

Computer Aided Drafting Application (CAD) as – A Design Tool

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Abstract: Computer Aided Drafting or (CAD) is a computer application known among the construction engineering field as a drafting tool, that offers computer aided drafting only, and does not combine the produced drawings with construction engineering information like engineering specifications, bill of quantities, material specifications, project scheduling, and other related data. On the other hand, the main purpose of the emergence of Computer Aided Drafting or (CAD) technology is to minimize effort and time consumed in the preparation of construction drawings. Such process is the most tedious and the core task of the design firms. Research work in this paper focus on introducing a base system concept that may lead to a computer program/script or a “Plug-in” that may give a (CAD) based software application commonly known as (AutoCAD Architecture Desktop) an (AI) capacity. The paper started with a short explanation of the major elements of the architectural design process from a cognitive approach, followed by a briefing about (CAD) technology as a drafting tool, then goes directly towards explaining the “CAD - Plug-in” suggested base system, and criteria with a simulation of the suggested concept over an architectural design example; a “Hospital 4 Surgery Rooms Zone”, as a case study. At the end, the paper concludes a Programming Scheme the (CAD - Plugin Syntax Code) written in “Prolog” computer programming language.

Keywords: Computer Aided Drafting (CAD), (CAD) in Architecture Design, (CAD) and Design, Design Process, Architecture Design

1. Introduction

Since the beginning of the concept in 1960's, “Computer Aided Drafting – or (CAD)” has been used in creating a more accurate and precise engineering drawings by the help of computers rather than engineering drawings generated by human hand.

In the beginning, the term (CAD) was coined as Computer Aided “Design” not “Drafting”. Although the application does not participate or generate any type of design, because the later involves the thinking power of the human brain, as the architectural design process is a pure cognitive activity [1].

1.1. Literature Review

Most research work done in the (CAD) field is focusing on enhancing and/or expanding the capacity of the computer application by releasing more updates and new versions

through the work of companies developing the software like “Autodesk inc.”, “Graph iSOFT inc.” and others. Few attempts are trying to explore the possibility of equipping (CAD) with Artificial Intelligence - (AI).

Literature in this paper focus on introducing a base system concept producing a computer program/script or a plug-in that may give a (CAD) based software application commonly known as (AutoCAD Architecture Desktop) an (AI) capacity. The paper does not involve much in investigating (CAD) from the drafting perspective, or as a drafting tool, but a briefing for the purpose of showing the differences between the two approaches.

1.2. Goal

The goal of research work in this paper is to introduce a “Base System Concept” forming a computer program/script, or a “Plug-in” that may give a (CAD) based software application commonly known as (AutoCAD Architecture

Desktop) an (AI) capacity

2. Method

The paper started with a short explanation of the major elements of the architectural design process from a cognitive approach, followed by a briefing about (CAD) technology as a drafting tool, then goes directly towards explaining the “AutoCAD Architecture Desktop - Plug-in” suggested base system, and criteria. At the end, the paper concludes a Programing Scheme, and an (AutoCAD Architecture Desktop - Plugin Program Syntax Code) written in “Prolog” computer programming language.

3. Result

The computer script introduced by this research paper forms a plug-in that connects “El Dars (AI) capacity” with Autodesk (AutoCAD Architecture Desktop), providing the later with the ability to create various design schemes.

4. Discussion

4.1. The Cognitive Architectural Design Process

The cognitive process¹ of architecture design involves; power of imagination, information/data synthesis, and optimal selection between alternatives (Best choice).

Machine learning - (ML)² via artificial intelligence – (AI)³ may succeed in data synthesis and optimal selection between alternatives but it is quite difficult to gain the power and capacity of human imagination.⁴ [2-5]

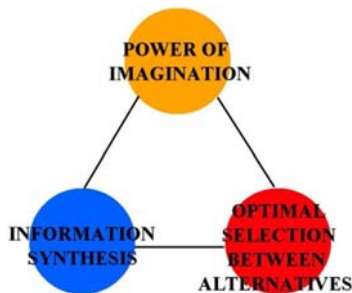


Figure 1. A diagram showing elements of the Architectural design cognitive process. Ref. [Research].

¹ “The Cognitive Architectural Design Process”, is a theoretical hypothesis that is trying to explain how the architectural design starts and ends inside the human brain, some explanations include the physical cycle between the brain and freehand sketching on paper during the initial phases of design thinking

² “Machine Learning – (ML)”, is an algorithmic process that provides a computer with the ability to improve its performance by analyzing “Updated” information in databases

³ “Artificial Intelligence” is providing the computer with the ability to think like a human brain, take decisions and execute commands and tasks according to different situations without depending on pre-programmed routines.

⁴ This section of the paper is not discussing the typical phases of a design process and services like: Schematic Design, Design Development, Construction Documents, Bidding/Procurement, Contract/Construction Administration, rather than focusing on the cognitive architectural design process.

4.1.1. Cognitive Power of Imagination

In general, the cognitive power of imagination is the ability of the human brain to create and construct a mental imagery, vision, or a scenario, for a situation, theory, physical creation like a building, or a preposition. Without the human brain power of imagination human creatures will not be able to interact and affect their living environment. [6]

4.1.2. Cognitive Information/Data Synthesis

“Cognitive power of synthesizing information and data” is the ability of the human brain to analyze and extract conclusions from all types of data that it receives from its external surroundings. [7]

4.1.3. Cognitive Optimal Selection Between Alternatives

In general, the ability to evaluate and make the best choice between potential alternatives is one of the main characteristics and power of the human brain, in some academic resources; it might be commonly described as the ability to take a decision, or what is called “Decision Making”, that in turn will be followed by taking a certain action based on such decision. [8]

4.2. Computer Aided Drafting – (CAD) as a Drafting Tool

Computer Aided Drafting or (CAD) is a computer application known among the construction engineering field as a drafting tool, that offers computer aided drafting only, and does not combine the produced drawings with construction engineering information like engineering specifications, bill of quantities, material specifications, project scheduling, and other related data. On the other hand, the main purpose of the emergence of Computer Aided Drafting or (CAD) technology is to minimize effort and time consumed in the preparation of construction drawings. Such process is the most tedious and the core task of the design firms.

