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Introduction

Our Senior Project, the "Brand New Windows Database," was created for the general contractor, Thomas Potoski. Our client's privately owned business, Brand New Windows, is located in West Pittston, Pennsylvania. Brand New Windows installs new windows as well as removes and replaces currently existing windows. The windows supplier that they currently use is Interstate Windows. Mr. Potoski started his business performing general construction, but is now looking to specialize in the windows division. The main emphasis of this newly directed business will be window replacements. Mr. Potoski employs five laborers and services the greater Wilkes-Barre / Scranton area.

Currently, Mr. Potoski's business utilizes a paper order form to record his business transactions, which needs to be remedied. The order form allows the general contractor to document such necessary information as customer demographics and window configurations, as well as the corresponding prices. The order forms are satisfactory in the client's eyes; however they are not easily referenced. Price calculations, window measurement restrictions, and paper congestion in general show why the current order system is inefficient. Previous order lookups are a lengthy, meticulous process. Currently, his order forms are kept in chronological order, making it difficult to perform such searches as previous job histories for a particular customer. His current system is not easily portable, which hinders his performance when creating estimates with potential customers. Currently, he has to carry two 3-ring binders, one containing previous orders and blank order forms, and the other housing product offerings and price lists. In addition to his binders, he brings a sample model of a window to meetings with potential customers. The hassle of carrying all of these tools needs to be dealt with. The database that we have created acknowledges and solves all of these problems for the client.

The overarching goal of our senior project was to provide Brand New Windows with a system that will allow the business to keep records of past jobs completed and produce customizable estimates for future jobs. This system was designed to enable Mr. Thomas

Potoski to eliminate a great deal of the paper documentation in his environment. Thus, a higher level of organization will be achieved. We aimed to make the management of his orders a more efficient system. In doing this, we needed to make an easily portable system that would save him the hassle of transporting cumbersome binders to every customer meeting. We wanted our project to provide Mr. Potoski with a system for managing his inventory, as far as product offerings and pricing lists, customer demographics, and customer orders. Once this system was created, we also set out to complete the objective of providing our client with a way to easily search through the information within the system. This includes searching through such data as customer telephone numbers, previous order information, and product attributes in general.

Background (Literature Review)

In the modern day world, technology advancements are continuing to create a paperless environment. Our senior project provides our client with a database management system that will enable his business to produce customizable estimates as well as keep records of past and current window installation jobs. It works without the use of paper as a primary means for recording data. The system includes the creation of a user-friendly interface that is supported by a database. The creation of this application is performed in Microsoft Access. Additionally, we have chosen to use SQL as the underlying language for our relational database. Visual Basic for Applications (VBA) enhances our user interface. The customized forms in Microsoft Access are easy for the client to use. They meet his everyday business needs by adhering to the user specifications that he has listed for us. Furthermore, the tables that we have created contain data fields for things such as customer demographics and window characteristics. By utilizing Microsoft Access, SQL and VBA, we were be able to produce a customized database system that meets the needs of our client.

(Why Microsoft Access, SQL and VBA)

We chose to use Microsoft Access as a result of the software that was available to our client. Our client informed us that he already had Microsoft Access, which made choosing a database management system (DBMS) very easy. Microsoft Access has many characteristics that fit the needs of our client. “The most popular database used in small businesses is Microsoft Access (Harrison, 2).” Since our client is the owner of a small construction business, Microsoft Access seems to fit the trend. If our client did not have Microsoft Access,

MySQL would have been the next choice for a DBMS. MySQL is open source software, which would eliminate some costs for our client (Allen, 3). Our product is intended for the use of only one user at a time. We do not have to worry about multiple users accessing the database in parallel. Thus, Microsoft Access was an applicable choice, because it was a single-user design which fulfilled the requirements of our client (Allen, 2). If we needed to worry about multiple users, MySQL would have been an excellent choice for a DBMS. MySQL allows for multiple users to access the same data at the same time (Allen, 2). This access scenario is better known as concurrency. If programs are written with concurrency in mind, it adds greatly to their complexity (Ramakrishnan, Gehrke, 9). We do not need to protect against inconsistent changes made by different users accessing the data. Along with the single-user design, a very valuable characteristic of Microsoft Access is its portability. Our client has Microsoft Access installed on his laptop, allowing him the capability of bringing the database system to potential client interviews or job estimations. He does not have to worry about connecting to a server; he would have everything in front of him. An additional bonus of having a laptop is that he is able to provide pictures of past jobs that have been stored on that same computer.

