

# Tools for improving sustainability in buildings

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# Sustainability and Architecture

- Building's sustainability depends on the materials effects over the environment (and on its Life Cycle Assessment), But particularly it also depends on the emissions due to energy needs.
- Inside sustainable buildings energy needs must be reduced. However, comfort of its inhabitants should be maintained.
- To improve sustainability without reducing comfort levels architecture must be carefully designed, targeting several goals, like for instance:
  - heat comfort levels must be reached with a very high contribution of renewables energies;
  - light comfort levels must be reached, with a very high contribution of daylighting; etc.

# Methods for improving sustainability of buildings

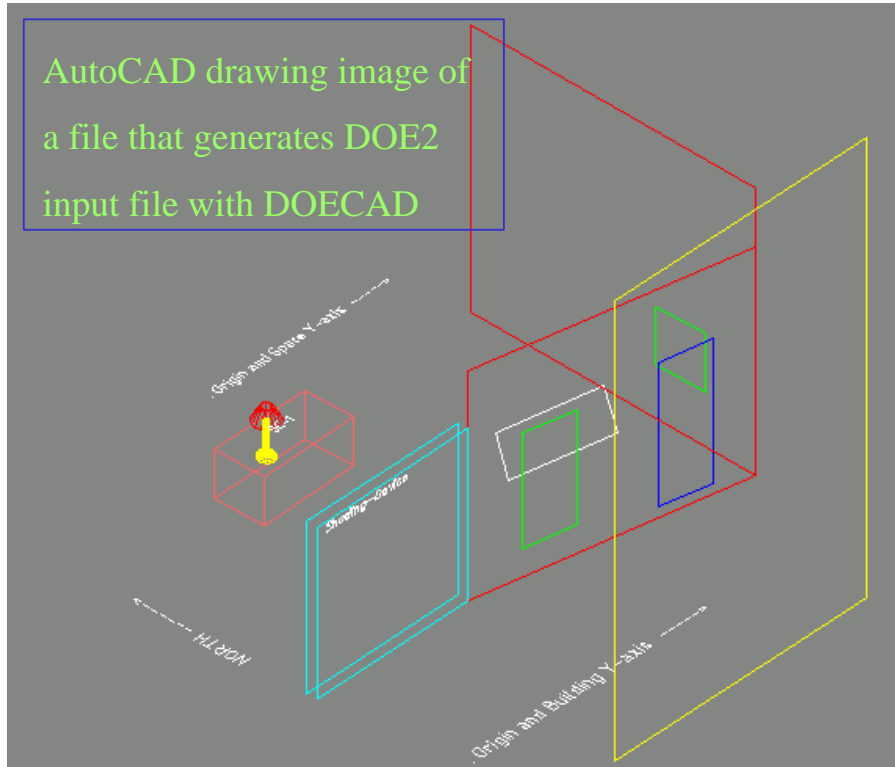
- There are several computer based methods that give information about building's performance, so that project developers can search for the better solution when designing a Building. For instance, DOE2, now EnergyPlus, or Radiance for daylighting evaluation;
- However, the tasks of evaluating building's performance is often, very much time expensive, and it is difficult to perform while the earlier designing decisions are taken.
- To improve this process,[I mean: that the good designing decisions can be take as much earlier as possible], several other softwares have been developed, and are still being developed [here in INETI-DER], like for instance:
  - Interface Software between Physics modulation and CAD programs;
  - Knowledge based systems based on Standards and National Code Rules;

# Developed Software

- **DOECAD** – An interface program between DOE2.1C and AutoCAD. Released in the VII Congresso Ibérico de Energia Solar, Vigo, 1994. ***“Utilização do Programa AutoCAD como ferramenta de apoio ao projecto e concepção de edifícios bioclimáticos”***. Proceedings Volume I, page 609;
- **An interface between Radiance and AutoCAD programs;**
- **RCTCAD** – An interface program between RCCTE (portuguese thermal code for buildings) and AutoCAD. Released in the VIII Congresso Ibérico de Energia Solar, Porto 1997. ***“Uma aplicação AutoCAD para utilização na regulamentação térmica de edifícios”***. Proceedings, page 383;
- **Expert System for the RCCTE code** – International Conference EPMESC VII (Enhancement and Promotion of Computational Methods in Engineering and Science), Macau 1999. ***“Development of a knowledge based system for the Portuguese code for thermal behaviour of buildings”***. Proceedings page 741;
- **Under development.** An AutoCAD independent program that includes all of these facilities.

