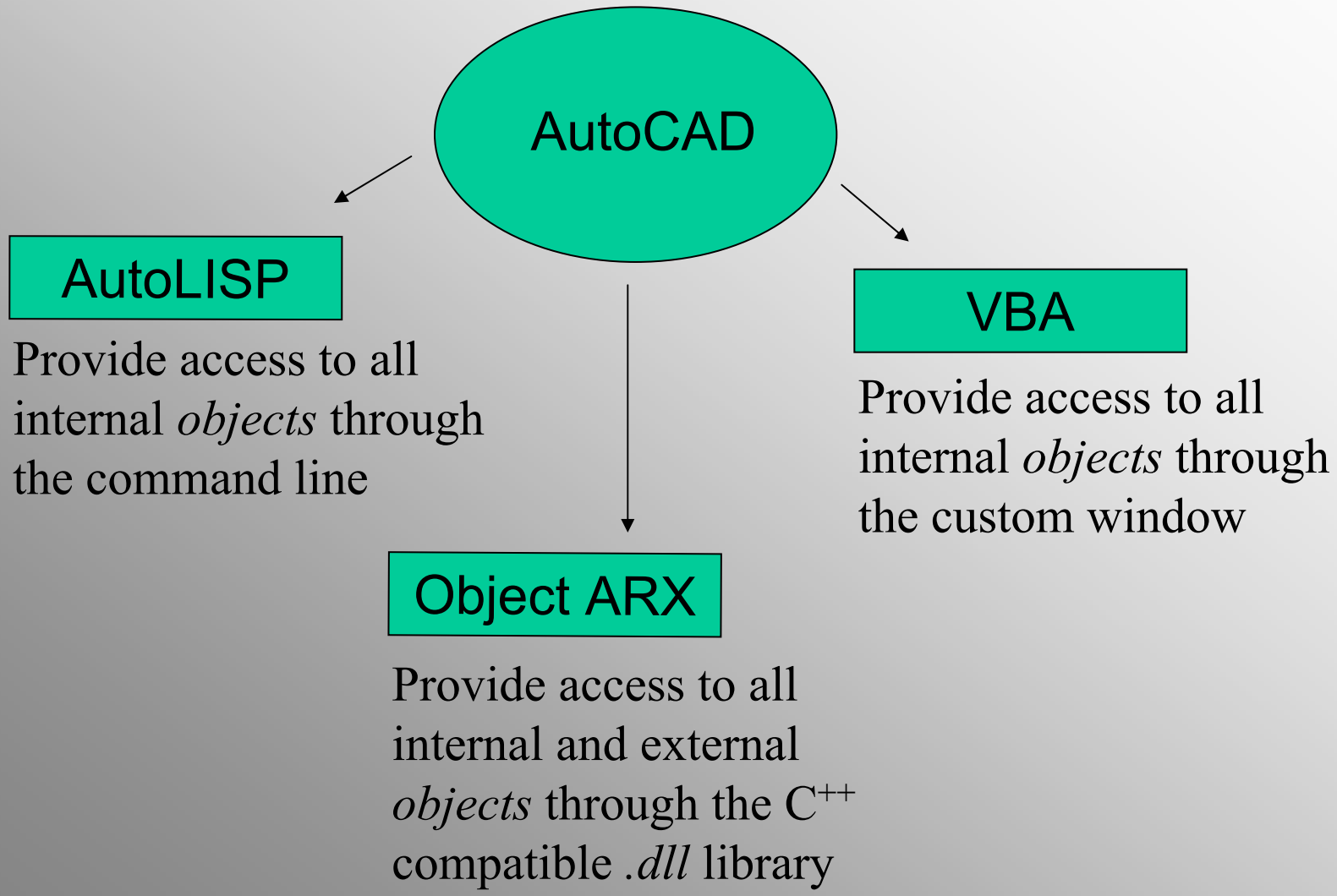
COMPUTER SYSTEM OF WALL DECORATION ON THE BASE OF PROGRAMMABLE DIRECT-X LIBRARY

Alex Sharmazanashvili

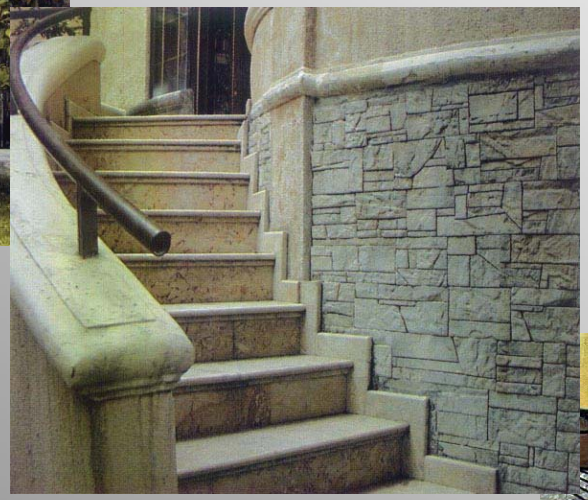
Dr Professor

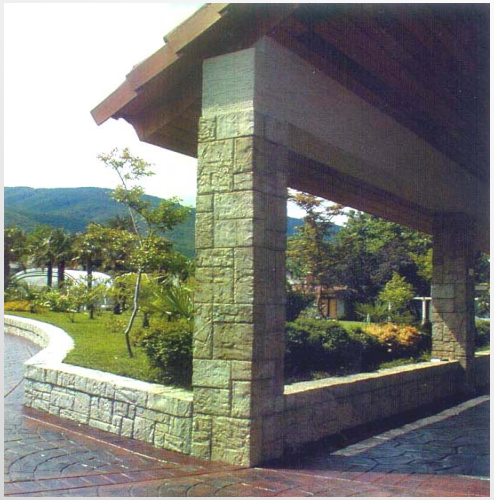
Georgian Technical University