In addition to all of the previous characteristics of Microsoft Access, one of the most important is providing a user-friendly interface. In order for our client to add customer and window information into the database it is simple. All the user will have to do is click on a button to add a customer's data. Upon clicking the button, a form will appear which our client will be able to enter the customer's demographic and window information. MySQL is not an end-user friendly DBMS (Harrison, 3). Ease of use and customization to our client's specifications help justify why we prefer Microsoft Access as opposed to MySQL.

The underlying language used in our Microsoft Access database management system is SQL. "SQL is the standard database query language," meaning it is used in such DBMS's as Oracle and MySQL. SQL commands are characterized into two groups. Data Definition Language (DDL) is the first group, which includes such functions as creating or dropping tables. The Data Manipulation Language (DML) is the second grouping, which utilizes commands to modify data. Such commands are "INSERT," "UPDATE," and "DELETE" (Post, 146). The International Organization of Standards (ISO) is responsible for creating the standard of the SQL language (Post, 145). Because SQL is the underlying programming

language of such highly regarded DBMS's as Oracle, learning SQL is a valuable resource that we can take with us to future jobs. We have the basis to work with most DBMS's as a result of knowing SQL.

Visual Basic for Applications is the core automation language that's built into every copy of Microsoft Access (Harkins, Gunderloy, 9). We utilized VBA to enhance the Microsoft Access user interface design. This event driven programming language will streamline and speed up data entry. VBA can be used to manipulate the user interface features such as menus and toolbars. It can also work with custom user forms or dialog boxes (Harkins, Gunderloy, 1-3). In accordance to the client's specifications, we will design forms with applicable textboxes, drop down menus and query buttons. These features are easily achievable when utilizing VBA.

(Forms/Reports)

Forms are what allow our client to maneuver around the database in order to add customers, find customers, add orders, etc. Our client will do all of these operations through a main menu form, known as a switchboard form, which "direct[s] the user to other forms and reports in the application (Post, 230)." These operations will be done by clicking on command buttons. For example, when adding a customer, the user will click on the add customer button, which brings up a new form window. In the customer form, a single-row form will be used, which displays a single row of data, "in which the designer can arrange the values in any format on the screen (Post, 231)." There is no need for a tabular form in this situation because we only need to add one customer at a time. Tabular forms "display the columns and rows from a table or query (Post, 230)." Thus, a tabular form should be used when performing a search for customers, for instance. Subform forms can be a very beneficial form for our client. This is due to the fact that a subform is usually a tabular form that is embedded in a main form (Post, 232). For example, if our client wanted to display the data for a specific customer and also that customer's window information, he could do so through a subform form. Every form that is created will maintain consistency, strive for clarity and we will receive feedback regarding changes the client would like (Post, 225-226). Clarity will provide an easy to operate interface for our client.

On every form there will be data that must be entered, and to maintain semantic integrity we will use certain types of data entry fields. Semantic integrity is the part of data

integrity concerned with "keeping accurate data, which means fewer errors and also that the data reflects the true state of the business (Post, 400)." Advantages of Microsoft Access that add to semantic integrity are drop-down boxes (combo boxes) and list boxes (McFedries, 172). Combo boxes as well as list boxes only allow a user to choose one value from a list of items (Post, 240). In certain situations a check box would be valuable, for example when selecting an additional attribute of a window. Check boxes allow for the user to select more than one of the items that are listed (Post, 239). By providing our client with semantic integrity, we will effectively reduce redundant entries, which will in turn decrease typographical errors.

Data integrity is an important part in our implementation of creating forms and our overall DBMS. In an effort to further prevent errors, VBA allows us the ability to "specify pop-up messages that appear when a cell is selected, as well as error messages that appear when data is entered improperly (McFedries, 208)." Since our system only has to focus on servicing one user at a time, one aspect of data integrity we do not have to worry about when implementing our DBMS is concurrency control. Programs that protect data from changes made by different users who access the same data simultaneously need to add concurrency controls. This additional feature will add greatly to the complexity of the program so that concurrent database changes are handled correctly (Ramakrishnan, Gehrke, 8).