4.3. Computer Aided Drafting – (CAD) as a Design Tool

4.3.1. The Suggested “(CAD) - Design” Concept

(i). Base System

The first attempt for providing the computer with an artificial intelligence capacity in the schematic architectural design process was early introduced by “Zakareya El Dars”⁵ in his PhD thesis in (1964), he introduced a computational method that assigns a numerical value to each architectural space inside a specific building. [9]

(ii). “El-Dars” Computational Criteria

The numerical value is based on the function, importance, and priority of such space (Space Function and Priority in Design), space relevance to its adjacent one and to each other (Space Relevance), and access to such space in the spatial

⁵ Doctor “Zakareya El-Dars” is currently a professor emeritus at the department of architecture, faculty of engineering, Al-Azhar University, Cairo, Egypt. His invention and theory are the first attempt in the twentieth century in the field of applying artificial intelligence in the schematic architectural design process

zoning relationship (Space Connection and Corridor System). The computer starts calculating these numerical values based on the mentioned criteria and produce a spatial zoning diagram. This zoning diagram is a simulation to a spatial zoning relationship like that produced by human architectural design thinking. The “Dars” system then suggests a corridor system providing suitable access to, and connecting related spaces generated by his algorithm.

(iii). Space Function and Priority in Design

Any building is composed of internal spaces that varies in function, area, and priority; the architect arranges such spaces accordingly. Success and perfection of such assembly of spaces depends on the personal (IQ)⁶ of the architect, and his/her ability to create a logical spatial plot. Since such process is purely cognitive; to involve the computer in a similar process, such human brain activity should be interpreted into numerical values that the computer can manipulate and understand. [10]

(iv). Space Relevance

Each space inside a building has a relationship with its neighbor, and regardless such relationship is direct or indirect; assembly of such spaces follows a logical criterion based on the function and purpose of each space. This logical assembly is commonly known among architects as “Spatial Relation”. Since such process is also pure cognitive; to involve the computer; such human brain activity should be interpreted into numerical values that the computer can manipulate and understand

(v). Space Connection and Corridor System

Different architectural spaces inside a building should be easily accessed by users inside this building. Spaces are connected by facilitating spaces called corridors, lobbies, waiting areas, and entrances. The architect designs such communication spaces as an essential and integral part of the overall generated architectural design floor plan. The process is also pure cognitive; to involve the computer; such human brain activity should be interpreted into numerical values that the computer can manipulate and understand. “El-Dars” computational system also suggests corridors and communication spaces in its generated spatial relation diagram.

4.3.2. In This Research

The computer script introduced by this research paper summarizing a plug-in that connects “El Dars (AI) capacity” with Autodesk (AutoCAD Architecture Desktop) for the purpose of providing the later with the ability to create various design schemes.



Figure 2. Is a diagram expressing the relationship between “El-Dars” computational system and the Plug-in that connects “El Dars (AI) capacity” with Autodesk (AutoCAD Architecture Desktop) providing The later with the ability to create various design schemes. Ref.: [Research].

4.3.3. Experiment and Case Study

At first, a data entry for the simulation in the form of arranging the required spaces in the “EL-Dars - Spatial association chart”. The computer will then suggest a spatial zoning scheme based on importance, relevance, and priority of various space allocations to one another according to calculations in the chart. Afterwards, the computer introduces an optimal corridor, and/or passage system connecting such internal spaces together. What follows is a simulation of the suggested concept over an architectural design example of a “Hospital 4 Surgery Rooms Zone

A “Hospital 4 Surgery Rooms Zone”

This example applies the suggested base system over a “Hospital four surgery rooms zone”.

- 1) Step 1: is the creation of, and the feeding of “El-Dars Association Chart” with information about spaces required for the four surgery rooms zone and assigning each space with its equivalent numerical value based on the defined criteria.

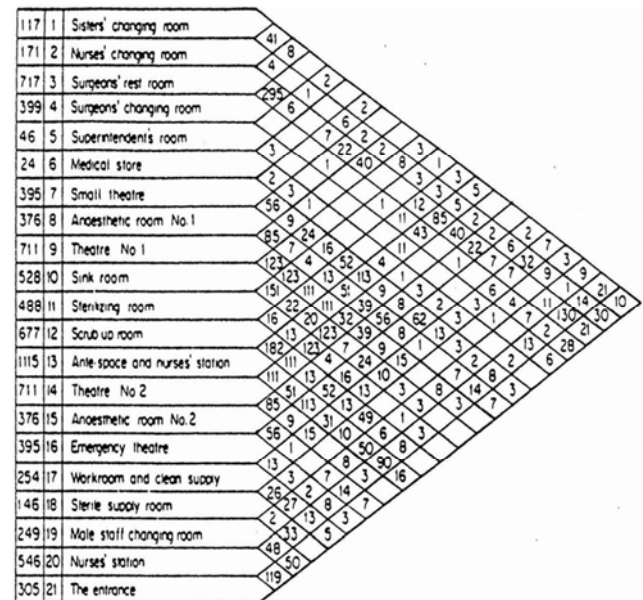


Figure 3. Is a diagram showing entering various spaces of the surgery area inside “EL-Dars Association Chart”. Ref.: [Research].

- 2) Step 2: The computer generates a spatial zoning scheme based on importance, relevance, and priority of various space allocations to one another, and according to calculations in the association chart

⁶ “Intelligence Quotation” or short as (IQ) is an evaluation system created by psychologist “William Stern” at the University of Breslau for testing the mental ability of persons. Since architecture design is a complex process that involves data analysis, creativity, logic, art, and many other complicated factors. it is important to say that the more an architect is intelligent and with great mental capacity the more s/he will be able to produce successful architectural designs

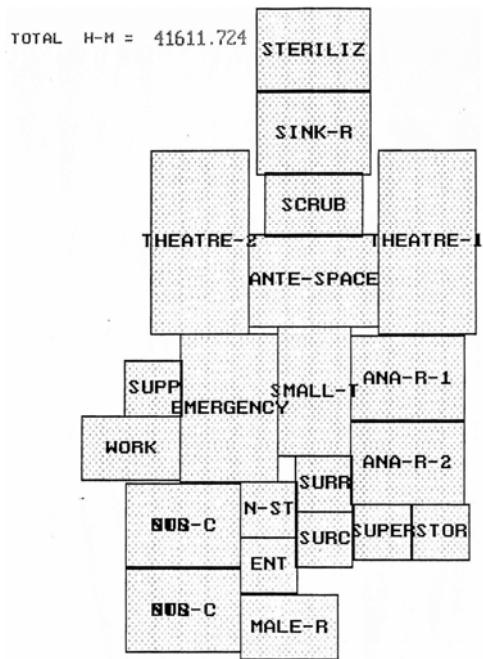


Figure 4. Shows the computer-generated spatial zoning scheme based on importance, relevance, and priority of various space allocations to one another, and according to Calculations in the association chart. Ref.: [Research].

