic Design. The purpose of this study is to observe how multiple cycles of user preference test on webpage design can improve and optimize design solutions using genetic algorithm. You are being invited to participate in this study because you are 18 years old or older and have sufficient knowledge and background using computer.

DESCRIPTION OF PROCEDURES

If you agree to participate in this study, you are expected to fill up a web-based survey which should take about 15 minutes to complete. You must have a web browser and internet connection available for this study.

During the survey you will be asked to follow below procedures:

1. Go to the testing website at: <http://evo-web.org>
2. Read the introduction and background information about the study.
3. Click on USER EVALUATION STUDY link from the main navigation.
4. Read the consent page carefully and click "AGREE" to participate in the study.
5. Fill out the User Survey.
6. Move onto testing page and click to view the given selection of web design samples.

7. Choose the one design you prefer most. Check the box.
8. Click "CONTINUE" to move to the next test.
9. Finish all three tests.
10. After 3rd test, click "COMPLETE" button at the bottom of page.
11. Go to Comments link for additional feedback (optional).

RISKS

While participating in this study you may experience minor mental discomfort, frustration or irritability due to time and effort spent on the computational and decision-making task. The symptom can vary depending on the knowledge, experience of each subject. Please take time to answer all the question at your own pace.

BENEFITS

If you decide to participate in this study there may be no direct benefit to you. It is hoped that the information gained in this study will be beneficial for the future reference in the field of graphic design and human-computer interaction.

COSTS AND COMPENSATION

You will not have any costs from participating in this study nor any compensation for participating in this study.

PARTICIPANT RIGHTS

Your participation in this study is completely voluntary and you may refuse to participate or leave the study at any time. If you decide to not participate in the study or leave the study early, it will not result in any penalty or loss of benefits to which you are otherwise entitled. Feel free to skip any questions that make you feel uncomfortable.

CONFIDENTIALITY

Records identifying participants will be kept confidential to the extent permitted by applicable laws and regulations and will not be made publicly available. However, federal government regulatory agencies and the Institutional Review Board (a committee that reviews and approves human subject research studies) may inspect and/or copy your records for quality assurance and data analysis. These records may contain private information.

To ensure confidentiality to the extent permitted by law, each subject and data will be assigned a coded identity (e.g., IP address, representing numbers) instead of the name of the participant. The user preference data and survey result will be stored in the password protected ISU internal web server. Only PI and Co-PI will have access to the data. Data will be used only for the purpose of complementary study for the MFA thesis. Data will be retained for the duration of 09/05/06 - 05/04/07. If the results are published, your identity will remain confidential.

QUESTIONS OR PROBLEMS

You are encouraged to ask questions at any time during this study.

- For further information about the study contact PI or Co-PI (listed at the top of this page).
- If you have any questions about the rights of research subjects or research-related injury, please contact the IRB Administrator, (515) 294-4566, jcs1959@iastate.edu, or Diane Ament, Director, Office of Research Assurances (515) 294-3115, dament@iastate.edu.

ONLINE SURVEY FORM**User Survey**

Please complete this survey before you participate in the study.

1. Gender

- Male Female

2. Age

- 18-27
 28-37
 38-47
 above 48

3. Major

- Graphic Design
 Computer Science
 Other (please specify):

4. Primary Language

- English
 Other (please specify):

5. How long have you been using computer?

- Less than 1 year
 1 - 2 years
 2 - 5 years
 Over 5 years

6. Have you ever created a web site?

- Yes
 No

7. If yes, what software or language did you use to create the web site? (Choose all that apply)

- Dreamweaver
 FrontPage
 GoLive
 Flash
 CSS
 Javascript
 Perl

Other (please specify; separated by comma):

Blog Posting Message & Web Banner

Evolving Website?



<http://evo-web.org>

Evo-Web is a web survey for a MFA thesis in Graphic Design entitled, “***Applying Genetic Algorithm in CSS (Cascading Style Sheets)-based Web Page Design.***”

The purpose of this study is to observe multiple cycles of user preference test on webpage design and how this can improve and optimize design solutions using genetic algorithm.

Your participation is greatly appreciated and completely voluntary. It is hoped that the information gained in this study will be beneficial for the future reference in the field of graphic/web design and human-computer interaction.

For further information about the study and procedure please contact:

PI: Sunyoung Park (graduate student), 515-451-4063, sunyoung@iastate.edu

Co-PI: Sunghyun Kang (major professor), 515-294-1669, shrkang@iastate.edu

[**http://evo-web.org**](http://evo-web.org)

(web banner)

Email Message

Dear (participant name),

You are invited to participate in a web survey for a MFA thesis in Graphic Design entitled, "***Applying Genetic Algorithm in CSS (Cascading Style Sheets)-based Web Page Design.***"

The purpose of this study is to observe multiple cycles of user preference test on webpage design and how this can improve and optimize design solutions using genetic algorithm.

You can participate in this study by simply going to the testing website at:

<http://evo-web.org>

The study should take about 5 minutes or less. More information about the study, procedure, and other confidentiality information can be found on the above web site.

Your participation is greatly appreciated and completely voluntary. It is hoped that the information gained in this study will be beneficial for the future reference in the field of graphic/web design and human-computer interaction.

Thank you in advance for your time and participation in this study!

For further information about the study and procedure please contact:

PI: Sunyoung Park (graduate student), 515-451-4063, sunyoung@iastate.edu
Co-PI: Sunghyun Kang (major professor), 515-294-1669, shrkang@iastate.edu

Best regards,

Sunyoung Park
Art & Design Department
College of Design
Iowa State University

Flier

Web-based Survey for MFA thesis



You are invited to participate in a web survey for a MFA thesis in Graphic Design entitled, ***“Applying Genetic Algorithm in CSS (Cascading Style Sheets)-based Web Page Design.”***

The purpose of this study is to observe multiple cycles of user preference test on webpage design and how this can improve and optimize design solutions using genetic algorithm.

You can participate in this study by simply going to the testing website at:

<http://evo-web.org>

The study should take about 10 minutes or less. More information about the study, procedure, and other confidentiality information can be found on the above web site.

Your participation is greatly appreciated and completely voluntary. It is hoped that the information gained in this study will be beneficial for the future reference in the field of graphic/web design and human-computer interaction.

Thank you in advance for your time and participation in this study!

For further information about the study and procedure please contact:

PI: Sunyoung Park (graduate student), 515-451-4063, sunyoung@iastate.edu
Co-PI: Sunghyun Kang (major professor), 515-294-1669, shrkang@iastate.edu

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