Reports are tools that, in the scope of our project goals and client's visions, are vital elements in a DBMS. There are more differences than similarities when comparing reports to forms. Reports are designed to print multiple pages of output that are received from the queries that search the tables in the database for specific information. Two differences between forms and reports are: 1) forms collect data from a user and 2) reports summarize data that is collected on forms (Post, 247). Our client will want to be able to produce reports for finding customer orders within a certain zip code. With this data, he will be able to perform such tasks as generating lists of addresses for potential clients to visit sites where he has completed previous installation jobs. Reports will greatly decrease inefficient time usage and the amount of hand-written paperwork. In respect to searching for certain customers or any other request by our client, reports can easily handle multiple pages of detailed and summarized data output (Post, 247). The types of reports will depend on the client's specifications and needs. Some possible report types available are tabular, label and groups

(subtotals). Tabular reports are the simplest of the reports and produce output similar to a query (Post, 250). Tabular reports can be useful to our client when a list of customers is needed. Groups or subtotal reports produce output that is grouped together by a certain attribute, such as the type of windows ordered (Post, 251). Reports are a tool that will be heavily utilized by our client.

(Tables)

The storage of data is a key concept that must be dissected in order for us to choose the correct storage techniques. There are a few types of data models to choose from, namely the relational and object-oriented models. The relational model is based on a collection of mathematical principles drawn mostly from set theory and predicate logic. The relational model defines the way data can be represented (data structure), the way data can be protected (data integrity), and the operations that can be performed on data (data manipulation) (Riordan, 8). All data is conceptually represented as an orderly arrangement of data into rows and columns, called relation. All values are scalar, meaning that at any given row and column position, there is one and only one value. All operations are performed on an entire relation and result in an entire relation. This is known as closure (Riordan, 9). As long as the data in the relational model is carefully defined, the database can answer almost any question that the user asks of it (Post, 16). We will be utilizing the relational model for its ease of use. Insertions, updates, and deletions of data can be carried out without any undue difficulty.

The object-oriented paradigm brought about a fundamental change in the way we look at data and the procedures that operate on data. Object orientation combines data and their relationships with the procedures, as never done before this model. This combination of entity's procedures allows entities to become self-contained units that can be reused and moved around rather easily. A unique feature of the object-oriented data model is that it supports direct many-to-many relationships (Harrington, 10). Since object-oriented database's navigational nature requires predefined relationships that cannot have new relationships inserted into them at a later date, this data model was not the best choice for our system. Seeing as how we did not know the client's windows business in the fullest extent, we had to account for new data relationships to be thrown at us, even in the middle of the programming phase.

First, second and third normal forms aim at reducing the redundancy of data that occurs in tables. First normal form ensures that there are no repeating groups in a table. This means that every row in a particular table must have the same number of columns (Post, 89). In second normal form, each non-key column must depend on the entire primary key (Post, 92). All of the attributes of a table must correspond to all of the primary keys in that table. Lastly, third normal form corrects the mistake of a non-key column's dependency on another non-key column (Post, 94-97). To fix this redundancy mistake, another table must be created with all of the attributes that correspond to the non-key column that will now be the primary key in the new table.

Upon designing a database, three levels of design need to be taken into consideration. The internal level of design is concerned with how the data is actually stored. Developers must first understand the company before they can represent each element of that enterprise. The internal level deals with such items as the medium on which data is stored, the format of that data and methods used to provide access to data. Additionally, form of entries and organizational entries must be taken into account (Fidel, 9-10). When focusing on the internal level of design for our database, the organization of data will be a key factor. We will need to carefully define the data in the tables so that the relational model can be fully utilized.

The external level factors in the particular views of the data that are geared to specific purposes (Fidel, 10). This means that the developer must figure out how to retrieve and display information in a way that is useful for the user. This particular level corresponds directly with the forms and reports of Microsoft Access. Lastly, the conceptual level of design involves the representation of the entire company in the database (Fidel, 11). This means that the developer must answer the questions of what, where, why and how when considering the storage of data elements. The corresponding decisions of the conceptual level are independent of internal and external level decisions. A majority of the planning that is done at the conceptual level is provided for by the client. After the database developer understands the business practices of the company, the user specifications will take care of his unanswered questions. After taking into account and employing the correct storage techniques and the three levels of design, we have created the database tables efficiently and effectively.

(Conclusion)

After researching the various aspects of databases we were able to choose the qualities that best suited our needs. Microsoft Access was chosen for its ease of use, user friendly interface and mainly because our client already owns a copy. SQL and VBA will further enhance our database management system in terms of design enhancements and data entry capabilities. We will provide our client with a relational database because that style of database will best meet his reporting needs. Further, we will provide forms and reports that will enable our client to input and export metadata. With our database management system integrated into our customer's current business practices, not only will he be able to expedite the estimation process, but he will also eliminate nearly all of the paper mess from his everyday order management functionality.