3) Step 3: The computer generates a refined spatial zoning diagram showing interpolated and intersected space walls and connections

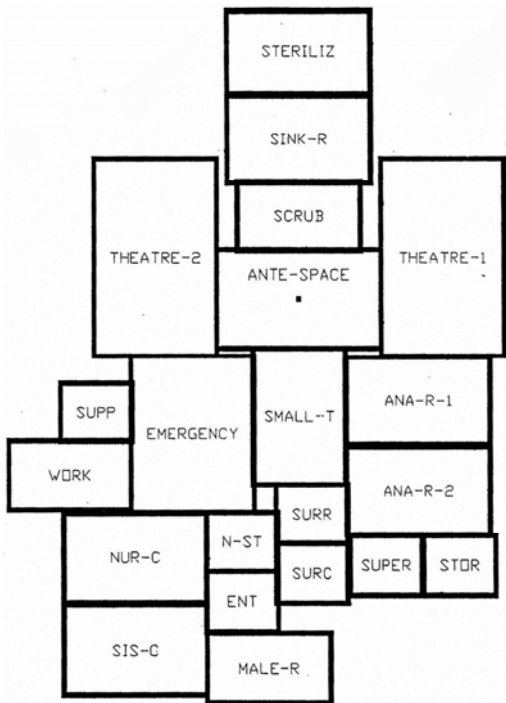


Figure 5. Is a generated computer refinement of the generated spatial zoning diagram showing interpolated and Intersected space walls and connections. Ref.: [Research].

4) Step 4: The computer generates a spatial zoning diagram showing interpolated corridor system connecting and

providing access to various architectural spaces

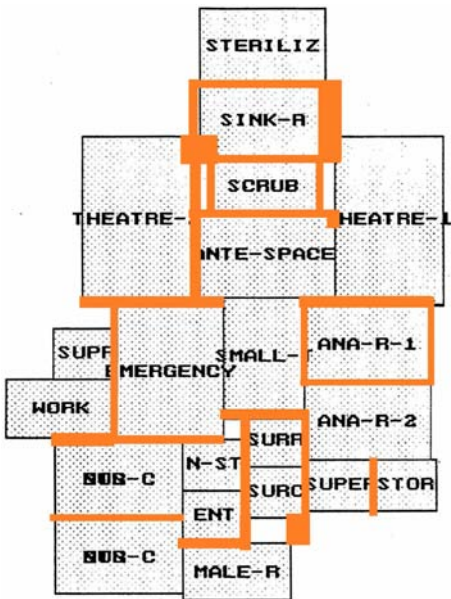


Figure 6. Is a generated computer spatial zoning diagram showing interpolated corridor system connecting and providing access to various architectural spaces. Ref.: [Research].

5) Step 5: The following diagram shows the architectural plan in its final form after some modifications to minimize corridors turns and unnecessary dead ends

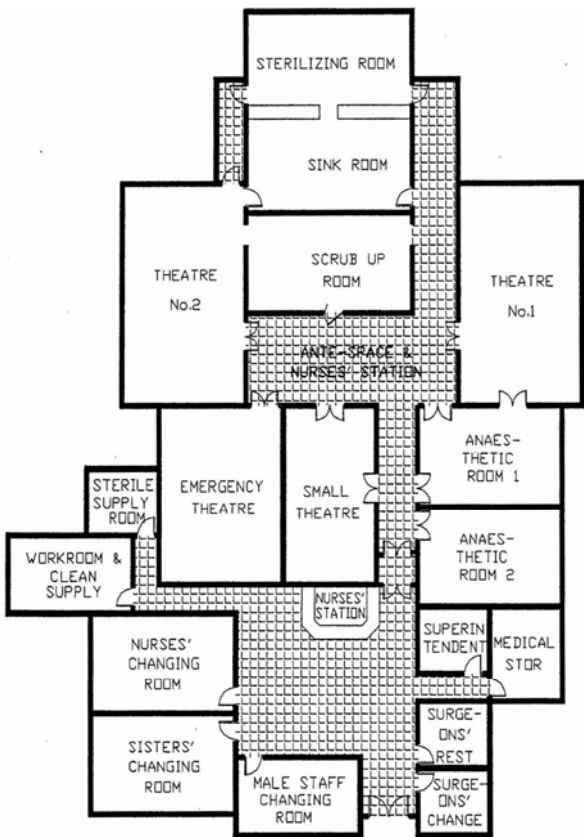


Figure 7. Shows the architectural plan in its final form after modifying turns and deadlocks. Ref.: [Research].