# DOECAD

(AutoLISP based Program)



```

B-L      AZ=90  LAT=38.7  LON=9.1  ALT=77  ..

SOMBRA1=B-S  X=6.66  Y=5.97  Z=0
H=10  W=29.02
AZ=306.9  TILT=90
TR=0.1  S-SCH=HORARIO_SOMBRA  ..

SC-1=S-C  T=(18.0)  F-W=0
P-SCH=OCUP  N-O-P=1  P-H-G=100
L-SCH=ILUM  L-W-A=5.0  L-T=SUS-FLUOR
E-SCH=HOR-EQ  E-W-A=3.0  Z-TYPE=CONDITIONED
    
```

```

$ ---- ESPACO ESPACO-1 ---- $
ESPACO-1=S  X=-21.47  Y=2.36  Z=0
AZ=0  A=500  V=2500
S-C=SC-1  ..

PAREDE_DE=T-W-V  X=11.68  Y=-5.25  Z=0
H=3  W=6.67
TILT=90  AZ=90  CONS=BETAO_NORMAL
I-C=0.2  G-R=0.5  ..

PAREDE_DE_TR=WI  H=3  W=6.67
G-T=VIDRO_SIM
S-SCH=HOR-SOMB  C-SCH=CONDUT
M-S-SCH=RADIR  W-S-T=NO-SHADE
C-T-SCH=TEMPMIN  S-C-P=0.9  ..

PAREDE_EXTE=E-W  X=12.95  Y=6.57  Z=0
H=5  W=7.29  CONS=PAREDE-DUPLA11+15
AZ=0  TILT=90  S-S=YES  ..

PAREDE_EXTER=WI  H=1  W=1
X=1  Y=1
SETB=0.12  G-T=VIDRO-SIM  ..

PAREDE2=E-W  X=11.88  Y=1.41  Z=0
H=4  W=5.27  CONS=PAREDE-DUPLA11+15
AZ=101.75  TILT=90  S-S=YES  ..

PAREDE2-1=WI  H=2  W=1
X=1  Y=0.5
SETB=0.12  G-T=VIDRO-SIM
OH-A=0.5  OH-B=0.2
OH-D=0.7  OH-W=2  OH-ANG=30  ..

PAREDE2-2=DOOR  H=2.5  W=1
X=3.5  Y=0.2
SETB=0.12  CONS=MADEIRA  ..

COMPUTE LOADS ..
END ..
STOP ..
    
```

DOECAD output = text file to be used as DOE2.1C input

# Interface Program between Radiance and AutoCAD



redrawing...

done;

```
# Superficie 1 - PAREDE_REBOCO
PAREDE_REBOCO polygon Superf_1
0
0
12
4.25 1.77 3
4.25 1.77 0
4.25 4.16 0
4.25 4.16 3
```

```
# Superficie 2 - PAREDE_REBOCO
PAREDE_REBOCO polygon Superf_2
0
0
12
5.25 1.77 3
5.25 1.77 0
4.25 1.77 0
4.25 1.77 3
```

```
# Superficie 3 - PAREDE_REBOCO
PAREDE_REBOCO polygon Superf_3
0
0
12
0 1.62 3
0 1.62 0
5.25 1.62 0
5.25 1.62 3
```

# RCTCAD Program

## ◆ Interface between AutoCAD program and INETI's RCCTE program.

- Taking advantage of the same AutoCAD facility (of creating new AutoCAD commands), some AutoLISP “Macros” have been developed, to help defining a 3D drawing;
- RCCTE is a Solar Load Ratio based program that calculates the energy needs of a building and checks if that building fulfils the thermal code behaviour rules.
- As general application, such drawing must fulfil certain rules, that in this case are: grouping different construction elements inside different AutoCAD “Layers”;
- After defining every building surface, there is another AutoLisp command that performs the measurements needed to run RCCTE program.



