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Development of a 3-D Printer Selection Engine

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Development of a 3D Printer Selection Engine

Abstract

This paper focuses on the deployment of a tool that will enable any category of end user to match their needs and product specifications to 3D printers by means of a webpage. Any user connected to a network can enter the CAD geometry and product specifications into a web based form to select the most appropriate 3D printer. The parameters that drive the selection of 3D printers have been inspired by the largest/biggest/most well-known 3D printer manufacturers. The purpose of the selection system is to display printer specification in a common format so users are able to make "apples to apples" comparisons. The resource and the database will continuously expand and improve the 3D printing pairing engine. The technology, techniques and methods of designing the 3D printer selection engine is reported in this paper.

Introduction

3D printing is an integral part of the visualization, design, and prototyping process. As it becomes more accessible to even the layperson, it has spawned new industries and small businesses [2,3,4,5]. Friedman [6] has suggested that technology—ie computers, modems, cell phones, cable systems, the Internet, and the like—have enabled us all to reach further into more and more countries and into one another's lives, faster, deeper, and cheaper than we've ever done before. Referring to this phenomenon as "the democratization of technology", this phenomenon, according Friedman, has put banks, offices, newspapers, bookstores, brokerage firms, schools, and even factories in our homes.3D printing has paved a path for the democratization of manufacturing and is perceived by some as the next industrial revolution [7]. It has created a paradigm shift in the practice and process of traditional manufacturing aided by the interconnectivity and digitization offered by information technology. It has become an integral part of the visualization, design, and prototyping process and in the production of goods.

As 3D Printing becomes more accessible aided by copious 3D printers being introduced the market every year, hobbyists, K12 schools, libraries, professionals and other end-users around the globe are facing increasing difficulties making educated decisions when selecting a 3D printer. Many 3D printer experts and scholars [11, 12, 13, 14, 15] have studied and reported on strategies for selecting suitable 3D printers based on a given design. They have either limited their investigations to professional users or restricted their research to 3D printer parameters and part accuracies. Also, at any point in time, research is superseded as new and improved 3D printers are introduced to the market. On the other hand, many big 3D printer manufacturing companies such as 3D systems [10], Stratasys [8], and Makerbot [9], provide their printer specifications in disparate format making an "apples to apples" comparisons difficult. As well, the layperson and even professionals may not have access to these resources or may have difficulty assimilating these through conference and journal papers. And in many instances, jargon and many terms may make no sense to the layperson.

The authors in their prior work [1] have designed a system model and associated parameters for the design of a web based 3D printer selection system. This paper expands on their previous work and focuses on the deployment of a tool that will enable any category of end user to match their

needs and product specifications to 3D printers by means of a webpage. The technology, techniques and methods of designing the 3D printer selection engine is reported in this paper.

Model and Method

Figure 1 depicts the webpage of the Selection Engine; Figure 2 depicts the high level model for the system. The webpage introduces the user to the selection engine. Links are provided to access resources such as selection engine, user feedback and to educate novice users about 3D printers and materials. Like a digital index, this resource enables any category of end user to match their product specification to 3D printers by means of a webpage mapped to a central 3D printer database. Any users connected to a network can enter the CAD geometry and product specifications into a web based form to enable selection of a 3D printer. The parameters that drive the selection of 3D printers have been reverse engineered from most common and widely used 3D printer specifications such as 3D Systems [10], Stratasys [11], and Makerbot [12].

Figure 1. Webpage of the 3D Printer Selection Engine.