What follows is the plugin program syntax code written in “Prolog” computer programming language: [11]

```

AREA_D
code=3500
project "moh"
include "global_d.pro"
domains
ssy=reference symbol
sre=reference real

constants
area1=" ENTER NEW DATA "
area2=" DELETE STORED DATA "
area3=" EDIT Bid. TYPE NAME "
area4=" EDIT PROJECT NAME "
area5=" EDIT ELE. NAME "
area6=" EDIT X RATIO "
area7=" EDIT Y RATIO "
area8=" DISPLAY STORED DATA "
area9=" EXIT "
predicates
a_find(string)
area_c(integer)
replacing(symbol,symbol,symbol,real,real,real)
replacing(symbol,symbol,symbol,real,real,real)
displaying(ssy,ssy,ssy,sre,sre,string)
dis_a(ssy,ssy,ssy,sre,sre)
da(integer)
fda
rad(symbol,symbol)
choice1(KEY)
choicea(KEY)
clauses
area_prop(A):- makewindow(8,112,0,"",9,23,12,42),
makewindow(2,7,0,"",8,21,12,42),
cursor(2,3),write(area1),
cursor(3,3),write(area2),
cursor(4,3),write(area3),
cursor(5,3),write(area4),
cursor(6,3),write(area5),
cursor(7,3),write(area6),
cursor(8,3),write(area7),
cursor(9,3),write(area8),
cursor(10,3),write(area9),
scr_attr(2,0,0),cursor(2,0),
field_attr(2,3,33,113),
a_find(A).

a_find(A):-readkey(K),choice1(K),a_find(A).
a_find(A):-cursor(X,Y),C=X-1,removewindow(8,1),
removewindow(2,1),C<=8,!,area_c(C),area_prop(A).
a_find(A):-!,save(A,area).

choice1(up):-cursor(X,Y),W=X-1,W>=2,!,field_attr(X,Y,37,7),
field_attr(W,Y,37,113),scr_attr(W,0,0),cursor(W,0).
choice1(up):-cursor(X,Y),W=X-1,W<2,!,field_attr(X,Y,37,7),
field_attr(10,Y,37,113),scr_attr(10,0,0),cursor(10,0).
choice1(down):-cursor(X,Y),W=X+1,W<=10,!,field_attr(X,Y,37,7),
field_attr(W,Y,37,113),scr_attr(W,0,0),cursor(W,0).
choice1(down):-cursor(X,Y),W=X+1,W>10,!,field_attr(X,Y,37,7),
field_attr(2,Y,37,113),scr_attr(2,0,0),cursor(2,0).
choice1(crl):-!,fail.
choice1(_):-!,beep.

area_c(1):-makewindow(1,7,7,"",10,5,3,65),
write(" ENTER THE NAME OF THE NEW Bid. TYPE : "),
cursor(X,Y),L=Y-3,field_attr(X,3,L,113),
readln(PN1),upper_lower(PN,PNT1),
write(" ENTER THE NAME OF THE NEW PROJECT : "),
cursor(X1,Y1),L1=Y1-3,field_attr(X1,3,L1,31),
readln(SN1),upper_lower(SN,SN1),
write(" ENTER THE NAME OF THE NEW ELE. NAME : "),
cursor(X2,Y2),L2=Y2-3,field_attr(X2,3,L2,112),
readln(N1),upper_lower(N,N1),
write(" ENTER THE X SIZE RATIO : "),
cursor(X3,Y3),L3=Y3-3,field_attr(X3,3,L3,113),readreal(XR),
write(" ENTER THE Y SIZE RATIO : "),
cursor(X4,Y4),L4=Y4-3,field_attr(X4,3,L4,113),readreal(YR),
rad(PN,SN),removewindow(1,1),beep,
assertz(prop(PN,SN,N,XR,YR),area).
area_c(2):-makewindow(1,7,7,"",10,5,3,65),
write(" ENTER THE NAME OF THE Bid. TYPE : "),
cursor(X,Y),L=Y-3,field_attr(X,3,L,113),
readln(PN1),upper_lower(PN,PNT1),
write(" ENTER THE NAME OF THE PROJECT : "),
cursor(X1,Y1),L1=Y1-3,field_attr(X1,3,L1,31),
readln(SN1),upper_lower(SN,SN1),
write(" ENTER THE NAME OF THE ELE. NAME : "),
cursor(X2,Y2),L2=Y2-3,field_attr(X2,3,L2,112),
readln(N1),upper_lower(N,N1),
write(" ENTER THE X SIZE RATIO : "),
cursor(X3,Y3),L3=Y3-3,field_attr(X3,3,L3,113),readreal(XR),
write(" ENTER THE Y SIZE RATIO : "),
cursor(X4,Y4),L4=Y4-3,field_attr(X4,3,L4,113),readreal(YR),
prop(PN,SN,N,XR,YR),beep,beep,
displaying(PN,SN,N,XR,YR,"DELETED RECORDS"),
write("THIS DATA WILL BE ERASED" CONFIRM Y/N ?
),beep,
readchar(CH),upper_lower(CH1,CH),CH1=Y,
removewindow(1,1),!,retractall(prop(PN,SN,N,XR,YR),area).
area_c(3):-makewindow(1,7,7,"",10,5,3,65),
write(" ENTER THE NAME OF THE OLD Bid. TYPE : "),
cursor(X,Y),L=Y-3,field_attr(X,3,L,113),
readln(PN1),upper_lower(PN,PNT1),
write(" THE NAME OF THE NEW Bid. TYPE : "),
cursor(X1,Y1),L1=Y1-3,field_attr(X1,3,L1,31),
readln(SN1),upper_lower(SN,SN1),beep,beep,
displaying(PN,SN,N,XR,YR,"SELECTED RECORDS"),beep,
write("REPLACE THE Bid. TYPE NAME FOR THIS DATA"
CONFIRM Y/N ? ),
readchar(CH),upper_lower(CH1,CH),CH1=Y,
removewindow(1,1),!,replacing(PN,"",SN),
area_c(4):-makewindow(1,7,7,"",10,5,3,65),
write(" ENTER THE NAME OF THE Bid. TYPE : "),
cursor(X,Y),L=Y-3,field_attr(X,3,L,112),
readln(PN1),upper_lower(PN,PNT1),
write(" ENTER THE NAME OF THE OLD PROJECT : "),
cursor(X1,Y1),L1=Y1-3,field_attr(X1,3,L1,113),
readln(OSN1),upper_lower(OSN,OSN1),
write(" THE NAME OF THE NEW PROJECT : "),
cursor(X2,Y2),L2=Y2-3,field_attr(X2,3,L2,31),
readln(NSN1),upper_lower(NSN,NSN1),beep,beep,
displaying(PN,OSN,N,XR,YR,"SELECTED RECORDS"),beep,
write("REPLACE THE PROJECT NAME FOR THIS DATA"
CONFIRM Y/N ? ),
readchar(CH),upper_lower(CH1,CH),CH1=Y,
removewindow(1,1),!,replacing(PN,OSN,"",NSN),
area_c(5):-makewindow(1,7,7,"",10,5,3,65),
write(" ENTER THE NAME OF THE Bid. TYPE : "),
cursor(X,Y),L=Y-3,field_attr(X,3,L,113),
readln(PN1),upper_lower(PN,PNT1),
write(" ENTER THE NAME OF THE PROJECT : "),
cursor(X1,Y1),L1=Y1-3,field_attr(X1,3,L1,31),
readln(SN1),upper_lower(SN,SN1),
write(" ENTER THE NAME OF THE OLD ELE. : "),
cursor(X2,Y2),L2=Y2-3,field_attr(X2,3,L2,112),
readln(ON1),upper_lower(ON,ON1),
write(" THE NAME OF THE NEW ELE. NAME : "),
cursor(X3,Y3),L3=Y3-3,field_attr(X3,3,L3,31),
readln(NN1),upper_lower(NN,NN1),beep,beep,
displaying(PN,SN,ON,N,XR,YR,"SELECTED RECORDS"),beep,
write("REPLACE THE ELE. NAME FOR THIS DATA"
CONFIRM Y/N ? ),
readchar(CH),upper_lower(CH1,CH),CH1=Y,
removewindow(1,1),!,replacing(PN,SN,ON,NN),
area_c(6):-makewindow(1,7,7,"",10,5,3,65),
write(" ENTER THE NAME OF THE Bid. TYPE : "),
cursor(X,Y),L=Y-3,field_attr(X,3,L,113),
readln(PN1),upper_lower(PN,PNT1),
write(" ENTER THE NAME OF THE PROJECT : "),
cursor(X1,Y1),L1=Y1-3,field_attr(X1,3,L1,31),
readln(SN1),upper_lower(SN,SN1),
write(" ENTER THE NAME OF THE ELE. NAME : "),
cursor(X2,Y2),L2=Y2-3,field_attr(X2,3,L2,112),
readln(N1),upper_lower(N,N1),prop(PN,SN,N,XR,_),
write(" THE CURRENT X SIZE RATIO : "),XR,nl,
write(" THE NEW X SIZE RATIO : "),
cursor(X4,Y4),L4=Y4-3,field_attr(X4,3,L4,113),readreal(NXR),
beep,beep,displaying(PN,SN,N,XR,_,"SELECTED
RECORDS"),beep,
write("REPLACE THE X RATIO FOR THIS DATA" CONFIRM
Y/N ? ),
readchar(CH),upper_lower(CH1,CH),CH1=Y,
removewindow(1,1),!,replacing(PN,SN,N,XR,0,NXR),
area_c(7):-makewindow(1,7,7,"",10,5,3,65),
write(" ENTER THE NAME OF THE Bid. TYPE : "),
cursor(X,Y),L=Y-3,field_attr(X,3,L,113),
readln(PN1),upper_lower(PN,PNT1),
write(" ENTER THE NAME OF THE PROJECT : "),
cursor(X1,Y1),L1=Y1-3,field_attr(X1,3,L1,31),
readln(SN1),upper_lower(SN,SN1),
write(" ENTER THE NAME OF THE ELE. NAME : "),
cursor(X2,Y2),L2=Y2-3,field_attr(X2,3,L2,112),
readln(N1),upper_lower(N,N1),prop(PN,SN,N,_YR),
write(" THE CURRENT Y SIZE RATIO : "),YR,nl,
write(" THE NEW Y SIZE RATIO : "),
cursor(X4,Y4),L4=Y4-3,field_attr(X4,3,L4,113),readreal(NYR),
beep,beep,displaying(PN,SN,N,_YR,"SELECTED
RECORDS"),beep,
write("REPLACE THE Y RATIO FOR THIS DATA" CONFIRM
Y/N ? ),
readchar(CH),upper_lower(CH1,CH),CH1=Y,
removewindow(1,1),!,replacing(PN,SN,N,0,YR,NYR),
area_c(8):-makewindow(1,7,7,"",10,15,10,55),
cursor(1,2),write(" 1- DISPLAY ALL
),
cursor(2,2),write(" 2- DISPLAY FOR Bid. TYPE NAME
),
cursor(3,2),write(" 3- DISPLAY FOR PROJECT NAME
),
cursor(4,2),write(" 4- DISPLAY FOR ELE. NAME
),
cursor(5,2),write(" 5- DISPLAY FOR X & Y SIZE RATIO
),
cursor(6,2),write(" 6- EXIT
),
write(" ENTER YOUR CHOICE (1-6) : "),readln(DO),
scr_attr(1,0,0),cursor(1,0),
field_attr(1,2,37,113),!,fda.

area_c(_):-!,beep,clearwindow,
write(" OPERATION CANCELED ! "),
readchar(_),removewindow(1,1),
replacing(PN,"",NPN)-PN<-NPN,PROP(PN,SN,N,X,Y),
retractall(prop(PN,SN,N,X,Y),area),

