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A PROTOTYPE MULTIMEDIA AUTO BROKER

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ABSTRACT

Intelligent, easy to use, and entertaining multimedia information brokers are vital to the explosive role of information technology. With the advent of interactive television and the information superhighway in the near future, information management systems (information brokers) for consumer services and products will be necessary.

This paper describes the application requirements process and subsequent prototyping efforts for a multimedia auto broker. The research activity presented has distinct phases which overlap and take place concurrently in some instances. The phases include a *knowledge acquisition* phase, *applications requirements definition* phase, and *testing and validation* phase. The details of each of these phases which led to the prototype multimedia auto broker are characterized, followed by a brief introduction of effort underway for the system architecture, and recommendations for generalizing the multimedia information broker to other applications.

NOMENCLATURE

DB - Database
EER - Extended Entity Relationship
GT - Georgia Tech
IDEF0 - a functional data model
MMDB - Multimedia Database
MDI - Multiple Document Interface
OLE - Object Linking and Embedding
ODBC - Open Database Connectivity
RDB - Relational Database (software)
SQLMM - Multimedia Query Language
THIMD - Hypermedia Interfaces for Multimedia DB
VBP - Visual Basic Pro (software)
WIMP - Windows, Icons, Menus, and Pointers

INTRODUCTION

Information management is a key component in the competitiveness and efficiency of business as well as the manufacturing and design aspects of industry (Bradley and Agogino 1991) (Chadha et al., 1991a). Currently, there is a demand for a new generation of intelligent and intuitive information management systems to service the growing information needs of the consumer. The multimedia auto broker is a tool for fulfilling this requirement.

The multimedia information broker is a database which integrates database management technology with multimedia data storage and presentation capabilities. This information broker will present data types such as text, graphics, pictures, audio, tables, and videos. The principle objective is to provide the user with access to a broad spectrum of information (both textual and multimedia) in one system which would otherwise exist in many different resources.

The multimedia auto broker will allow the consumers to literally purchase an automobile “from the comforts of their living room”! What this system offers is an integration of *complete* auto information accessibility within one location (see Fig. 1).

INFORMATION BROKER APPLICATION

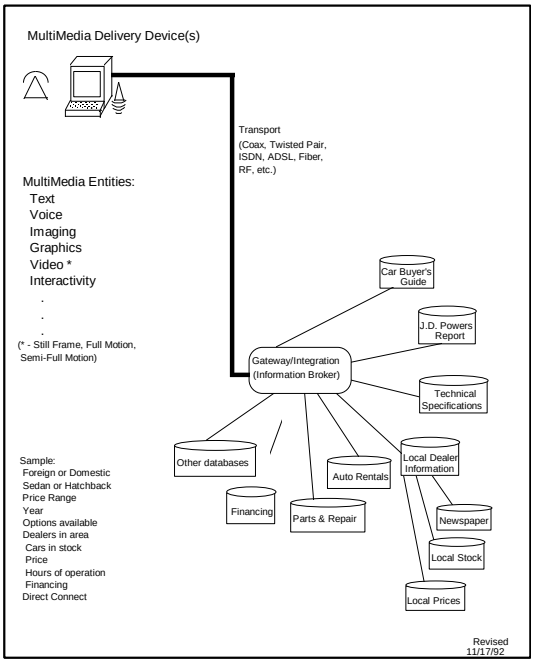

Figure 1

Presently, much of the information regarding automobiles is scattered and not so easily accessed (see Fig. 2). The consumer will be able to browse static (not changed often) data such auto comparisons, physical and technical specifications, and dynamic (changed often) data such as cost, loan, availability, commercial and classified advertisements, and location (see Fig. 3).