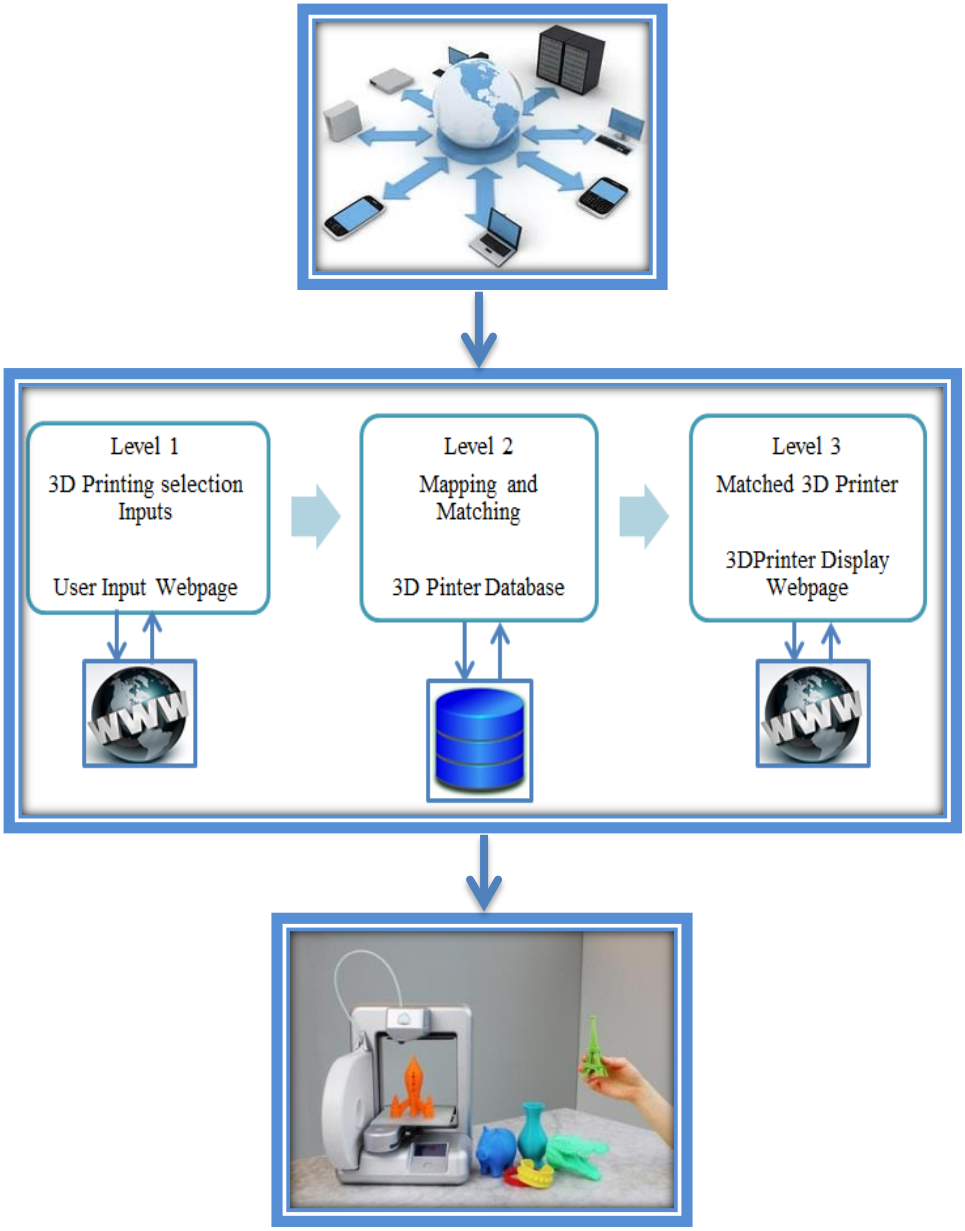


Figure 2. 3D Printer Selection System Model.

The system level model has been designed as an improvement over previous research to include a web based entry and display system making the selection system more accessible. Also the purpose of the selection system is to display printer specification in a common format for "apples to apples" comparison. Level 1 of the system is used by a user to enter user category and desired product specifications and submit them to the 3D printer server. System Level 2 converts the users' inputs into matching and mapping query to the database of 3D printers.

Once a suitable match has been found, a webpage containing suitable 3D printers will be displayed in Level 3 with a hyperlink to the machine webpage hosted on the manufacturer's website. As new 3D printers become available commercially, they will be added to the database.

The authors and the graduate students dedicated to creating this database of 3D printers will continuously update the database as new 3D printers become available.

3D Printer Selection Engine

The selection parameters of the web based 3D printer selection system are the product and design specifications such as model dimensions, material type and the category of users to name a few. Figure 3 depicts the user interface as being developed on Microsoft Expression Web 4.0 and being deployed on the local server. Figure 4 depicts the parameters of the system that the end user inputs at Level 1. These parameters that drive the selection of 3D printers have been reverse engineered from most common and widely used 3D printer specifications such as 3D Systems, Stratasys, and Makerbot.

Figure 3. User and Server Interface.

Broadly these parameters are classified as category of user, the part dimensions of the product, the material of the product, different colors needed, the overall part costs, and the resolution of the desired product and is depicted in Figure 4.