```

```
GLOBAL_D
/* global.pro */
global domains
name=symbol
xsize,ysize,sangle,eangle=real
file=dat;ram;ram1;dat1;area
n= integer
list=integer
ROW, COL, LEN, ATTR = INTEGER
STRINGLIST = STRING*
INTEGERLIST = INTEGER*
KEY = cr, esc; break; tab; btab; del; bdel; ctrlbdel; ins;
end; home; fkey(INTEGER); up; down; left; right;
ctrlleft; ctrlright; ctrlend; ctrlhome; pgup; pgdn;
ctrlpgup; ctrlpgdn; char(CHAR); otherspec

constants
pi=3.141592653
global database
head(symbol,symbol)
ele(integer)
element(integer,name,xsize,ysize,sangle,eangle,real)
relation(integer,integer,real)
counter(integer,real)
sorter(integer,name,xsize,ysize,sangle,eangle,real,integer)
sorter1(integer,name,xsize,ysize,sangle,eangle,real,integer)
```

```

data(integer,integer,integer,integer,integer)
data1(real,real,real,real)
data2(real,real,real,real,string)
position(real,real,real,real)
xmax(real,real,real,real)
ymax(real,real,real,real)
xmin(real,real,real,real)
ymin(real,real,real,real)
mdistance(real)
edist(integer,integer,real,real)
scale(REAL)
tv(integer,real)
report(name,integer,integer,xsize,ysize,sangle,eangle,real,real)
total(real)
tcost(real)
cost(string,real)
margin(real)
GLOBAL database - area
prop(symbol,symbol,symbol,symbol,real,real)
global predicates
nondetem drow
drow1(string,char) - (i,i)
start
ed_data(string) - (i)
readkey(KEY) - (o,i)
choice(KEY) - (i)
ed(integer,string) - (i,i)
ins_obj
dd
c_r(integer) - (i)
sorting(integer,integer) - (i,i)
sort(integer) - (i)
ff(integer,integer) - (i,i)
ssr
/*check_angle(real,real,real,real,real,real) - (i,i,i,i,i,i)*/
error(string) - (i)
menu
rpt1
proportion(real,real,symbol,symbol,symbol,symbol) - (o,o,i,i,i,o)
area_prop(string) - (i)
editor

```

MENU_1

```

project "MOH"
include "global_d.pro"

```

PREDICATES

```

ff(integer,integer)*/
CLAUSES

```

```

ff(X,Y):-X>=23,!,Y>78,!,
ff(_78):-cursor(X,_),!,X1=X+1,ff(X1,0),
ff(X,Y):-cursor(X,Y),Y1=Y+1,
scr_char(X,Y,1178),
ff(X,Y1).

```

goal

```

makewindow(1,4,4,"0,0,25,80,1,0,"1178|178|178|178|178|178"),
ff(0,0),
makewindow(4,48,0,"2,12,5,80"),
makewindow(3,30,0,"1,10,5,80"),
write("int COMPUTER APPLICATIONS IN ARCHITECTURE"),
write("int K.B.S. & A.I. IN ARCHITECTURAL DESIGN"),
write("int ARCH. ASHRAF GAFAR /1993 ").*/

```

RPT_D

```

project "MOH"
include "global_d.pro"
predicates

```

```

rr

```

```

rpt

```

```

rr1

```

```

cang(real,real)

```

```

print(char,string)

```

```

clauses

```

```

rr- report(N,A,B,XS,YS,DIS,ANG),cang(ANG,ANG1),
sorter(No,N,XS,YS,S,E,H_),cost(N,C),
write("n %4",No),
write(" %10",N),
write(" %5.2f %5.2f XS,YS),
write("t %5.0f %5.0f S,E),write(" %6.2",C),
write(" %7.2",H),
AREA=XS*YS,cost(N,COST),
write(" %4",No),
write(" %10",N),
write(" %6.2",AREA),scale(SC),Ax=round(A/SC),By=round(B/SC),
DIS1=DIS*COST/SC,
write(" %4, %4",Ax,By),
ABx=round((A-319)/SC),ABY=round((B-239)/SC),
write(" %4, %4",ABx,ABY),
write(" %4",ANG1),
write(" %7.2",DIS1),
retractall(sorter(No,N,XS,YS,S,E,H_)),retractall(cost(N,C)),
retractall(report(N,A,B,XS,YS,DIS,ANG)),
fail.
rr-!,write("n -----

```

```

cang(ANG,ANG1):-ANG<0,!,ANG1=ANG+360.