COMPARISON OF EXISTING SOURCES OF INFORMATION

Data sets / Sources	Geometry	Performance /Enjoyment	Compar-ison Info	Option	Owner/ Dealer	Techn. Details	Test Drive
Newpaper Classifieds	■			■	■		
Advertise-ments (Newspaper, Magazine)	■	■		■			
Buyers/ Consumer Guide & Reviews	■	■	■	■		■	
Dealerships/ Owners	■	■		■	■		■

■ Available Not Available

Figure 2

DATA SETS FOR AUTOMOBILE PURCHASING PROCESS

Resources

- **Automobile Physical Information (Text, Picture, Video)**
  Size, Color, Shape, Dimensions, # of doors, Style
- **Automobile Technical Information (Text, Picture, Audio)**
  Horsepower, Accelerations, Turning Radius, Engine Noise
- **Automobile Financial Information (Text)**
  Vehicle Cost, Maintenance Cost, Loan Availability, Interest Rates
- **Newspaper Ads (Text, Picture)**
  Vehical Availability, Current Prices
- **Consumer Guides (Text, Picture)**
  Comparisons between Different Cars, Objective Reviews
- **Dealerships (Text, Pictures, Video, Audio)**
  Current Prices, Vehical and Options Availability, Loan Availability, Video and Audio Advertisement

...

Figure 3

Such a system is very complex to define because there is so much data of all types and representations. Also with such an application, there is not just one, but several approaches to choosing an automobile. A case study approach has been adopted in this paper to identify the application requirements for a multimedia information system. The research activity follows the STEP Application Protocol guidelines defined by the ISO 10303 product data standard where possible (ISO 10303, 1991). A full account of the knowledge acquisition, applications requirement definition, and testing and validation, which led to the prototype will be described.

BACKGROUND

This project is a triad effort among Digital Equipment Corporation, Georgia Institute of Technology and two companies that are defining the applications requirements, BellSouth and Emory. The project team was formed in September 1992 to investigate the integration of data management technology with multimedia storage and hypermedia/graphical user interface capabilities, thus this defines a multimedia information broker or multimedia database (MMDB). The Georgia Tech (GT) research assistants are an interdisciplinary team of Mechanical Engineering and Computer Science students. The GT team is subdivided into three groups: Applications, Database, and User Interface. The Digital staff served as a link between GT and the application Providers. Both BellSouth and Emory University Hospital provided applications as case studies which aided in the formulation of the requirements. This paper will describe activities for one of the applications, the auto broker. *Modeling Patient Care for Multimedia Databases*, a companion paper in these proceedings, gives the details of the other application (Cohen et al., 1995).

APPLICATION REQUIREMENTS PROCESS AND SUBSEQUENT PROTOTYPING EFFORTS

Following is a detailed description of the research activity. As stated earlier, there are four phases which the activity can be categorized. Many times these phases overlapped and took place concurrently. Also some of the phases were revisited and updated throughout the case study.

Knowledge Acquisition

In order to define application requirements for multimedia auto broker, the application process, the intended users, and the expected capabilities (as defined by the application provider) of the system must be known. Most of this necessary information is undocumented and must be obtained through extensive interviews and observations of the application activity. The applications group functions as the knowledge engineers who are responsible for extracting the information and establishing the system's database and user interface capabilities.

This activity started with several brainstorming sessions with the applications group members and Staff of BellSouth. Within the sessions the multimedia data, auto information, auto-related information sources, possible application scenarios, and key considerations for the auto broker were discussed (see Fig. 1). As a result of these brainstorming sessions, it was decided that the best way to characterize the auto purchasing process would be through an informal survey of auto consumers.

The choice of consumers was random, and each of the consumers were of different gender, race, age, size and backgrounds. Each consumer surveyed was asked to describe the process and considerations made when purchasing an automobile. This information was captured in a process model (IDEF0) (Bravoco and Yadav, 1985a-b) (Chadha et. al., 1991b), for each consumer surveyed (see references for detailed description of modeling tool). From the surveys, the intial perception that there are many approaches to purchasing a vehicle was validated. We analyzed the surveys by comparing the differences and likeness and developed a generic model which characterized the auto purchasing process (see Fig. 4). Afterwards process models, which encapsulated all of the differences found from the surveys and the ideas generated in the brainstorming sessions, were developed as the final auto purchasing process model (see Figs 5a-f). Also an accompanying data dictionary was created as part of the process modeling effort.

Another outcome of the brainstorming sessions was possible scenarios which could be used to aid in the development of the requirements. Two test case scenarios which best meet the expectations of the application providers were selected (see Figs 6a-b).

These test scenarios, IDEF0 models and data dictionary aided the team in understanding the needs of the application and the auto purchasing process. As discussed in an appraisal of modeling tools (Chadha et. al., 1991b), IDEF0 is a top down hierarchical method which demonstrates flow of data, data resources, interactions, and constraints quite effectively. However, it is not a flexible modeling tool, and does not capture relationships and levels of abstraction well. In order to capture and understand the application more effectively, an EER model (Chen, 1979) was developed (see Fig. 7).

