

# Evaluation of existing CAD Programs used by clients in housing design and marketing

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## Abstract

There exists a knowledge gap between architects and buyers in the North American homebuilding industry. Mass produced housing is commonly conceived for a user whose needs are unknown to the designer during the design process. In a built model unit, potential home-buyers can appreciate how their future home will look prior to the purchasing decision. Changing this process, by allowing the user to participate in the design process, can only be accepted once both the builder's and the buyers' objectives are satisfied. We wanted to explore the possibility of having clients directly involved in their home design for the purpose of improving both user satisfaction as well as unit marketing potential. Given the fact that computers have become more accessible to both designers and the public at large, we assumed that users can operate a pre-prepared program by themselves, on which they can make limited design decisions. In our preliminary research, we found several software companies that are already marketing such programs. The objectives of our research were to determine the merit of these programs and to establish their potential in order to narrow the knowledge gap between builders/architects and clients in the marketing and the construction of housing. We found that these programs do not adequately familiarize the user with the manipulation of the software or hardware systems. Their operation is rather complex for the lay person and better documentation and instructions are needed if these programs are to be integrated in the future marketing of housing.

## Introduction/Background

The widening of the affordability gap adversely affected the North American housing market in the late 1980's. The rise in the cost of serviced land made it difficult for first-time home buyers to purchase a house in most Canadian urban centers. The need to make a trade-off between amenities and budgetary constraints often meant that for a consumer, an important step in becoming a homeowner, was to lower his or her expectations. In addition, socio-demographic changes are transforming the composition of the clientele in the housing market. User groups considered marginal in the past - such as single parent families - now occupy a significant share of the market [Friedman 92]. The homebuilding industry started to amend traditional design approaches which ignored these clients and respond to market demand. Such adaptations are a matter of survival in this time of economic downturn [Friedman 90]. The need to find a tool which responds and helps both buyers and builders was thus our main concern in experimenting with this approach. In order to further understand the rationale for our approach, one needs to understand the constraints that influence the building and marketing of housing in North America.

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The homebuilding industry is made up of a large number of small companies. More than 55% of all companies build less than 25 housing units per year [Charney 71]. Most companies have a small number of in-house employees, and almost all of the actual construction work is usually sub-contracted. Developers are responsible for many tasks for which they are not professionally trained, such as marketing and finance. The architectural profession is not involved, for the most part, in providing design services to builders in mass housing construction. In the rare instance in which an architect is retained for his services, site review is often not part of the architect's mandate [Blau 84]. The reasons for this exclusion are varied: they range from a very tight profit margin, to the builders' need to have control over every aspect of the process, given their mode of operation.

Because of the marginal involvement of the architect, builders need to find other means which will respond to specific space needs and possible layout arrangements of new user groups, like single parent families, and must use design resources very efficiently. The need to accommodate these clients in the low-cost end of the market, where they are concentrated, is even more complex.

Given the small organizational structure of their companies, builders cannot afford to spend their scarce resources catering to individual client choices, which might include preferences ranging from interior layout design to finishing materials [Friedman 87]. This state of affairs is even more relevant in affordable housing, where profit margins are smaller than in upwardly-mobile or high-end market segments. The options that builders may offer in the context of affordable housing is usually limited to the choice of surface finishing, such as colour schemes or tile patterns. On the other hand, adequately servicing these diverse client groups is a marketing and economic challenge that the builder cannot afford to lose. The need to develop an approach that can assist in both optimizing builder resources, as well as user requirements, will most likely respond to a demand in the North American homebuilding industry. In this research, the tool which responds and helps both buyers and builders will be a CAD program manipulated by a user, outlined below. Prior to an evaluation of existing programs of this nature, the existing communication process will be explained.

### **Existing communication process in the homebuilding industry**

There exists a knowledge gap between the supply and demand sides in the homebuilding industry. Unlike custom designed houses, the buyer is largely unknown to the designer until the time of purchase. The prime source of information for programming is the builders' own experience, on which assumptions about the buyers' wants is conveyed, in turn, to the architect [Zeisel 81]. The end user in the programming stage thus becomes an "imagined entity". The architect rarely knows the socio-economic or life-stage characteristics of potential buyers. The common design approach is to suggest several layouts which may fit potential buyers' needs, and to build one as a model unit. After visiting the site and seeing the model, the buyer may decide to purchase the unit as is, or to modify the layout. The degree of flexibility in modifications given to buyers in affordable housing is very often limited due to the willingness of the builder to be actively involved in the process. Engaging an architect may prove to be too expensive for both the user and the builder.