```

```

/* sorter(No,N,XS,YS,S,E,H_),cost(N,C),
report(N,A,B,XS,YS,DIS,ANG),ANG<0,ANG1=ANG+360,
write("n %4",No),
write(" %10",N),
write(" %5.2f %5.2f XS,YS),
write("t %5.0f %5.0f S,E),write(" %6.2",C),
write(" %7.2",H),
AREA=XS*YS,cost(N,COST),
write(" %4",No),
write(" %10",N),
write(" %6.2",AREA),scale(SC),Ax=round(A/SC),By=round(B/SC),
DIS1=DIS*COST/SC,
write(" %4, %4",Ax,By),
ABx=round((A-319)/SC),ABY=round((B-239)/SC),
write(" %4, %4",ABx,ABY),
write(" %4",ANG1),
write(" %7.2",DIS1),
retractall(sorter(No,N,XS,YS,S,E,H_)),retractall(cost(N,C)),
retractall(report(N,A,B,XS,YS,DIS,ANG)). */
cang(ANG,ANG1):-!,ANG1=ANG.

```

```

ssr- makewindow(1,7,7,"10,5,5,65"),
dir("","dro",STR,1,1,1),
removewindow(1,1),
consult(STR),concat(STG,"DRO",STR),
concat(STG,"RPT",RRR),
makewindow(10,11,7,"9,5,4,15,0,0,"2011|87|2001|88|2051|86"),
scale(SC),write("n SCALEin ",SC),
makewindow(11,7,7,"9,27,4,25,0,0,"2011|87|2001|88|2051|86"),
write("n FILEin ",STG),
makewindow(12,9,7,"9,60,4,15,0,0,"2011|87|2001|88|2051|86"),
ele(Xg),write("n NO OF ELE in ",Xg),
makewindow(1,7,7,"15,0,10,80"),openwrite(ram,RRR),
writedevic(ram),
write("intintint COMPUTER APPLICATIONS IN
ARCHITECTURE",
write("intintint FACULTY OF ENGINEERING / ZAGAZIG
UNIVERSITY",
write("intintint ARCH. ASHRAF GAAFAR 5/3/1994 "),
write("intintint YASMIN ver. 4.1 ln"),
write("intintint -----ln"),
write("intintint GENERAL REPORT ln"),
write("intintint -----ln"),
write("intintint FILE : ",STG),nl,nl,
write("-----ln"),

```

```

write("t Bid. TYPEint PROJECTint NO. OF ELEt MARGIN
SIZEt SCALEln"),
write("-----ln"),

```

```

head(PN,SN),margin(M),!,
write("t %20t %20t PN,SN),write(" %5t %5t
%5ln",Xg,M,SC),
write("-----ln"),

```

```

/* concat(STG,"DAT",SSTG),file_str(SSTG,S),write(S),
write("-----ln"),
write("t ***** GENERAL LOCATION REPORT (ORIGIN) *****",
write("ln-----ln"),
write(" NAMEt SIZES AREA LOCATION ANGLEtH-
MOVEMENT"),
write("ln-----"),
write(" NO. NAMEt",write("X & Y SIZES"),
write("S-ANGLE E-ANGLE ",write("COST"),
write(" TOTAL RELATION ",write("NO. NAMEt",
write(" AREA LOCATION (ORIGIN) LOCATION (CENTER) ANGLE
H-MOVEMENT"),
write("ln-----"),
rr,
write("t ***** GENERAL LOCATION REPORT (CENTER) *****",
write("ln-----ln"),
write(" NAMEt SIZES AREA LOCATION ANGLEtH-
MOVEMENT"),
write("ln-----"),
rr1,write("ln-----
lnln"),*/

```

```

retractall(ele_),retractall(scale_),retractall(head_),retractall(cost_)
),

```

```

retractall(margin_),retractall(sorter(_)),retractall(data2_
_),

```

```

concat(STG,"YME",YME),consult(YME),
write(" *** ELEMENT DATA ***",
*** LOCATION DATA ***ln"),
write("-----ln"),

```

```

write("
LOCATIONln",
write("NO. NAME t",write("X & Y SIZES"),
write(" S & E ANGLES ",write(" COST"),
write(" T-REL ",write("NO. NAMEt",
write(" AREA (ORIGIN) (CENTER) ANGLE H-M ln"),
write("-----

```

```

rr,rpt.closefile(ram),file_str(RRR,SAS),
display(SAS),removewindow(1,1),removewindow(10,1),
removewindow(11,1),removewindow(12,1),