GENERIC AUTO PURCHASING PROCESS

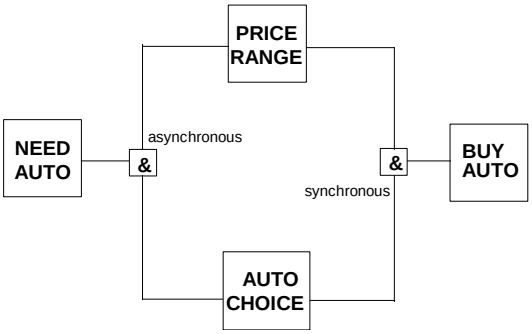

Figure 4

AUTOMOBILE PURCHASING

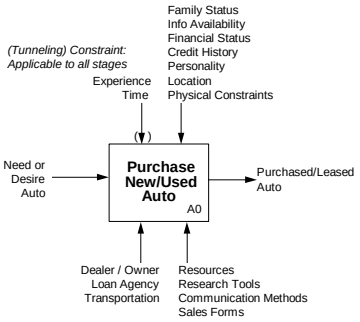

Figure 5a

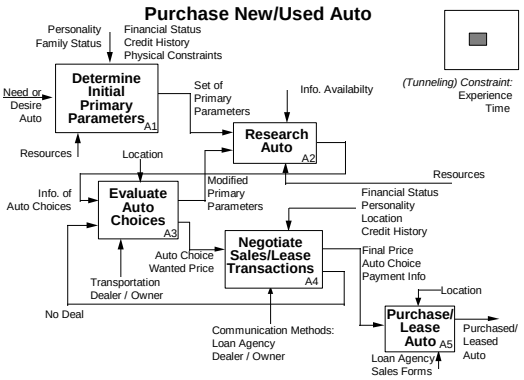

Figure 5b

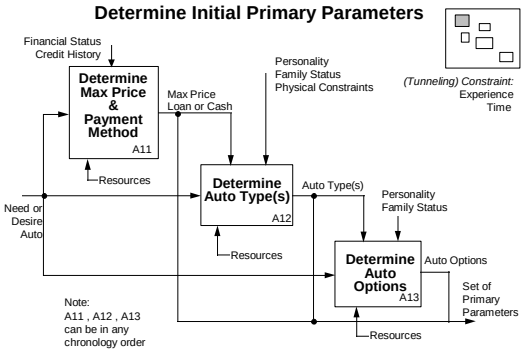

Figure 5c

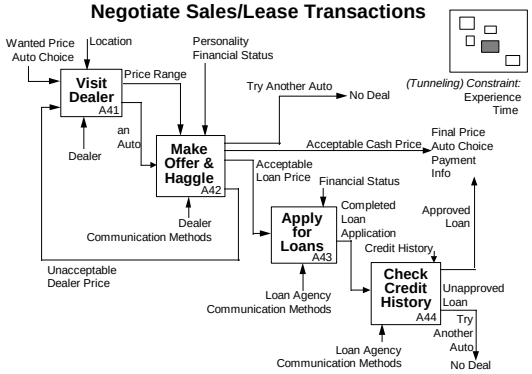

Figure 5f

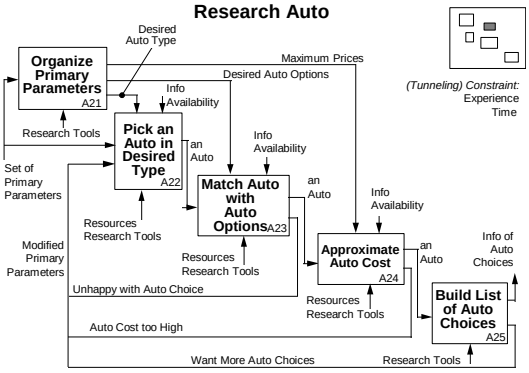

Figure 5d

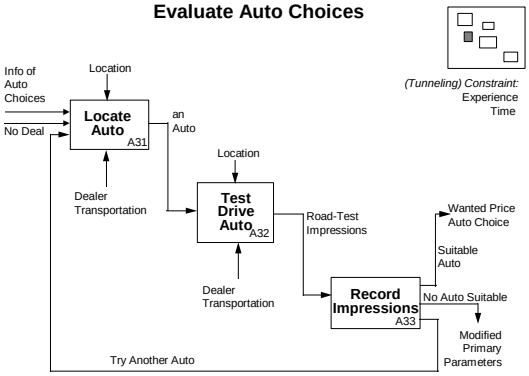

Figure 5e

Test Case #1

I am in the market for an automobile. I access your system some way and the process begins. My interest is in a new car, one that will hold its value well and I am willing to pay a little extra up front if I am reasonably sure that it will be worth more later, dependable, comfortable, etc.

I'm accessing the system from a particular location and I don't want to drive too far to find the dealer; no more than 20 miles maximum. So, limit my search to dealers within a radius of 20 miles of my location, which I can accurately specify by street address. Don't send me to a dealer who doesn't have the color, make, and model of car that I want and don't send me to a dealer who is not open when I get there.

(1) Inform me about all four door sedans that are American made that cost below $30,000 in price that have a value after four years of no less than 75% of the purchase price.

(2) That was too many cars. Show me the top 10 based upon consumer testing in order of their rating with the same criteria as above.

(3) That list is much better. Now there are 5. How much do they cost and who has them? DARN!! I'd have to drive all the way to Douglasville to get some of those. Ok, don't show me any cars that are not in stock within 20 miles of Gwinnett Place Mall.

(4) Okay, now there are 3 cars shown. I want to see a 3-D of how each one looks. The first one looks good. Ok, now let's see the second one. YUCK, don't show me any more from that company!

(5) All right, the third one looks great. Let me hear how it sounds at various spots around the car that I want to specify. (e.g. hood up at the front of the car, hood down at the front of the car, driver's side, etc.)

(6) I'm really worried about maintenance cost on this car plus I like to do things myself when I can. Show me the gas mileage figures, weight of the car, towing capacity, expected costs to maintain, warranty, etc.