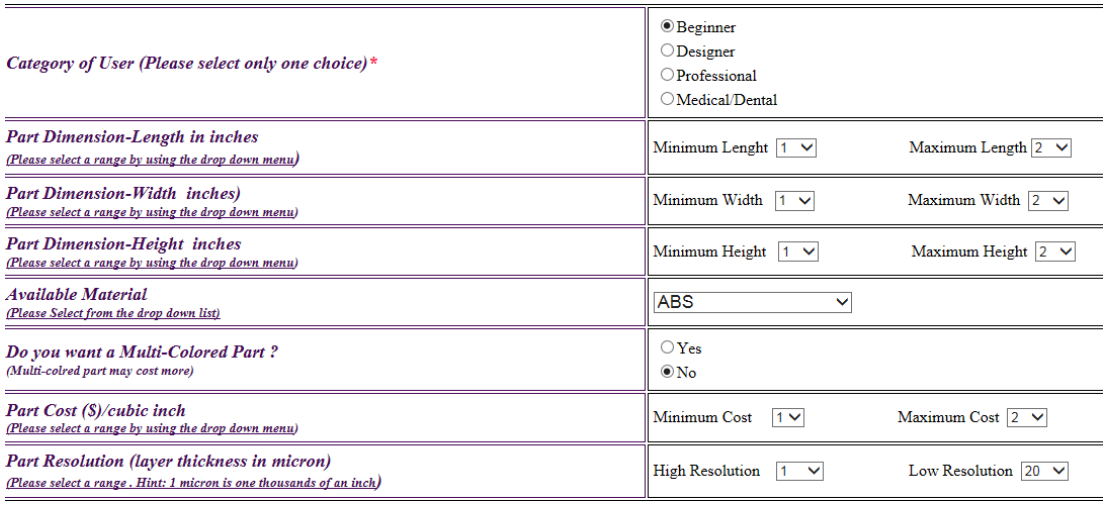


Figure 4. Selection Parameters.

A radio button is used to select the user type ranging from a Beginner to a Medical/Dental Professional. Two sets of three inputs are incorporated for entering the minimum and maximum part build volume indicating the min and max length, width, and height of the part as drop down menus as depicted in Figure 5.

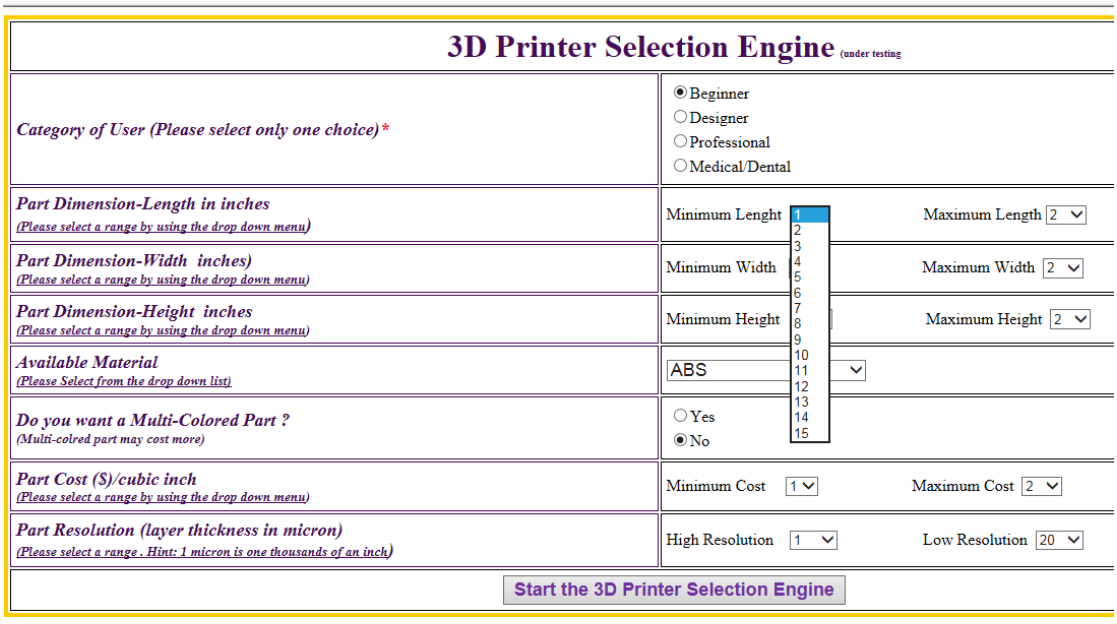


Figure 5. Selection Parameter-Drop Down Menu for Min. Part Length.

The users will have the ability to select the product's material using a drop down menu as depicted in Figure 6. Choice of part color is entered by means of a radio button. Range of part costs such as cost/cubic inch and resolution is entered through a drop down menus.

Once the user completes and submits the selection engine form, the engine converts the users' inputs into matching and mapping query to a 3D printer database and a webpage containing suitable 3D printers are displayed as depicted in Figure 7.