The need to engage potential buyers in the design of their future homes was thus our concern. We were fully aware that the acceptance in this approach contributes to both builder and buyer goals [Friedman 89]. In this respect, an approach that improves the marketing potential of a unit as well as buyer satisfaction has a chance to succeed.

## **The proposed communication system**

Our proposed system involves computer aided design by the user. The premise is that since computers are increasingly common in business and residential environments, the users' familiarity is heightened. Similarly, advanced hardware and software systems are becoming less of a novelty. More clients either have computers or have access to them. Our change to the existing process is to leave the basic design decisions with the architect, but to have the user adapt the design to his or her specific needs by using computers. We have divided the communication process into three phases which are outlined below:

### **Data collection, basic design decisions, and background preparation**

In this first stage the architect discusses the project with the builder, establishing the selling price and the size of the units. Based on the builder's experience, they both make assumptions about the socio-economic characteristics of potential users. The design stage then begins, in which the architect considers zoning and code requirements. The end result will be the design of a shell and optional layouts in which the exterior configurations and the fenestrations are fixed. The interior layout will be one of a number of suggested options. Once this information is transferred onto a computer program, it will serve as a bases for changes by the user. This important stage will include substages such as familiarization of the user with the program and with the design.

The need to acquaint the buyer with the functioning of the computer and the required, basic knowledge about common architectural symbols is a main concern. One can not take for granted that every user will understand and read architectural drawings. One can also not assume that the user will be sufficiently comfortable with computer aided design and immediately able to manipulate the hardware and software systems. Accordingly, there are several critical questions which must be asked to finally determine the future development of this idea: can users with different training skills use the system?; what degree of familiarization should one assume prior to the actual design?; what level of intervention can one expect from an untrained buyer? These and other questions need to be answered in future research and identifying them was one of our objectives in this study [Baharoon 90].

In preparation for user intervention, the architect may want to limit the user's manipulation capabilities from a small number of simple internal changes, for example, the choice of finishing materials, to complex changes such as, for example, changing the layout of a bathroom or a kitchen. These programmatic decisions will be made jointly by the architect and the builder in accordance with the project's global objectives and cost.

### **Visit of a model unit**

The second stage involves a visit by the potential user to the model unit. As mentioned above, the built unit commonly displays one design option in which the buyers get to appreciate construction quality and layout. Sales representatives usually provide them with additional information about finishing options and cost. Quite often, a modest alteration to the build unit and display of other plan options are made on site. According to the proposed process, the buyer is given a computer disk on which information regarding a variety of options to the layout of the chosen model is stored. The disk will systematically list the range of choices that one can make in this particular process and their cost implications.

## **User intervention**

In this stage the buyers will get familiar with the program on their personal computer that will take into account issues regarding their space and affordability needs. The program will be used within the parameters that were assigned by the architect in the first stage. The user will get an opportunity to work at their own pace without the time pressure commonly applied in the model unit by the sales representative. The design can be re-examined by additional family members for further discussion. At the end of this stage, the buyer will have a clear idea about the economic implications of his or her choice. The information then can be saved on the same disk and returned to the sales representative if a decision to purchase is made.

## **Processing by the architect**

In this last stage, the builder receives the data from the buyers. He verifies that the modifications were made in accordance with the pre-assigned limits. The builder may also decide to invite a selected number of clients to clarify aspects that are not clear on the disk. We assume that the well-prepared plan and options list in the program will reduce possible errors and confusion to the user. Once approved, the information can be transformed into working drawings, and the project can proceed to the construction stage.

## **Program Assessment**

The methods used in evaluating the programs were the following: to review the requirements involved in operating the programs as well as their features, to review the information provided in the manual that helps familiarize the user with the hardware and software systems, and finally, to test the features that are involved in the manipulation of the program, which are summarized in Table 1, Table 2 and Table 3 respectively.

Of the three programs reviewed, the Home Series: Home rated the best overall because of its various user friendly features. The adage 'you get what you pay for' is pertinent in this situation, since this is the most expensive of the three programs. Insert cards which were provided as part of the package were especially helpful. Once in the program, an easily referenced command card guides one to the desired command. These commands represent the pulldown menus on the computer. Therefore, if one wanted to draw, for example, a curved wall, they can see the system of commands needed to complete the task. In this case, one would start at the Home pulldown menu and select Walls. From the Walls pulldown menu, one would select the desired command: Curved Walls. The same card insert feature is provided for the function key designated commands and a drawing step summary. The same applies for the easy to follow installation guide card insert.