(7) Show me an advertising video about the car. What options are available? Oh, and I want to start talking more about costs here, so keep me updated some way as I choose the options that I want. Start with the base amount of the car with no options and let me add them one at a time. By the way, if I get to a point where I've added enough options to jump me into a discount category, reflect it (like GS to LX to GT etc.). Also, be sure to let me know if delete something from the option list that takes me back down a level.

(8) Ok, I think I've decided on this car. Let's check on some financing options. I'll be trading in a 1988 Pontiac Grand Am with 85,000 miles on it. It has A/C, AM/FM radio, and power everything. Factor that in and tell me where I can get financing, what my monthly payments would be, how much down payment I'd need, etc. Also, show me the difference between leasing and purchasing.

(9) Who has the car in stock in red? How long would it take to get it? Where is the dealer located? Make sure he knows what I'm interested in before I get there or else give me something to take along so that he'll know what I want. What hours is he open?

Figure 6a

Test Case #2

I'm on a very tight budget, so I don't have a lot of money to spend. My family consists of my spouse and three kids but we haul neighbor kids to baseball every once in a while, so I want a van. I do carry equipment sometimes, so the rear seats need to be removable.

(1) Show me all vans that cost less than $20,000 that have various options that I specify (power steering/brakes, A/C, etc.). I need removable rear seats.

(2) Wow, that's a lot of vans! I've heard a lot about the Voyager, but I forget who makes it. Let me see those.

(3) Show me technical details (warranty, towing capacity, etc.) about all three versions of the Plymouth Voyager that were found.

(4) Show me the Ford Aerostar with the same options except for the removable seats, but add a sunroof.

(5) I wonder how many of the Voyager have been sold versus the Aerostar. Show me these figures for the last few years graphically.

(6) Let me hear how the Voyager sounds on the inside at various levels of sound on the outside (jackhammer, backfiring car, rainstorm, etc.). Now how about Aerostar?

(7) I really like the Voyager better and they're really close in price. What incentive programs are available? Any dealer specials?

(8) Put me behind wheel of the Voyager in video. Same for Aerostar.

(9) OK, I'll take the Voyager. Show me financing options, extended warranty coverage and costs, payments, etc. I have no trade-in.

(10) What dealer has it?