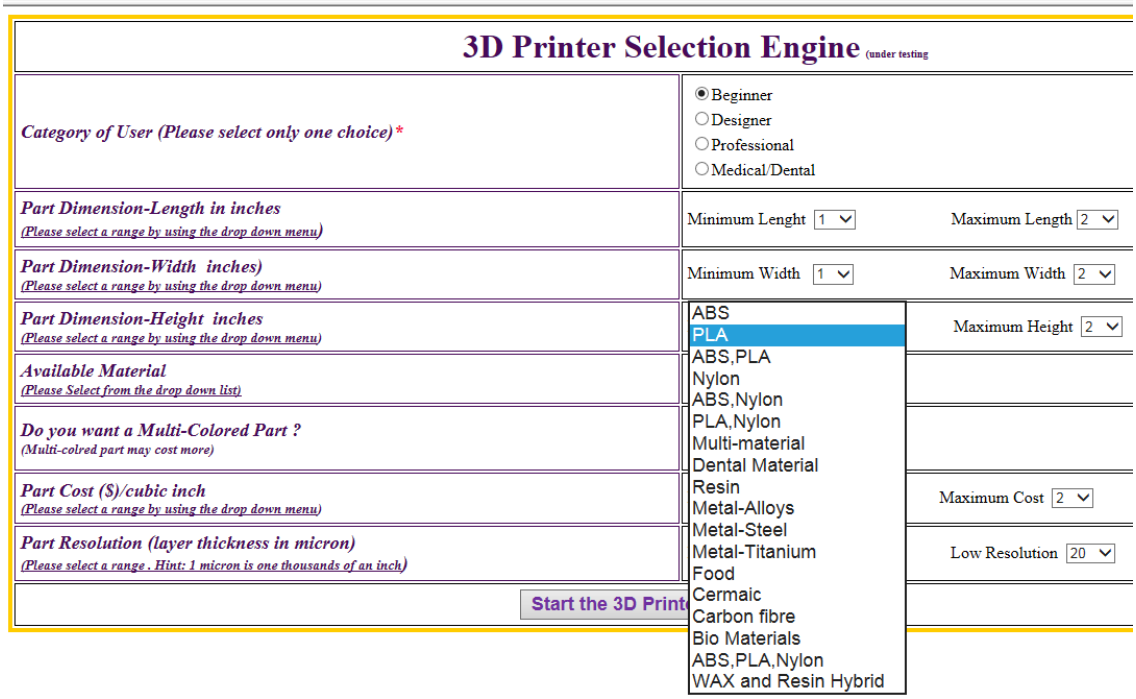


Figure 6. Selection Parameter-Drop Down Menu for Part Material

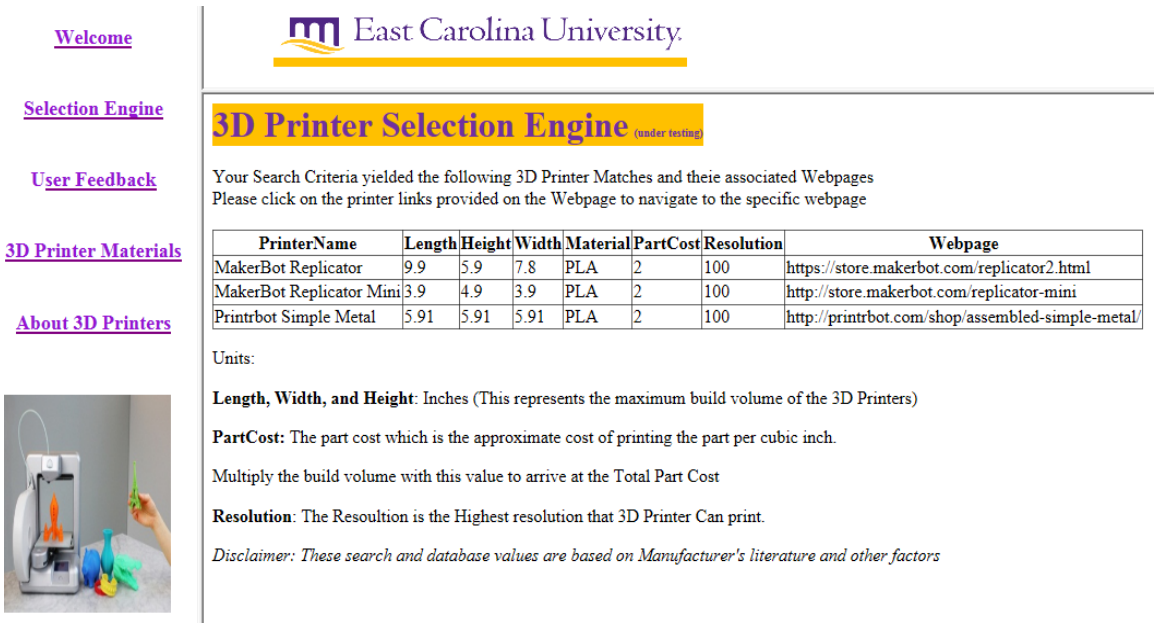


Figure 7. 3D Printer Match-Results Webpage.

The 3D printer name, maximum build volume, material, part cost, resolution, and a link to the 3D printer Webpage is displayed. The users can copy the hyperlinks to a web browser to directly go the 3D Printer manufacturer's webpage.

Through the hyperlink user feedback, user is prompted to complete a quick survey summarizing their experiences with using the system. In addition they are asked for their thoughts on how to improve the system. The feedback will be used to improve the system. The feedback page is depicted in Figure 8.