Unfortunately many commands are complicated such as the dimensioning command. For example, "to draw a wall 20' long, select the "Walls" menu and then click on the "CW Wall" command. Click near the center of the screen to place the first endpoint of the wall. Move the cursor horizontally to the right until the readout displays "Horizontal 20' Vertical 0". Then, click again to place the other end, resulting in a wall (exactly) 20' long.

Design Your Own Home: Architecture was considered to be the second most user friendly program after The Home Series: Home. The reason for this is mainly due to the operating hardware system, the user friendly Macintosh computer system. For computer use fundamentals, the manual suggests to refer to the Mac System Software Guide, thus computer fundamentals were not part of the package. Another good feature is that the

Table 1: Summary of minimum requirements for operating program as well as program features

NAME	COST	RECOMMENDED HARDWARE	FEATURES
<b>THE HOME SERIES: HOME</b> Autodesk Retail Products, 11911 North Creek Parkway South, Bothell, WA 98011 (800) 288-3601 (US and Canada) (206) 487-2233 FAX (206) 485-0021.	\$270.00 US.	IBM PC/XT/AT or compatible computer with 640K RAM and DOS 3.0 or higher. One hard drive, one floppy drive, a mouse (two or three button), and a graphics card (Hercules monochrome or color, CGA, MCGA, EGA, or VGA). A minimum of EGA is required for color. Epson dot-matrix printers or 100% compatibles and HP LaserJet printers or 100% compatible.	
<b>DESIGN YOUR OWN HOME: ARCHITECTURE</b> Abracadata, Ltd., P.O. Box 22440, Eugene, OR 97402, (503) 342-3030.	\$69.00 US.	Apple II+, IIe, IIc, Laser 128 version: 64k or more. Mouse, paddles, pad or joystick. 112 printers and 75 interface cards. Color printing not available. Apple II GS only version: 1MB or more. Mouse, Imagerwriter, Laserwriter and color printing optional. IBM/Compatibles version: 640 K, Hercules, CGA, EGA/VGA. Dos 2.1 to 3.3. Mouse or keyboard control. Over 175 printers. Color printing not available.	STUD SPEC 25 SAMPLE PLANS
<b>EXPERT HOME DESIGN</b> Expert Software, P.O. Box 143376 Coral Gables, Florida 33134.	\$14.95 US.	512 RAM, DOS 3.0 or higher; Hercules, CGA, EGA or VGA adapter. VGA requires 640 K RAM. Supports HP LaserJet II or compatible printer, Epson dot matrix or compatible printers.	EXPERT MORTGAGE MAKER ATTRIBUTES ON SEPARATE PAGE

Table 2: Information provided in the manual to help familiarize the user with the hardware and software systems

FEATURE	HOME	ARCHITECTURE	EXPERT
WRITTEN MANUAL	131p.	55p.	27p.
BACKUP RECOMMENDED	x	x	-
INSTALLATION GUIDE - CARD INSERT	x	-	-
COMMAND GUIDE - CARD INSERT	x	x	-
FUNCTION KEY COMMAND - CARD INSERT	x	x	-
DRAWING STEP SUMMARY - CARD INSERT	x	-	-
TUTORIAL THROUGH SAMPLE PLAN	x	-	x
MENU DRIVEN DRAWING PROGRAM	x	x	x
ON-LINE HELP FEATURE	x	-	-
PREDRAWN SYMBOLS	70	26	> 200 incl. rotated symbols
SAMPLE DRAWINGS	3	25	1
MENUS (PICTORIAL IN MANUAL)	x	-	-
SYMBOLS (PICTORIAL IN MANUAL)	x	x	-
DESIGN REMODELING FUNDAMENTALS	x	-	-
ARCHITECT ASSISTANCE RECOMMENDED	x	-	-
SYMBOL REPRESENTATION	satisfactory	crude	crude
FLOOR PLAN REPRESENTATION	satisfactory	crude	crude
SITE DESIGN CONSIDERATIONS	x	-	-
FURNITURE DESIGN CONSIDERATIONS	x	-	-
KITCHEN SAMPLE LAYOUTS	5 layouts	-	-
BATHROOM CONSIDERATIONS	x	-	-
INSTALL & CONFIG. SYSTEM GUIDE	x	x	x
COMPUTER USE FUNDAMENTALS	x	refer to Mac System Software Guide	-
GLOSSARY OF TERMS REFERRED TO IN MANUAL	x	-	-