# RctCAD program, (AutoLisp macros that )

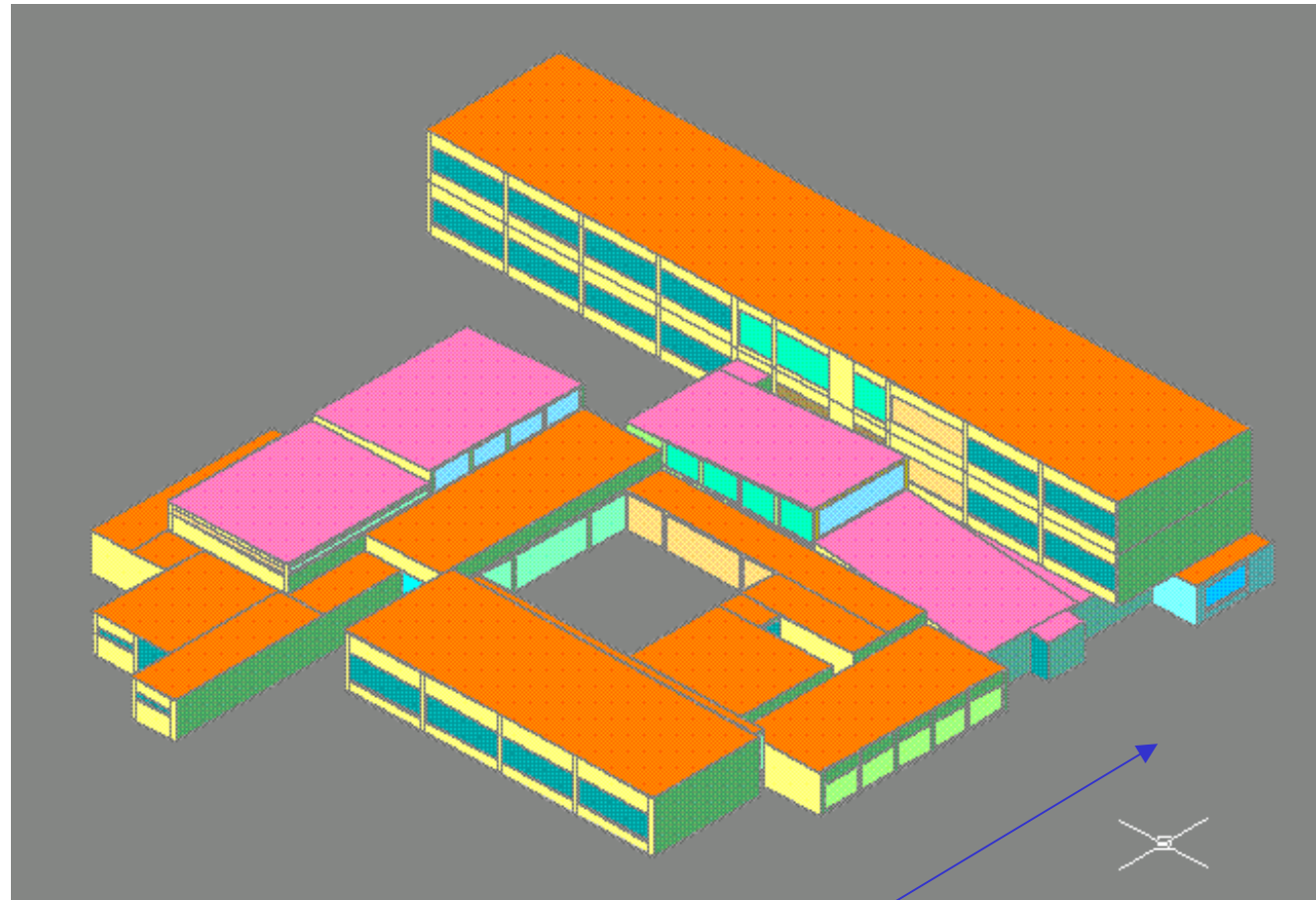