Approach

The database that we have created for our client acknowledges and solves all of the problems with his current order management system. By utilizing Microsoft Access as our database management system, we were able to meet the needs of our client. Along with its single-user design, a great characteristic of Microsoft Access is its portability. This quality will afford Mr. Potoski the capability of bringing the database system to potential client interviews or job estimations. In addition, Access allowed us to provide our client with a user-friendly interface. The underlying language used in our Microsoft Access database management system is SQL. This standard database query language allows us to use commands to create and drop tables as well as modify data. The "INSERT," "UPDATE," and "DELETE" commands were used throughout this project when creating and storing new customer information for instance. Additionally, we used Visual Basic for Applications which is included in every copy of Microsoft Access. VBA helped us enhance the user interface in areas such as custom user forms, command buttons and textboxes. This will help to streamline and speed up data entry for the user.

The SQL and VBA languages that we have chosen to use will be very beneficial for the user. This is easily illustrated when observing how easy it is for our client to add customer information into the database. Mr. Potoski will be able to click on a command button from the main menu view to add a customer's data. Upon clicking the button, VBA code will make the customer information form appear on the screen. On this form our client

will be able to enter the customer's demographic information. Next, he will click the command button to save the newly entered customer information. This command button will "SELECT" the correct table to enter the customer data into. Then it will utilize SQL's "INSERT" command to take the information from the textboxes and append a new row onto the customer table to store this new data.

Another example of how our implementation will solve the many problems of our client's inefficient order management system is the reports feature. Reports will generate printable data that is queried from the database. For instance, when Mr. Potoski wants a report for the jobs that he has completed that include a particular window configuration, he can utilize the "Previous Install Report" command button that we have included on the main menu form. This command button will make a form appear on the screen where the user will be able to enter in a specific window series and style combination. After entering in the desired configuration, Mr. Potoski will click the Preview Report command button. This button will utilize SQL to query the database for the desired information and will then display the results on the screen. This report can then be viewed and printed out if desired. The "Previous Install Report" and customer information form are two examples of how our approach to solving Mr. Potoski's inventory and order management system's problems will be handled.

Installation and Maintenance

The installation of our database system into our client's current business practices will be quite simple. Since Mr. Potoski does not currently have any computerized version of his order management system, the issue of interfacing current software applications with our new database system does not have to be directly dealt with. In order to integrate our database into our client's current business, the client must be given a brief overview of the system. Since Access provides him with a user-friendly interface and VBA will speed up and streamline data entry, we feel that our system is fairly straightforward. Our database will, in effect, totally replace the current paper version of Brand New Windows' ordering management system. All of the existing order forms will no longer be needed, as our database system has its own version of the order form that is not only familiar to the client, but has added functionality as well. Since the user will be familiar with the set up of the order form in our database, the training for this individual aspect of the database system should go smoothly. In

terms of training the client with the computerized order form, he will only have to be instructed on how the form makes it easier for him to select and enter window configuration information. Since VBA has been used, the command buttons on the order form will make it fairly easy for our client to calculate total prices for the order arrangements.

The client will also need instruction on how to run reports. From the main menu, we will inform him of the options that he has. Since we have discussed the desired functionality of the system with our client in previous meetings, the reports functionality will not come as a surprise to him. We feel that once instructed on how to utilize these reports, our client will be able to run a more efficient business, while thinking of additional creative ways to utilize this functionality. In fact, even before we created the system, the client was informed about report functionality and he had the recommendation of producing a zip code report, because he felt that type of report would prove to be useful, given his current business practices.

A final copy of the requirements document that we have prepared will be presented to the client. He will be able to reference this outline for solving issues such as unfamiliarity with our reports in the system. Although the majority of the requirements document was created with the help of the client, it contains additional information that may prove to be helpful in situations where the user does not understand why a particular function of the database system is not working for him.

The user interface prototype that we showed to the client early on in the design process was simple enough for his understanding, yet powerful enough for him to achieve added functionality. This functionality was warmly welcomed by the client, because he envisioned the hours of time that this new system would save him. Through various meetings with Mr. Potoski, the functionality of such objects as forms and reports have been discussed. Originally, the client supplied us with his 3-ring binder containing inventory options. The massive amount of information was further sorted out when the client described his ordering process to us. Through initial discussions, we felt that we had adequate information incorporated into our original database designs. However, through multiple meetings, our first drafts of the system proved to be slightly insufficient. The client expressed the need to have additional window attributes listed on the order form, such as United Inches, grid patterns and types, multiple glass options, as well as the color options being broken up into internal and external categories. Following each meeting, we edited forms and tables to meet

the specifications given by the user. After all, we wanted to mimic and improve the overall efficiency of his ordering management system.