LEGEND	
x	Provided
-	Not provided

Table 3: Summary of features involved in manipulation of the program

FEATURE	HOME	ARCHITECTURE	EXPERT
KEYBOARD CAPABILITIES	x	x	1
MOUSE BUTTONS APPLICABLE	2	double click	1
REAL WORLD SCALE	x	x	-
PLOT	any scale	depends on printer setup	print only
DIMENSIONING	complicated procedure	x	difficult to be accurate
SNAP	for orthogonal accuracy	x	-
MENU COMMAND DESCRIPTION	x	x	x
SCAN	-	similar to "AutoMaster"	-
WALLS	4"	-	3x line thickness
CUSTOM SYMBOLS	cannot save as "block"	x	-
ADDITIONAL SYMBOLS (ADD ONS)	compatible with Home Series programs	> 192 plans	-
DESKTOP	-	x	-
PATTERNS (HATCH)	-	very detailed	-
EXTENSION	.dwg	.pict	.pct
SCALE	unlimited	12 options	default 32
STUD SPEC	-	x	-
LINE	x	1-8 thicknesses	cannot type numerical value
TEXT	any height only	font, size & style variations	2 sizes
TRANSFER FILE	to Generic CAD	additional Architecture libraries	x
FILE TYPE	object oriented	object oriented	vector
UNDO	25	1	1
ERASE	objects	objects	dots only
STATUS LINE	feet & inches	metric & imperial	decimal
MENU COLORS	-	-	16
ROOM DESCRIPTION	-	-	attrib. printed on separate page

LEGEND	
x	Provided
-	Not provided

package includes twenty-five sample plans. The manual also shows the sample plans in elevation. As well, additional Design Your Own Home libraries are available, each with over four dozen plans. In this way, one may find one plan to their liking and thus one can reach their desired plan with a minimum number of manipulations.

One problem with this package is that more trial and error is needed since the pull down menus are not clearly defined nor are they shown anywhere in the manual.

An extra feature found only in Design Your Own Home: Architecture is the Stud Tool. Although for the lay person the definition of this term may be ambiguous, and it is questionable whether this is a necessary feature. It allows one to estimate lumber and boards.

The least friendly program was Expert: Home Design. The good feature of this program is that it has a limited number of commands, thus reducing confusion to the user. This vector driven program draws with dots, thus, for example, a line consists of a series of dots. The Erase command does not allow one to erase a window and thus makes erasing cumbersome. The Describe Room feature allows one to attach a more detailed description to individual rooms and is not found in the other two programs. These descriptions can be printed along with the layout as a second page.

One good feature included only in this package is the Expert Mortgage Maker. One can Compute Home Cost, Get Payment (by typing in information such as selling price, down payment, interest amount, number of payments, taxes, and insurance), Figure Max Mortgage, compute Early Payoff as well as Print Payment Schedule. Although this feature does not reflect the drawing portion of the software package, the idea is a good one. It would be better if this kind of add on would be a cost estimate which directly reflects the users' design decisions. In this way, the user can understand the cost implications associated with each design choice.

## Conclusions

The market is clearly changing. As we demonstrated, there can be a need for such a program if the design is correctly approached. In order for such a system to succeed, simplicity is of utmost importance. This simplicity will be beneficial to all parties involved; the architect, the builder and the developer. The more complex hardware and software systems we have, the less likely future integration in the market will take place. Based on our evaluations, the present state of the programs demonstrates that the present direction is not in line with the above objectives.

After thorough analyses of the aforementioned programs, it became clear that none would be appropriate in order to achieve our goals. In all cases, the user familiarization period proved to be far too long. The understanding of command definitions were also ambiguous. Some good things such as card inserts, clearly showed the user exact pictorial summaries of commands, symbols library and furniture. This is an important feature since, as mentioned before, one cannot assume that the user will understand the symbols representing an entity, such as a kitchen sink.

It is clear that a great deal of effort needs to be put into the programmatic design of an effective software system which caters to this particular problem. If one were to take the best attributes of the various existing programs available today on the market, one will be



closer to a buyer friendly program which will satisfy the needs of the user, developer and the architect.

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