Figure 6b

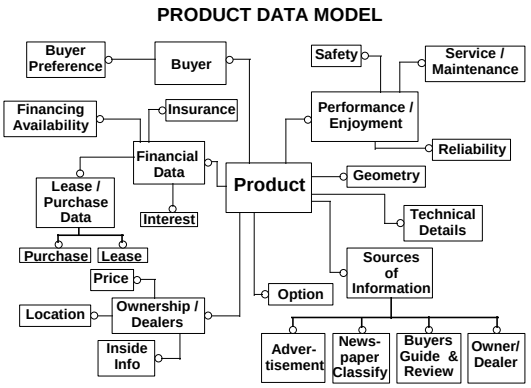

Figure 7

Application Requirements Definition

In this phase our team used the insight gained from consumer surveys, modeling efforts, test scenarios and working sessions with the application providers to define the needed requirements. The application requirements are documented for *the user interface, information management,* and *general system capabilities.* A brief description of each of these requirements is given in this paper; for more details see Multimedia Applications Requirements Documents (TR #94-1) (THIMD, 1994).

User Interface. The requirements for the user interface are ease-of-use, adaptability and customizability. The user will not have to be computer literate or familiar with query languages in order to retrieve the needed information. The interface will respond to natural human inputs such as speech and/or point and touch. The interface will have pictures and graphical icons so that the language or cultural background of the user will not be a major factor in the usability of the information broker. The user interface requirements are defined in terms of *user tools* and *user access* capabilities that must be available.

User tools. An assortment of tools shall be available to the user and the supporting staff. These tools shall make the system "user-friendly" by addressing the requirements in the following categories:

- Adaptive User Customization
- Uncertainty Handling
- System Response Time
- User Assistance
- Verification of User Inputs

User access. This section is concerned with the high-level user access by addressing the requirements in the following categories:

- Interruption
- Time-Out
- User Access Record

Information Management. The requirements for information management are defined in terms of *data management*, *information management tools*, and *application support information* capabilities. The management of the information is very important to all databases, and it determines a systems' overall capabilities and performance. The handling of multimedia data will require proper data organization, data manipulation, and data control. The information management tools must allow for the data handling to be done with accuracy within some given performance criterion. The information management tools must also be intelligent, adaptable and capable of handling vague queries as needed for the specific application.

General System Capabilities. The requirements for general system capabilities are categorized as *security*, *reliability*, *performance* and *flexibility*. The only limitations upon these requirements will be due to the available prototyping hardware configurations. The general system capability requirements are described for the following areas:

- Security
- Reliability
- Performance
- Flexibility

Testing and Validation

In this phase of our research activity the team started the prototyping efforts. There have been three stages of prototypes: a paper mock-up of the user interface, a hypercard mock-up user interface and multimedia database, and the final visual basic prototype with actual user interface and multimedia database capabilities.

Paper Mock-up. Initially, a paper mock up (slide presentation) of the user interface screens was developed. This paper mock-up was based on all the information acquired and the user interface requirements. It illustrated a consumer session which started with the user identifying his/her auto preferences (see Fig 8a). Fig. 8b shows a screen that displayed the vehicles which matched the consumer's preferences. A test driving screen via virtual reality is shown in Fig. 8c. The last screen ended with negotiations with the dealership (see Fig. 8d). This activity prompted feedback from the entire triad team which included the application providers. The paper mock up provided initial proof-of-concept for the two test case scenarios.