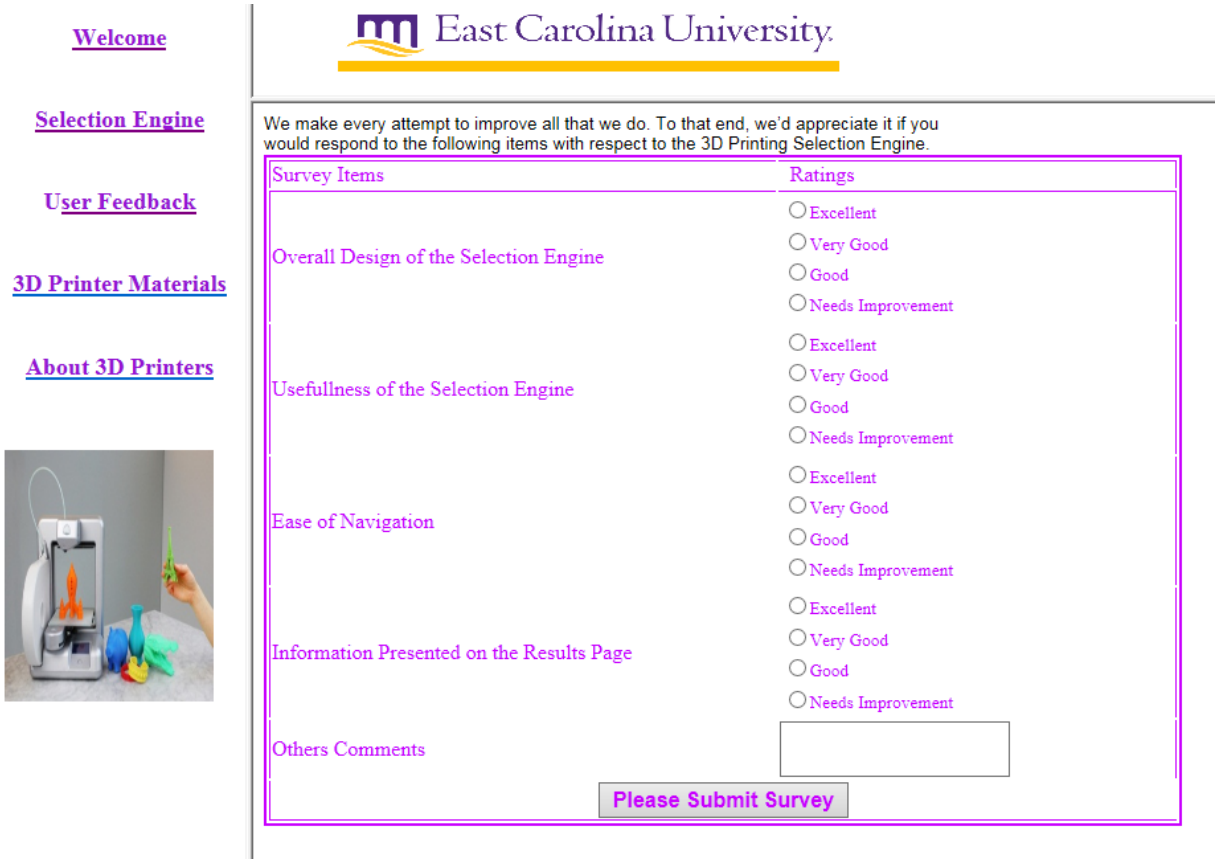


Figure 8. Selection Engine User Feedback Survey.

Hyper Links are also provided to educate novice users about 3D printers and materials as depicted in Figures 9 and 10.