We will provide on-going support of the database as client demands change and new styles of windows are manufactured. Seeing as how the client is a relative of one of the database's designers, maintenance needs can easily be expressed by the client. Changes that we foresee Mr. Potoski requesting are more reports and added window attributes. As previously noted, the client already informed us that a zip code report would be a very useful item to include in the database system. If he comes in contact with unfamiliar functionality or errors that Access may produce in response to data that has been entered, we plan on being only a quick phone call away from answering any questions that he may have. If he feels that an answer cannot be given over the telephone and that someone needs to literally walk him through the steps to resolve the issue, Matt will be a two hour drive away from helping our client with his troubles.

Future Work

In addition to maintenance of the system as requested by the client, we feel that there are several components that could be developed in the future. While the client was cooperative in the design process, he seemed to always have a request for added functionality that we sometimes could not provide him with, given the time constraints. One part that we agreed could be removed from the system requirements were special shaped windows. Initial attempts to handle special shaped windows drastically slowed our database design progress. The amount of customization necessary to incorporate these special windows into our database proved to be quite difficult. The vast amount of different shapes offered and inconsistent use of measurements to describe those windows made including these windows in our database system quite difficult. For instance, a semi-circle special shaped window can have measurements that include base width, how much the window arced, whether or not the semi-circle had extended legs or not, as well as the united inches restricting all of those measurements. With so many variables needing to be addressed, we felt that special shaped windows had to be disregarded for our initial implementation. Since the client had very few customers come to him requesting these special shaped windows, such as the semi-circle, he agreed that the system would still be acceptable without that functionality included. Adding

this functionality into the database system for Brand New Windows could be completed in the future.

In order to facilitate the training and maintenance processes, an instructional training and reference booklet could be completed. This manual would include such information as how to add a new customer, edit existing window information, and how to run a customer order report. The booklet would be easy to follow and could have step-by-step illustrations to help the user understand how to perform a particular task. It would include all of the database system's functionality as well as a quick reference guide or index. This would be very beneficial, as it could cut down on potential user errors and maintenance questions. If the user is unfamiliar with something, they could consult the manual before contacting one of us. Also, since Mr. Potoski is currently the only user that will be trained to use this system, if he feels the need to teach other employees how to use it, he can use the booklet to help this process.

Additional future tasks will include making user requested changes and updates to the system. New product offerings and the attributes that go along with them may require added database functionality. As stated before, we foresee the user requesting additional reports. These changes all constitute maintenance work that must be done in the future. Also, our client recommended that once our database system has been thoroughly tested it may prove useful to other Interstate Windows contractors. We could market this software to these contractors as well, and Mr. Potoski could recommend our services. This future work may include even more added functionality than our original client has requested, because every contractor may not sell the same window configurations or other product offerings. If it were the case where additional contractors requested the customization of our database system for their individual business, the training and reference booklet would be quite useful.

Lastly, Professor Koss brought to our attention the fact that our system needed to have separate forms for order estimates and final orders that have actually been placed. We feel that this functionality is necessary for the database system to work one hundred percent correctly. The way that things are currently set up in the system allows a user to query the database for orders that have been placed in a specified zip code. The problem with this is that if the user is performing this report because he would like to find jobs that he has completed in a general area, the data returned will be misleading. The current configuration

has order estimates and final orders together in the same table. The report that the user has just utilized has the potential to return information that may pertain to estimates, which is very misleading when the user originally wanted to look for data on jobs that have actually been completed. So, by creating separate forms and data table for estimates and finalized orders, this situation would be cleared up.

Conclusion

The goals of our project have been achieved. Brand New Windows now has a system that will enable it to keep precise records of past jobs completed as well as being able to produce customizable estimates for future jobs. The client will be able to keep track of product offerings as well as other operations already used in current business practices. On-site pricing estimate hassles will be a thing of the past. Also, previous order forms will be easily searched for pertinent information. Brand New Windows will now have an organized way of handling customer information that will allow the user to search for a particular customer by simply utilizing one of the many helpful report forms in the database system. The new database system is very portable and will allow Mr. Potoski to easily transport all necessary information to customer meetings in an effortless way. A great deal of paper has been eliminated from the Brand New Windows business, which reduces clutter and confusion, especially in terms of performing order form searches. Our database system will facilitate the speed of presenting Mr. Potoski's customers with an estimate for an entire windows replacement job, as the current prices for his services can be obtained without manual computation. The reports functionality that our database system has set up is straightforward and will prove to be a powerful addition to the business. Brand New Windows will now be a more efficient business because of its higher level of organization afforded to it by the database system that we have created.

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