Figure 8a

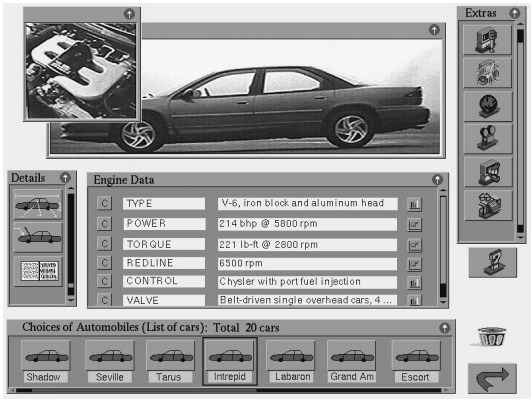

Figure 8b

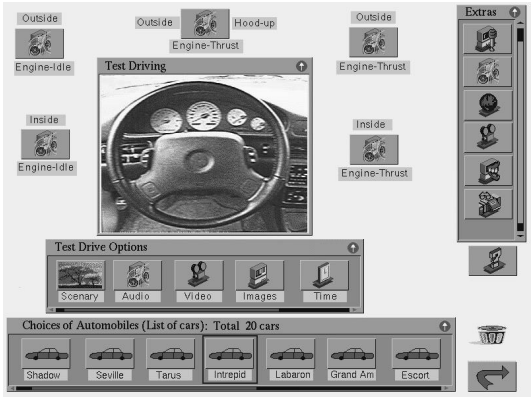

Figure 8c

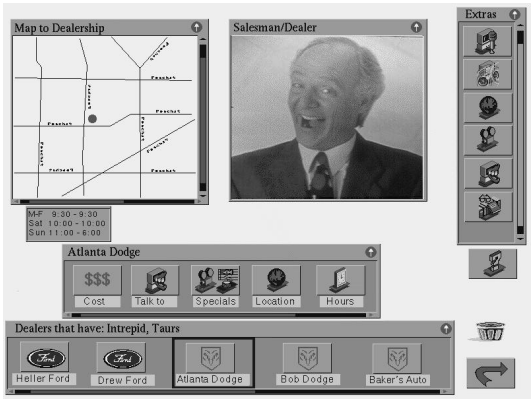

Figure 8d

Hypercard Mock-up. The next prototyping effort was done using the hypercard authoring tool on a Macintosh computer. Within this activity the ideas presented in the paper mock-up were used to design the hypercard presentation of the user interface and multimedia database. Icons, animation, pictures, and sound were incorporated for further proof-of-concept testing. This mock-up demonstrated a browsing and searching user sessions which allowed the user to see autos of their choice or those selected by the system based on their preferences. The hypercard presentation of the sessions was hardcoded, therefore no actual interaction with a database took place. This activity was again used to get feedback from the application providers, and aided in the validation and updating of the applications requirements.

Visual Basic Prototype. A prototype of the user interface is being developed on the PC platform using *Microsoft Windows*. This activity is ongoing. Many of the existing features can and will be extended. For easier user interface building, *Visual Basic Pro* (VBP) is used. The two scenarios of auto-purchasing sessions described earlier (see Figs 6a-b) will be explored and implemented using VBP. The user interface will access multimedia database information on a Digital Alpha workstation via *RDB* and *OLE*. The VBP prototype will be discussed in the

following three categories: architectural features, design rationale, and user interface capabilities.

Architectural Features. The user interface has a direct-manipulation interface called WIMP, which means Windows, Icons, Menus, and Pointer (Dix et. al., 1993). There is one main screen, a multiple document interface (MDI), which allows multiple windows to be opened within it. A different "child" window is opened for each task. The functionality of the windows is designed using object-oriented methodology. There are classes of windows defined based on their purpose. For example, a window which displays the picture of an auto is defined with certain options, and anytime a picture is displayed, an instance of this window is created. All of the windows are database driven --number of records in the table determines the number of options that appear in that window. For instance, if there are five auto manufacturers listed in the Auto-Make table, then there will automatically be buttons for five possible manufacturer options for that window. The graphical icons for each of the buttons are also stored in the database in bitmap form. Therefore, in order to add another option to a window, one simply has to add that record to the corresponding table along with the graphical icon and other information required in that table. The options in the windows are displayed based on an SQL query of the database, thus, information is always displayed in alphabetical order regardless of how the records are entered into the database. In addition to these features, there is audio and video which are stored as records in the database.

Design Rationale. The user interface design decisions are primarily governed by the applications requirement document (THIMD, 1994) user interface design rules-of-thumb and the capabilities of VBP. Throughout the development of the prototype, one of the main priorities is ease-of-use. The graphical user interface is designed for an average user whose extent of using a computer is an ATM machine. Minimum English literacy is expected of the user, so symbolic icons and speech is extensively used, along with simple labels to provide user assistance. Also on ambiguous selections, the interface will make intelligent guesses at what the user wants. Keeping all of this in mind, the rationale used is the following:

- Microsoft Visual Basic Pro is used for its ease in creating graphic interface objects. For example, instead of drawing a pretty 3D button using an art program, VBP provides a library of available control objects.