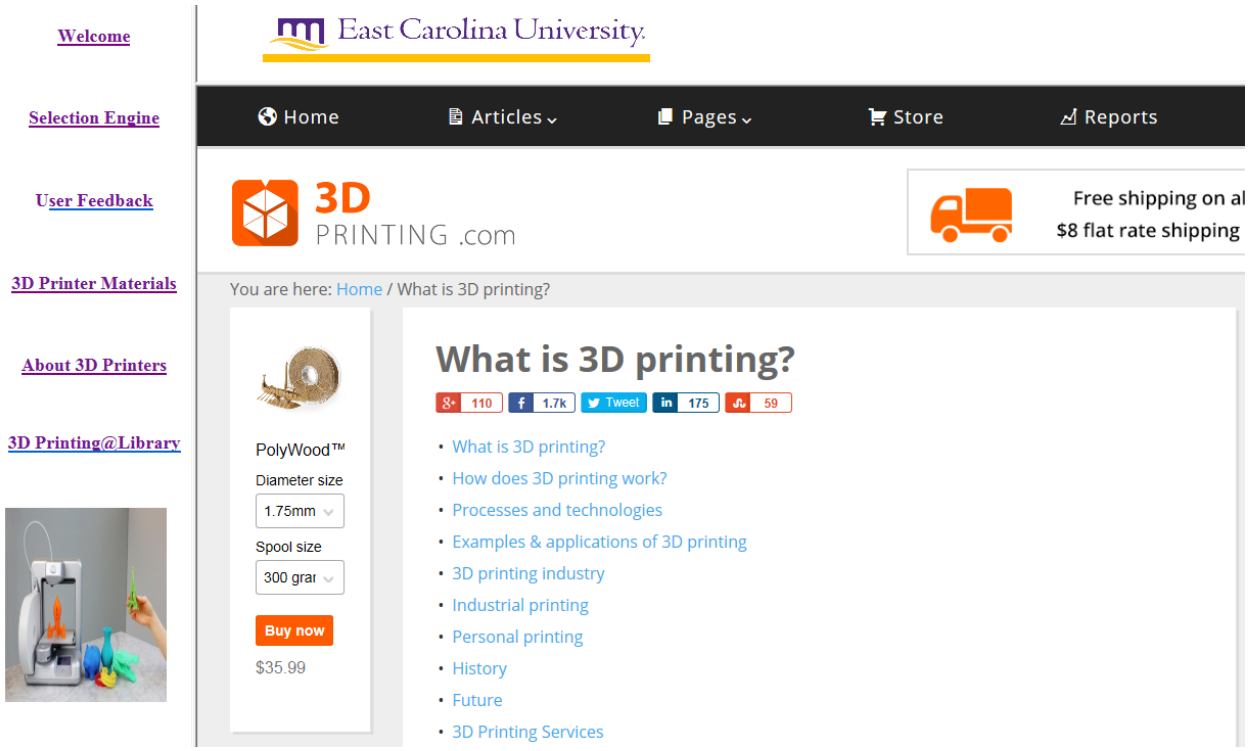


Figure 9. Hyperlink to educate Users on 3D Printers.

Figure 10. Hyperlink to educate Users on 3D Printing Materials.

System Design

The selection system is designed and hosted on Microsoft Expression Web 4.0. The logo of the software is depicted in Figure 11 [17]. According to Microsoft, "Expression Web 4 gives you the tools you need to produce high-quality, standards-based Web sites: built-in support for today's Web standards, sophisticated CSS design capabilities and visual diagnostic tools".

All the webpages are designed using Active Server Pages (ASP). According to Microsoft [17], "ASP.NET web pages enable you to create dynamic content for your site. With a static HTML page (.htm or .html file), the server fulfills a web request by reading the file and sending it as-is to the browser".

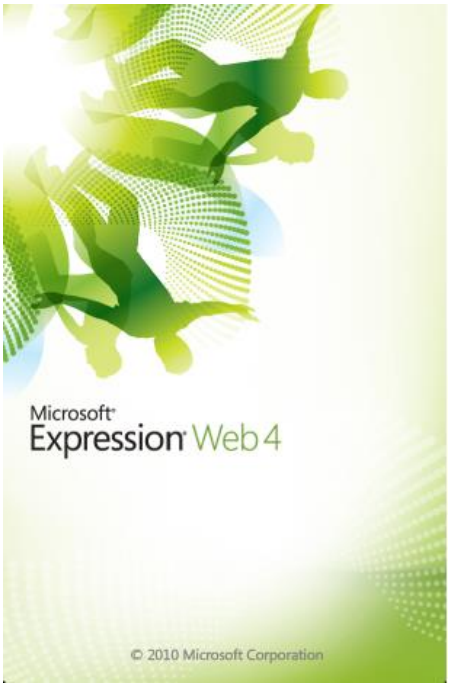


Figure 11. Microsoft Expression Web 4.0 Logo.

Once the user enters the desired product specifications and submits them to the 3D printer server, a Microsoft Access data source establishes a connection between the selection engine and the 3D printer Database. The 3D printer result and display webpage is designed to display results based on the connection to an Access Data source is displayed in Figure 12 and the Access database is depicted in Figure 13. According to Techopedia [18], "A data source, in the context of computer science and computer applications, is the location where data that is being used come from. In a database management system, the primary data source is the database, which can be located in a disk or a remote server. The data source for a computer program can be a file, a data sheet, a spreadsheet, an XML file or even hard-coded data within the program".