```



```

cursor(4,3).write(s3),
cursor(5,3).write(s4),
cursor(6,3).write(s5),
cursor(7,3).write(s6),
cursor(8,3).write(s7),field_attr(8,3,36,5),
cursor(9,3).write(s8),field_attr(9,3,36,3),
cursor(10,3).write(s9),field_attr(10,3,36,14),
cursor(11,3).write(s10),
scr_attr(2,0,0),cursor(2,0),
field_attr(2,3,36,113),
find.

find:field_attr(8,3,36,5),
field_attr(9,3,36,3),cursor(X,Y),
field_attr(10,3,36,14),field_attr(X,Y,39,113),
scr_attr(X,0,0),cursor(X,0),
readonly(K),choice(K),find.

find:-cursor(X_)C=X-1,removewindow(6,1),
removewindow(2,1),C>=10,
retractall(element(_)),
retractall(sorter(_)),
retractall(counter(_)),
retractall(relation(_)),
retractall(data(_)),
retractall(data1(_)),
retractall(data2(_)),
retractall(position(_)),
retractall(xmax(_)),
retractall(ymax(_)),
retractall(xmin(_)),
retractall(ymin(_)),
retractall(mdistance(_)),
retractall(edist(_)),
retractall(report(_)),
retractall(total(_)),
retractall(tcost(_)),
retractall(ele(_)),
retractall(cost(_)),
retractall(margin(_)),
retractall(head(_)),
retractall(prop(_),area),
retractall(scale(_)),do(C),menu.

find:-makewindow(1,110,7,"8,3,16,78),
write("\n THIS IS A PROGRAM FOR THE FIRST STAGE IN THE
PROCESS OF ARCHITECTURAL\n",
write(" DESIGN OF SINGLE STOREY PROJECTS [ SKETCH
DESIGN STAGE ] \n\n"),
write(" CRITERIA INVOLVED: \n"),
write(" 1- HORIZONTAL CIRCULATION.\n"),
write(" 2- CLIMATIC ORIENTATION.\n"),
write(" 3- VISUAL ORIENTATION.\n\n"),
write(" Arch. ASHRAF A. GAFAFAR \n"),
write(" DEPARTMENT OF ARCHITECTURE - SHOUBRA
FACULTY OF ENGINEERING\n"),
write(" ZAGAZIG UNIVERSITY - 108 SHOUBRA ST., SHOUBRA ,
CAIRO , EGYPT. \n"),
write(" Tel. 202-2022310 202-846815 202-
847397\n"),
write(" HOME Tel. 202-2044559 Fax: 202-202-3336 Post Code :
11245),
readchar(_),removewindow(1,1),beep,
system("mode 80^0^_").exit.
choice(up):-cursor(X,Y),W=X-1,W>=2,(field_attr(X,Y,39,7),
field_attr(W,Y,39,113),scr_attr(W,0,0),cursor(W,0).
choice(up):-cursor(X,Y),W=X-1,W<=2,(field_attr(X,Y,39,7),
field_attr(11,Y,39,113),scr_attr(11,0,0),cursor(11,0).
choice(down):-cursor(X,Y),W=X+1,W<=11,(field_attr(X,Y,39,7),
field_attr(W,Y,39,113),scr_attr(W,0,0),cursor(W,0).
choice(down):-cursor(X,Y),W=X+1,W>=11,(field_attr(X,Y,39,7),
field_attr(2,Y,39,113),scr_attr(2,0,0),cursor(2,0).
choice(cr):-!,fail.
choice(_):-beep.
do(1):-makewindow(1,7,7,"10,5,5,65),dir("",".kbs",STRING,1,1,1),
consult(STRING,area),removewindow(1,1),!,start,
save(STRING,area).

do(2):-makewindow(1,7,7,"10,5,5,65),!
write(" ENTER THE NAME OF THE STORED DATA FILE : "),
readln(STRING),!dir("",".YME",STRING,1,1,1),removewindow(1,1),
consult(STRING),editor!,save(STRING).

do(3):-!,makewindow(1,7,7,"10,5,5,65),!
write(" ENTER THE NAME OF THE STORED DATA FILE : "),
readln(STRING),!dir("",".YME",STRING,1,1,1),
consult(STRING),removewindow(1,1),
ed_data(STRING).

do(4):-makewindow(1,7,7,"10,5,5,65),
!write(" ENTER THE NAME OF THE STORED DATA FILE : "),
readln(STRING),!
dir("",".YME",STRING,1,1,1),
clearwindow,write(" PAUSE AFTER DROWING EACH ELEMENT
Y/N? ").
readchar(AZ1),upper_lower(AZ,AZ1),
consult(STRING),
removewindow(1,1),
drow,retractall(counter(_)),do,
retractall(sorter(_)),!,
assertz(counter(1,1)),concat(STG_,"YME",STRING).