- A WIMP interface is chosen because it offers more flexibility in the types of information being displayed, i.e. pictures, movies, technical data, etc. Also, most average users find this method adaptable. The primary pointing device is a mouse because it allows for touch screens to be easily implemented in the future.

- A MDI allows multiple windows within a window, such that the "child" windows can not be outside the "parent" window, thus allowing the user to compare different auto information (i.e. pictures, engine data, etc.) on one screen.

- By using SQL queries instead of the table itself for the window options, the number of options can be controlled. As a rule-of-thumb, you do not want to present too many options, because the short term memory capacity is 7 ± 2 (Norman, 1990).

- There are two modes in which the system can be accessed: Beginner and Advanced. This feature is added so that the system can be customized to the level of user competency of the auto broker (i.e., the advanced user will not be frustrated and the new user will not be overwhelmed and discouraged). Also there are several methods of input at some windows. For example, to adjust the price range, one can either type in the values, or adjust the range scroll-bars. Constraints are built in to eliminate user errors.

- User assistance and help screens always shorten the learning curve of a new user. To address this need, there is a "Suggestion" panel which gives the user an idea of what to do next, and a "What" panel which displays the function of the button currently under the mouser pointer (see Fig. 9a--bottom of screen).

User Interface Capabilities. The following will be a description of the current capabilities of the graphics user interface. Afterwards a short description of the ongoing activity and planned extended capabilities will be presented.

As described earlier, the user interface has two operating modes. In the Beginner mode, the users who have little familiarity with the auto broker or any other *Windows* based programs; in the Advanced mode, the users who are very comfortable with navigating around in the auto broker (see Fig. 9b). In the Beginner mode, the system has defined the order of tasks, but in the Advanced mode, the user determines the order of the tasks. Regardless of the operation mode, the system will acknowledge each task by giving the user audio feedback of the task completed. This feedback can be turned off by lowering the sound scroll bar(see Fig. 9c).

Once the user has started the system, he/she can enter in personal preferences such as the country, make, size, auto-type, and price-range. This information is optional, however it aids the system in narrowing down candidate autos for the undecided consumer. For the user who wants to see a particular auto he/she can specify this auto for the system to query. After options have been entered, and user clicks the button "find auto", the system displays a window of auto icons which matches his/her options (see Fig. 9d). Presently, this query is hardcoded, however the user interface will query the *RDB* database for this information. More details about this functionality will be discussed later.

The user will be to able click on the autos of his/her choice and see the picture, commercial, technical data, comparison data etc. of the auto. He/She will also be able to compare and contrast the system selections on the same screen (see Fig. 9e).