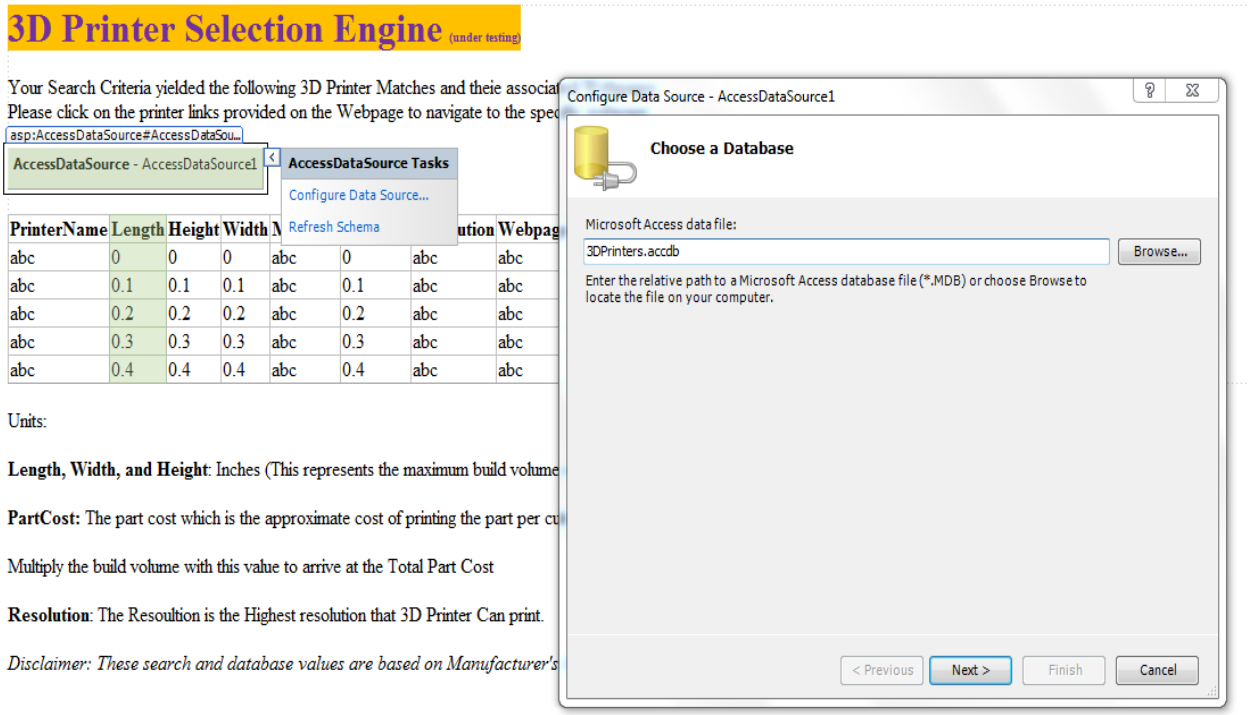


Figure 12. 3D Printer Result Webpage As Connected To Access Data Source.