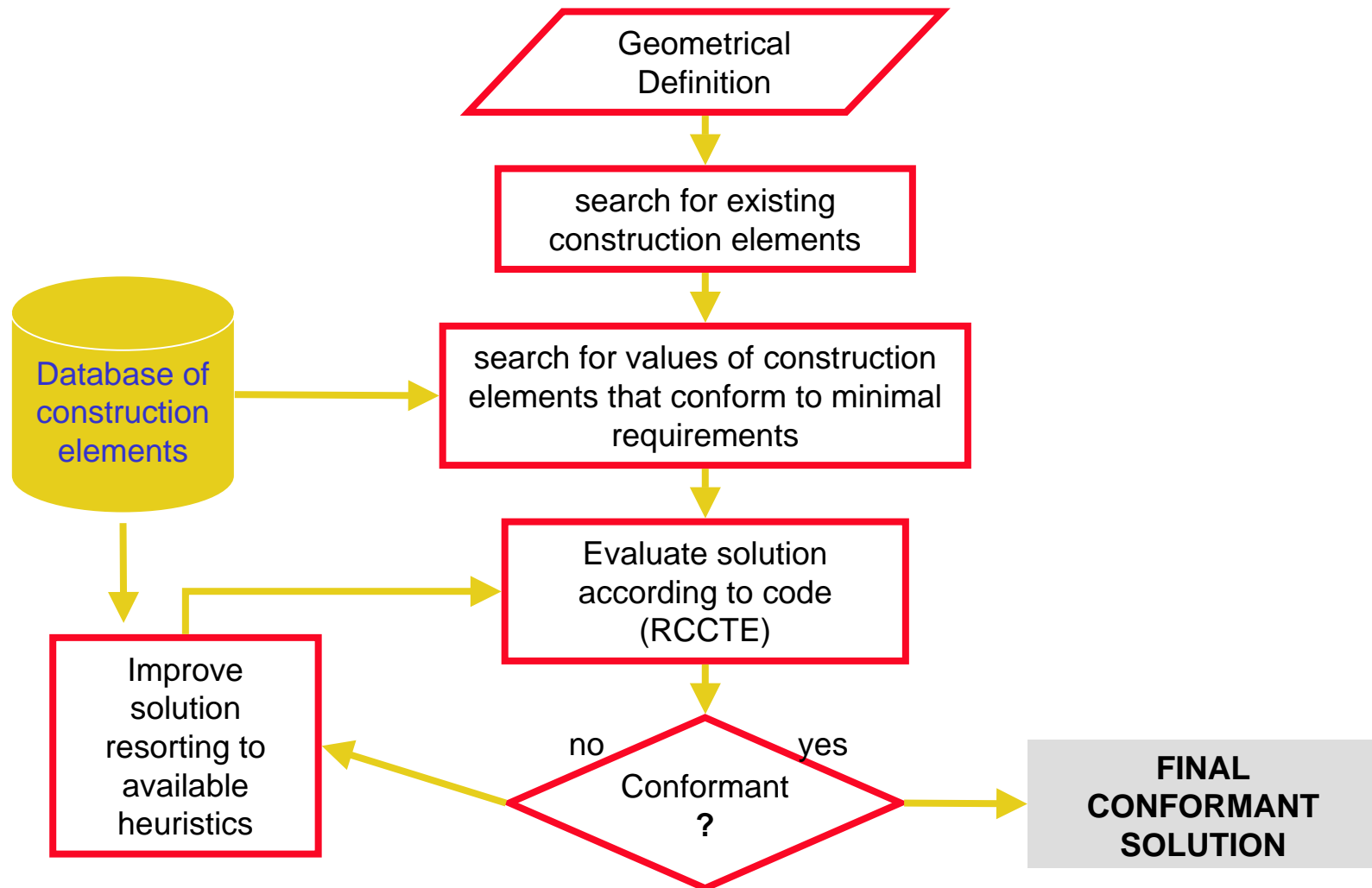