Figure 9a

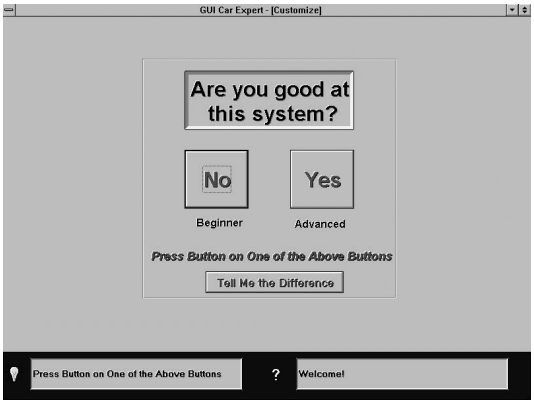

Figure 9b

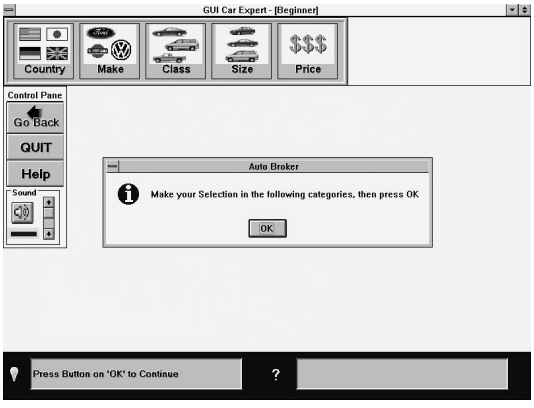

Figure 9c

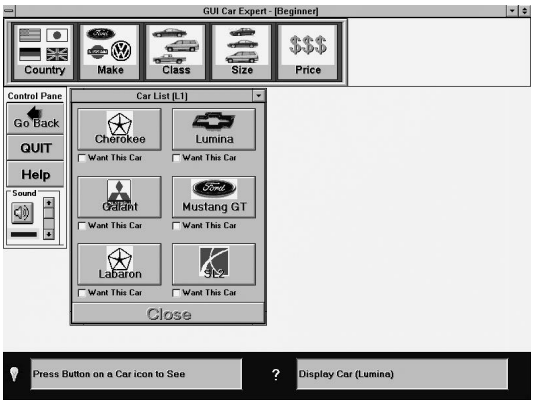

Figure 9d

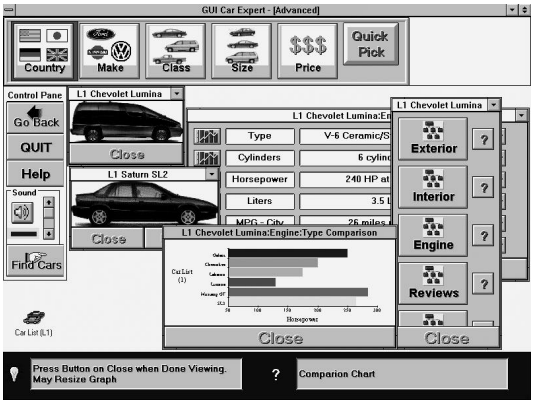

Figure 9e

Planned Extended Capabilities. The ultimate goal is for the user interface to be the front end to an auto information database in *RDB*. Presently, there is a user interface database schema in *Microsoft ACCESS* which defines the presentation of the information to the user. The user interface database schema is different from the auto information database schema in *RDB*. As explained earlier, the user interface database schema contains the graphics and pictorial icons seen in the screens of the user interface; however, the auto database schema contains tables of data from different auto information resources.

An auto database schema has been created in *RDB* which exists in OpenVMS. The schema was developed by the database group within the GT research team and implemented in *RDB* using a multimedia query language (SQLMM). The applications group is in the process of populating the database with textual and graphical, as well as video, audio, and pictorial auto information using Microsoft's Object Linking and Embedding (OLE). The next step is to establish a link of communication between the VBP user interface and the auto database via Open Database connectivity (ODBC). The auto database is populated with new vehicle data only. There are no

plans for including used vehicle data, although this extension can be easily implemented.

In summary, the next steps in the prototyping activity includes the following:

- Load both the user interface and the auto database schemas in RDB on the Alpha.
- Sufficiently populate the auto database with multimedia data for testing.
- Access these databases via ODBC from the VBP user interface.

System Architecture

Throughout this entire project other team members have been studying computer science issues and conducting similar activity to define the system architecture of a multimedia information broker. Some of the topics being researched include the following: user interface navigational methods, database free form querying issues, and relational vs. object oriented database studies. These topics along with the application scenarios, the applications requirements, and several proof-of-concept phases, this team is able to characterize, test and validate the system architecture definition. For details see the Hypermedia Interfaces for Multimedia Databases annual report (THIMD, 1994). This activity is still being carried out.

CONCLUDING REMARKS

Multimedia databases and clever user interfaces with virtual reality and simulation capabilities are essential for consumer information brokers. Today the interest of the average consumer is gained through witty advertisement followed up by the ability to touch, see, and test out the product. All of these functions must be captured in the information broker, which is not easy, due to the complexity and diversity of the data and tasks. The information is distributed among many different resources thus integration of the data is also required. A multimedia auto broker is an application which exemplifies all of the needs described above.

This paper characterized a methodology for defining and validating the application requirements for a multimedia auto broker. The methodology described included a knowledge acquisition phase, application requirements definition phase, and a testing and validation phase. Each of these phases consisted of logical data modeling techniques, overall system capability definition, and prototyping efforts respectively. The VBP prototype addresses many of the underlining graphical user interface and multimedia data management tasks required.

The underlining concepts of the auto broker can be extended to other applications such as manufacturing, building and construction, research, and medical applications, etc. In fact, the auto broker could possibly be used as a tool to aid the auto design process because it captures the consumers' voice. The wants, needs, and desires of the consumer can be captured, stored, and incorporated into the design process more effectively.

All the activities described in this paper are on-going. Therefore, all requirements and system capabilities are continually modified.

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