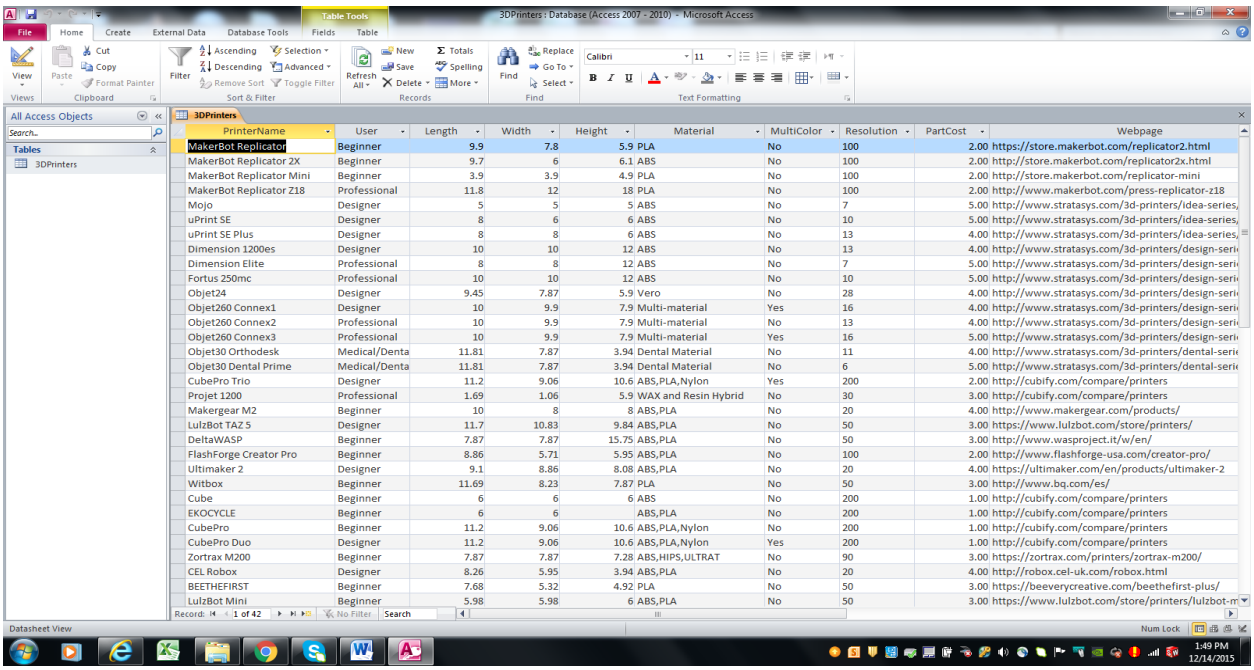
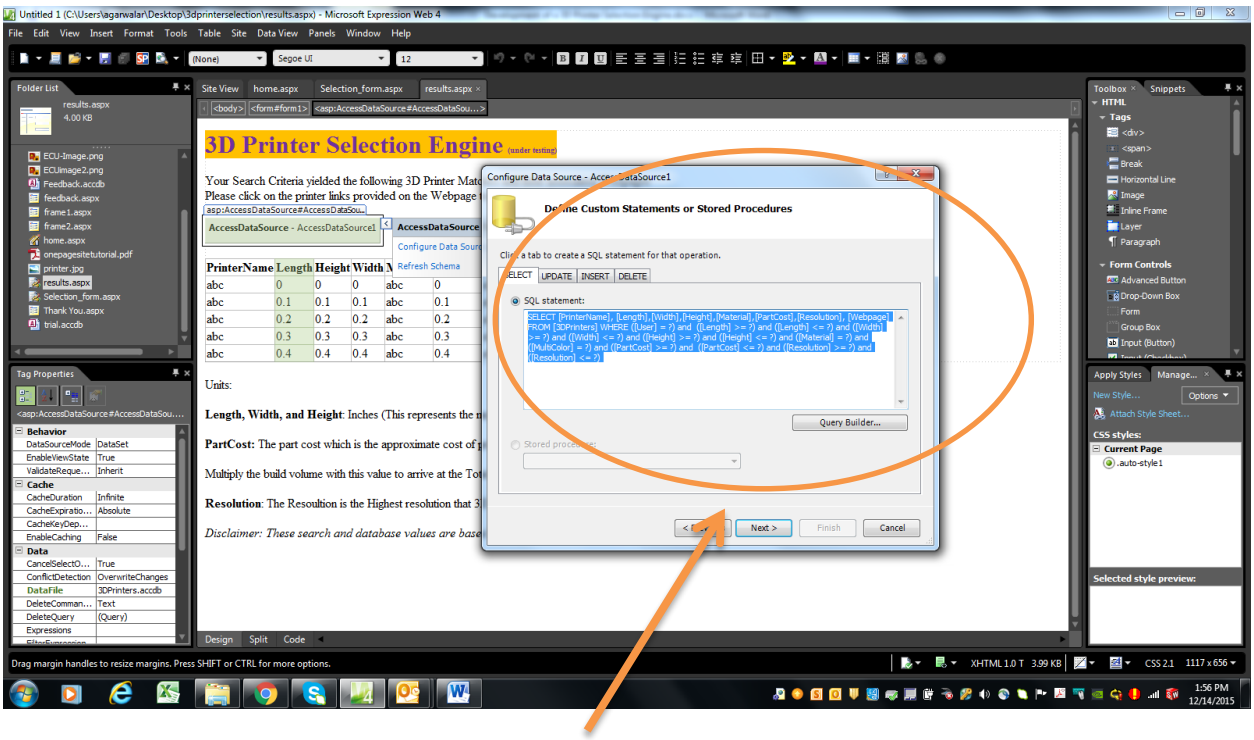


Figure 13. 3D Printer Access Database.

The data source connecting the selection parameters to the 3D printer generates the results based on a programmed sequential query language (SQL) statement to the 3D printer database. According to Techopedia [19], "Structured Query Language (SQL) is a standard computer language for relational database management and data manipulation. SQL is used to query, insert, update and modify data". Figure 14 depicts the SQL Code programmed by the authors. The parameter placeholders depicted by "?" in this code are based on the user input in the selection form.



SELECT [PrinterName], [Length],[Width],[Height],[Material],[PartCost],[Resolution], [Webpage] FROM [3DPrinters] WHERE ([User] = ?) and ([Length] >= ?) and ([Length] <= ?) and ([Width] >= ?) and ([Width] <= ?) and ([Height] >= ?) and ([Height] <= ?) and ([Material] = ?) and ([MultiColor] = ?) and ([PartCost] >= ?) and ([PartCost] <= ?) and ([Resolution] >= ?) and ([Resolution] <= ?)

Figure 14. SQL Code for the Selection Engine.

Conclusions

This paper focused on the deployment of a 3D Printer selection system. Many big 3D printer manufacturing companies provide their printer specifications in disparate format making an "apples to apples" comparisons difficult. The purpose of the selection system is to display printer specification in a common format so users are able to make appropriate comparisons. The technology, techniques and methods of designing the 3D printer selection engine was reported in this paper. The system, along with the website interface will be hosted on the webpage of an academic library during summer 2016. Once the webpage is hosted, the numbers of visitors using this webpage will be tracked. The authors will continuously expand and improve the 3D printing pairing engine. It is anticipated that users can save time by using the 3D printer

selection webpage instead of visiting the hundreds of 3D printer manufacturers' webpages available to match their design requirements with an appropriate 3D printer.

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