Image of user's Manual of RCTCAD program (ALTENER).

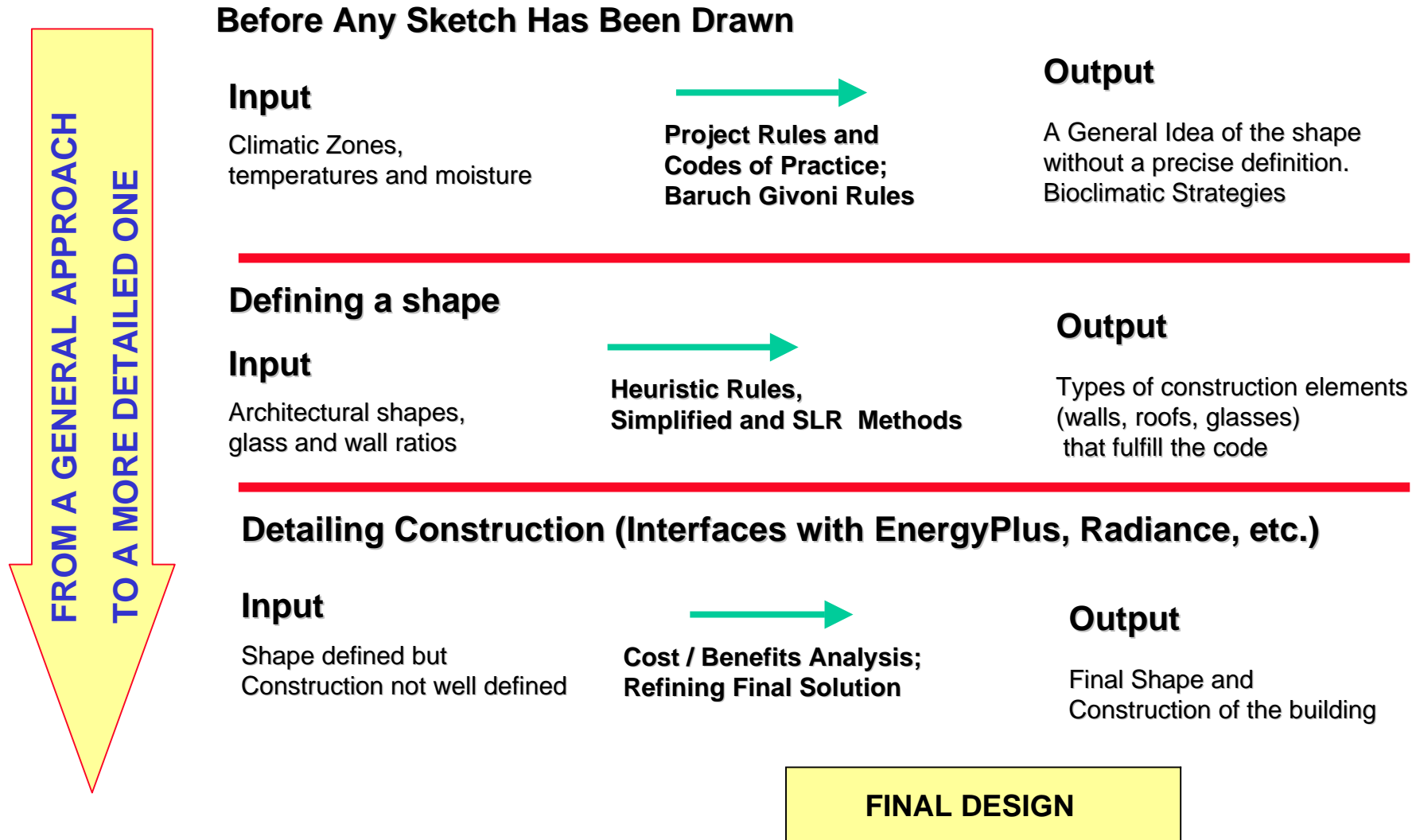
AutoCAD drawing built to run RctCAD program

# knowledge based system for the Portuguese code for thermal behaviour of buildings.

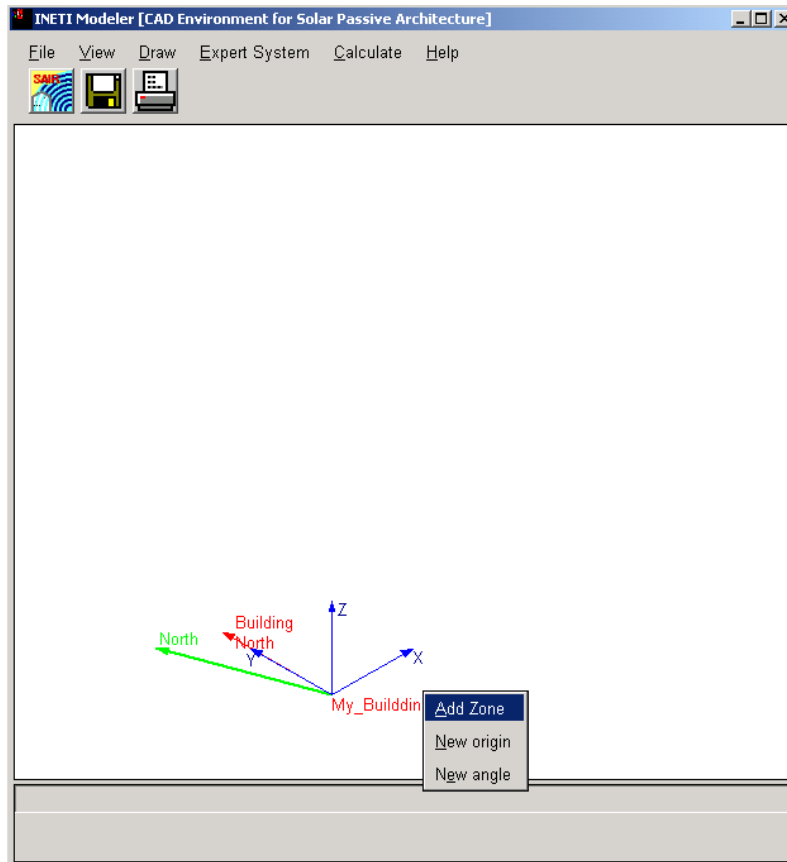
(Testing shape's thermal behaviour)