```

```

trap(drow1(STG,AZ),_error(STG)),_removewindow(5,1),
removewindow(4,1),removewindow(3,1),
makewindow(5,8,8,"",0,0,25,80,1,0,"178\178\178\178\178\178"),
ff(0,0),
makewindow(4,48,0,"",2,12,5,60),
write("nlnlnlnlnlt YASMIN - ver. 4.1"),
makewindow(3,30,0,"",1,10,5,60),
write("nlt COMPUTER APPLICATIONS IN ARCHITECTURE"),
write("nlt FACULTY OF ENGINEERING / ZAGAZIG UNIVERSITY"),
write("nlt ARCH. ASHRAF GAAFAAR 5/3/1994").

do(5):-makewindow(1,7,7,"",10,5,5,65),
write(" ENTER THE NAME OF THE STORED DATA FILE :"),
readln(String),
dir(" ",YME,String,1,1,1),
consult(String),removewindow(1,1),
ins_obj.save(String),
do(6):-ssr,l,
do(7):-l,system(""),
do(8):-makewindow(1,7,7,"",10,5,5,65),dir(" ",kbs,String,1,1,1),
consult(String,area),removewindow(1,1),l,area_prop(String),
do(9):-makewindow(1,7,7,"",10,5,5,65),dir(" ",dro,String,1,1,1),
removewindow(1,1),

consult(String),concat(ST1,"DRO",String),concat(ST1,"SCR",ST),
openwrite(ram1,ST),writedevic(ram1),scale(SC),
XCENTER=640/SC,YCENTER=480/SC,PLS=319/SC-
0.125,YYC=239/SC,PLE=319/SC+0.125,

write("LIMITSn0,0n",XCENTER,"",YCENTER,"nZOOMnALLnPLIn",
PLS,"",YYC,"nWn0.25n0.25n",PLE,"",YYC,"nln"),
report(NAME,A,B,XS,YS,_,_,_,scale(SC),
X1=(A-SC*XS/2)/SC,Y1=(B-SC*YS/2)/SC,
X2=(A+SC*XS/2)/SC,Y2=(B+SC*YS/2)/SC,
write("RECTANGn"),
write(X1,"",Y1),nl,
write(X2,"",Y2),nl,
write("TEXT"),nl,
write("J"),nl,
write("M"),nl,AX=(A/SC),BY=(B/SC-YS/4),
write(AX,"",BY),nl,
write("0.5n0"),nl,
write(NAME),nl,rectall(report(NAME,A,B,XS,YS,_,_,_,scale(SC),
link,rectall(element(_)),
rectall(sorter(_)),
rectall(counter(_)),
rectall(relation(_)),
rectall(data(_)),
rectall(data1(_)),
rectall(data2(_)),
rectall(position(_)),
rectall(xmax(_)),
rectall(ymax(_)),
rectall(xmin(_)),
rectall(ymin(_)),
rectall(mdistance(_)),
rectall(edist(_)),
rectall(report(_)),
rectall(total(_)),
rectall(tcost(_)),
rectall(ele(_)),
rectall(cost(_)),
rectall(margin(_)),
rectall(head(_)),
rectall(prop(_),area),
rectall(scale(_),concat(ST1,"YME",STR2),consult(STR2),link1,
rectall(element(_)),
rectall(sorter(_)),
rectall(relation(_)),
rectall(data(_)),
rectall(data1(_)),
rectall(data2(_)),
rectall(position(_)),
rectall(xmax(_)),
rectall(ymax(_)),
rectall(xmin(_)),
rectall(ymin(_)),
rectall(mdistance(_)),
rectall(edist(_)),
rectall(report(_)),
rectall(cost(_)),
rectall(prop(_),area),l,XXC=319/SC,XXC=XXC+1,

write("MIRRTXTn0nMIRROrnALLnln",XXC,"",YYC,"n",XXC,"",YYC
,"nYnZOOMnElNnSAVEASn"),
write(ST1),write("npointn",XXC,"",YYC,"nquit"),
closefile(ram1),writedevic(screen),concat("ACADR12 SCRIPT
",ST1,AUTO),
DISK(K),disk("c:\"),system(AUTO,0,_),DISK(K),system("exit",1,_),
do(_):-makewindow(1,7,7,"",10,5,5,65),
write("n CANT PROCEED THIS OPERATION"),beep,
write("n PRESS ANY KEY TO CONTINUE"),readchar(_),
removewindow(1,1),menu,
link:- report(NAME,A,B,XS,YS,_,_,_,scale(SC),
X1=(A-SC*XS/2)/SC,Y1=(B-SC*YS/2)/SC,
X2=(A+SC*XS/2)/SC,Y2=(B+SC*YS/2)/SC,
write("RECTANGn"),
write(X1,"",Y1),nl,
write(X2,"",Y2),nl,
write("TEXT"),nl,

write("J"),nl,
write("M"),nl,AX=(A/SC),BY=(B/SC),
write(AX,"",BY),nl,
write("0.5n0"),nl,
write(NAME),nl,
fail,
link1:-l,
link1:-data2(XC,YC,XS,YS,NAME),scale(SC),
A=(319+SC*XC)/SC,B=(239+SC*YC)/SC,
X1=(A-SC*XS/2)/SC,Y1=(B-SC*YS/2)/SC,
X2=(A+SC*XS/2)/SC,Y2=(B+SC*YS/2)/SC,
write("RECTANGn"),
write(X1,"",Y1),nl,
write(X2,"",Y2),nl,
write("TEXT"),nl,
write("J"),nl,
write("M"),nl,
write(X1,"",Y1),nl,
write(X2,"",Y2),nl,
write(NAME),nl,
fail,
link1:-l,
goal
makewindow(5,64,64,"",0,0,25,80,1,0,"178\178\178\178\178\178"),
ff(0,0),makewindow(4,48,0,"",2,12,5,60),
write("nlnlnlnlnlt YASMIN - ver. 4.1"),
makewindow(3,30,0,"",1,10,5,60),
write("nlt COMPUTER APPLICATIONS IN ARCHITECTURE"),
write("nlt FACULTY OF ENGINEERING / ZAGAZIG UNIVERSITY"),
write("nlt ARCH. ASHRAF GAAFAAR 5/3/1994"),
menu,clearwindow,removewindow(5,1),clearwindow,
removewindow(4,1),clearwindow,
removewindow(3,1),system("mode 80",0,_),

PROP D
project "MOH"
include "global_d.pro"
PREDICATES
valid(symbol,symbol,symbol)
c_a(symbol,symbol,symbol,real,real,real)
clauses
proportion(XS,YS,N,PN,SN,M):-not(valid(PN,SN,N)),l,clearwindow,
write(" ENTER THE RIGHT NAME AS IN K.B.SYSTEM :"),
readln(NS1),upper_lower(NS,NS1),
proportion(XS,YS,N,PN,SN,NS):-valid(PN,SN,N),l,NS=N,
write("t ENTER THE AREA OF ELE. ( ",NS," ) m253 :"),
cursor(X,Y),L=Y-6,field_attr(X,5,L,113),
readreal(AREA),c_a(NS,SN,PN,AREA,XS,YS),

valid(PN,SN,N):-prop(PN,SN,N,_),l;
prop(PN,SN,N,_),l,
write(" THERE IS NO DATA FOR THIS ELE.
NAME"),beep,beep,beep,
readchar(_),clearwindow,write(" ARE YOU SURE THAT THE
NAME IS :"),
cursor(X1,Y1),str_len(N,L),write(N),field_attr(X1,Y1,L,79),
write(" Y/N?"),
readchar(ANS),upper_lower(AN,ANS),AN=Y,clearwindow,
write(" REM II ILL ADD THIS ELE. TO K.B.SYSTEM
"),beep,beep,
cursor(X2,Y2),L2=Y2-1,field_attr(X2,L2,79),
readchar(_),nl,
write(" ENTER THE X SIZE RATIO :"),
cursor(X3,Y3),L3=Y3-1,field_attr(X3,L3,113),
readreal(XR1),XR=abs(XR1),
nl,write(" ENTER THE Y SIZE RATIO :"),
cursor(X4,Y4),L4=Y4-1,field_attr(X4,L4,111),
readreal(YR1),YR=abs(YR1),
assertz(prop(PN,SN,N,XR,YR),area),
c_a(N,SN,PN,AREA,X,Y):-prop(PN,SN,N,XR,YR),l,X=sqrt(AREA*XR/YR),
Y=sqrt(AREA*YR/XR).

```

Figure 9. Containing the plugin program syntax code that links “El-Dars” Computational System with “AutoCAD Architecture Desktop” written in “Prolog” computer programming language. Ref.: [Research].

6. Recommendations

Using computer to help in the design process has been always one of the most architect's dreams, helping the later in the brain exhausting design process using computer intelligence is under extensive research. Some attempts take different approaches, one of them is parametric computer-generated architectural designs.

Although the latter is a recent attempt in the field, it still limited to introducing computational solutions related to building equilibrium and stability of the structure rather than creating a design concept from the scratch.

It is recommended to establish a collaborated research work arena gathering architects, engineers, software development companies, and engineering research centers to improve the implementation of artificial intelligence in the architectural design process.

7. Future Research Work

Recently, "Building Information Modeling" - commonly known as (BIM), is also a more sophisticated computer aided drafting application that offers computer generated engineering drawings, but this time associated with engineering information like technical specifications, bill of quantities, material specifications, project scheduling, and other related data.

The computer program script introduced in this paper is for the purpose of connecting "El Dars (AI) capacity" with Autodesk (AutoCAD Architecture Desktop), the reason for selecting "AutoCAD architecture desktop" software version and not the standard "AutoCAD" version, is that the former provides tasks similar to those executed by Autodesk "REVIT" while the latter is a "Building Information Modeling" technology; Autodesk (AutoCAD Architecture Desktop) is the basic foundation for the emerging of (BIM) software, specially "REVIT" operating on Microsoft windows system platforms.

The introduced computer program script in this paper may also connect with "REVIT", if the syntax code may be reformatted from "Prolog" into "Python" computer programming language. Since both are a "logical" based programming languages that creates "Artificial Intelligence" algorithms.

In general, python language is recommended for compilation because of its power and capacity to transfer the script from "Prolog" [12-15]

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