# Structure of a new system under development (Designing steps and software under development)

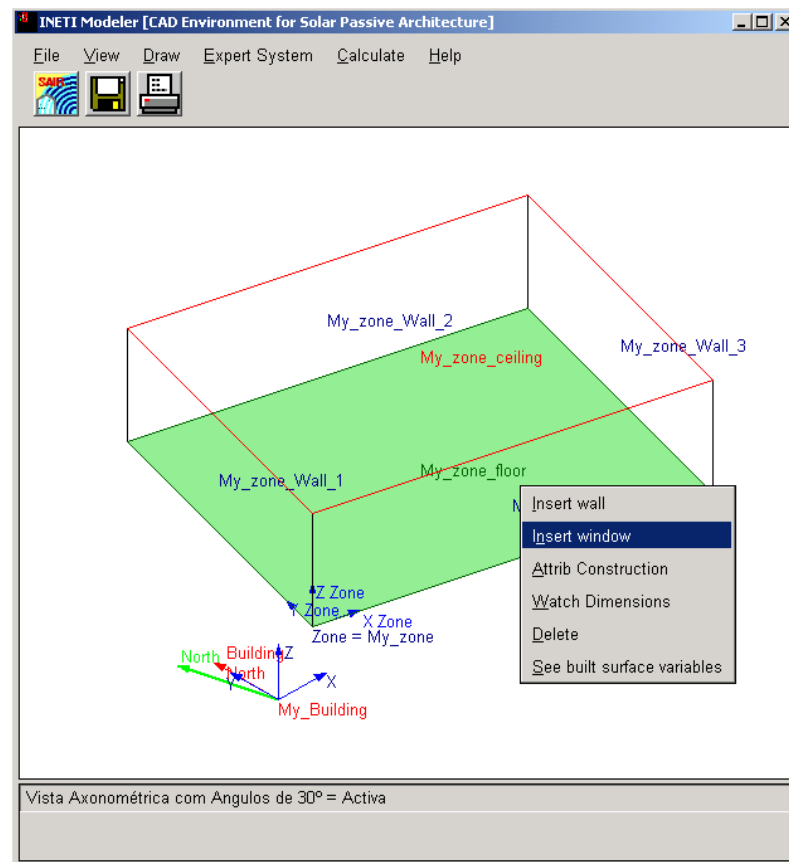
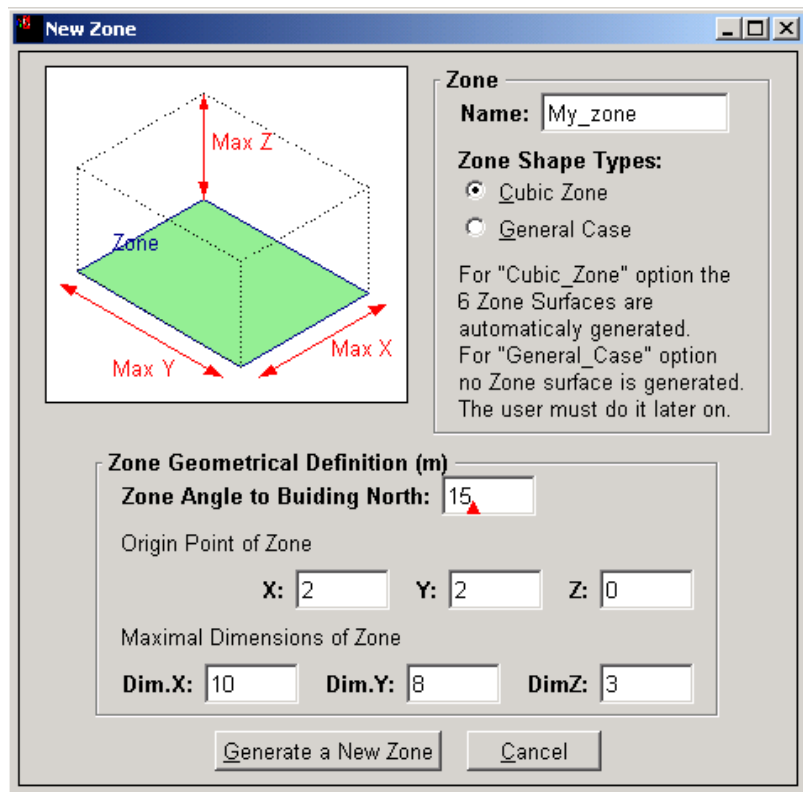


# The new system under development

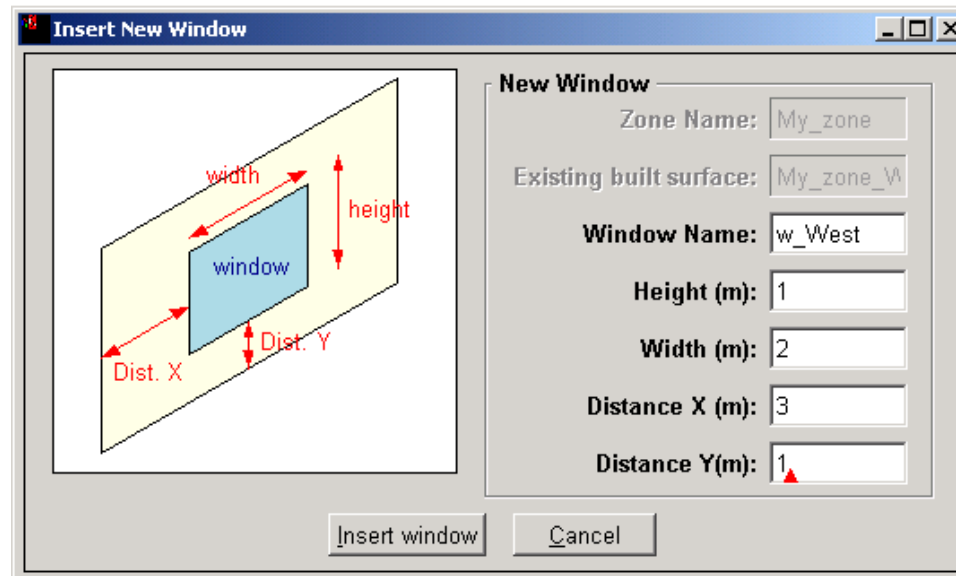
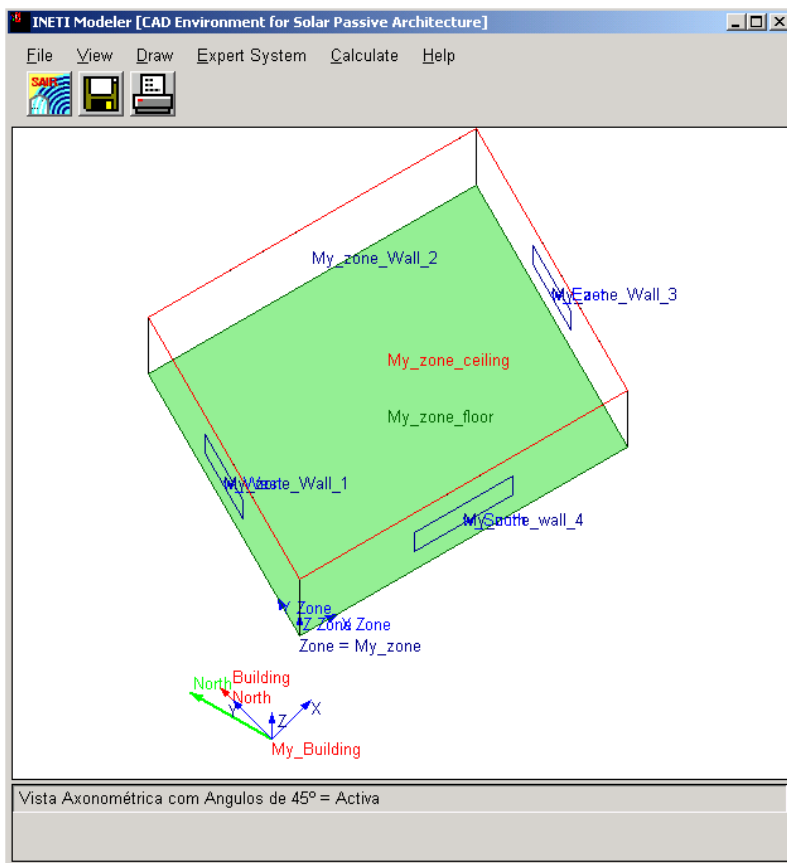


- Using the XPCE/SWI-Prolog Language a 3D Modeler Program is under development, including the following facilities:
  - Artificial Intelligence algorithms that perform searches to find the most convenient materials and shapes, that fulfil construction codes and rules of practice.
  - Measuring tasks facilities to support included algorithms;
  - Facility of generating input to other program like EnergyPlus, Radiance, and others [3D Interface].
- XPCE/SWI-Prolog, includes:
  - A Prolog interpreter;
  - XPCE module which is an Object Oriented based language to develop GUI applications.

# Creating a new Zone



# Inserting Windows inside Walls



# http://www.esim.ca



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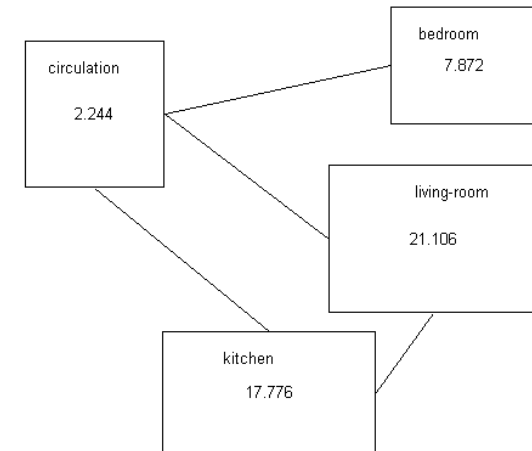
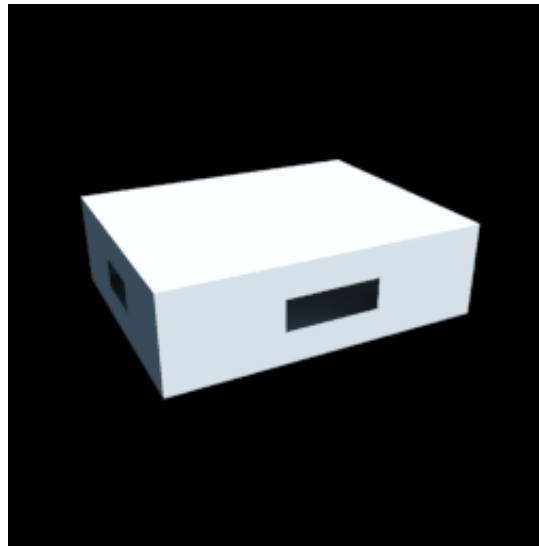
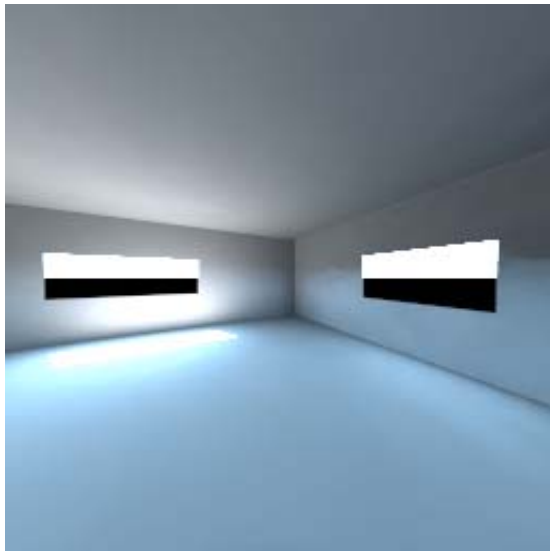
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# Future Developments



End

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