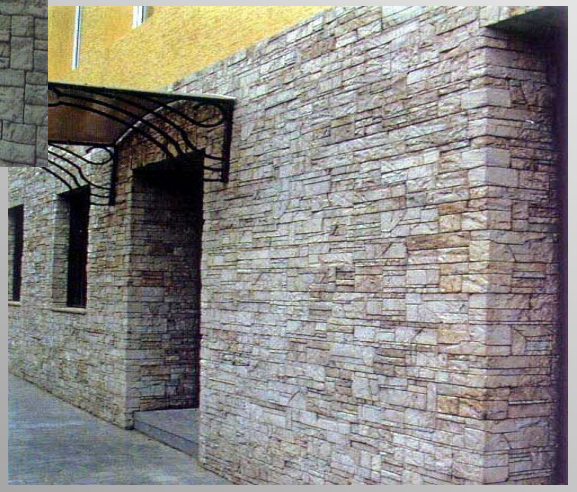
AutoDESK: *"AutoCAD now becomes a CAD programming engine"*



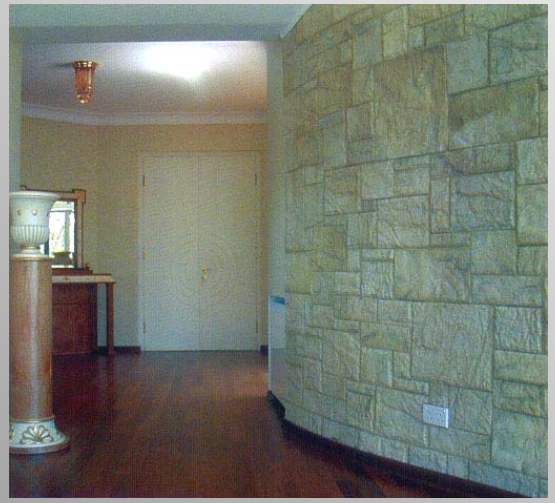
Customer Requirements







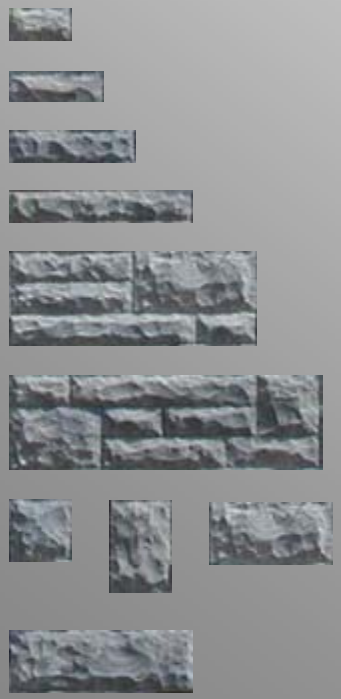
Customer Requirements



Conditions for Decoration

Array of Plates

"Tlili"

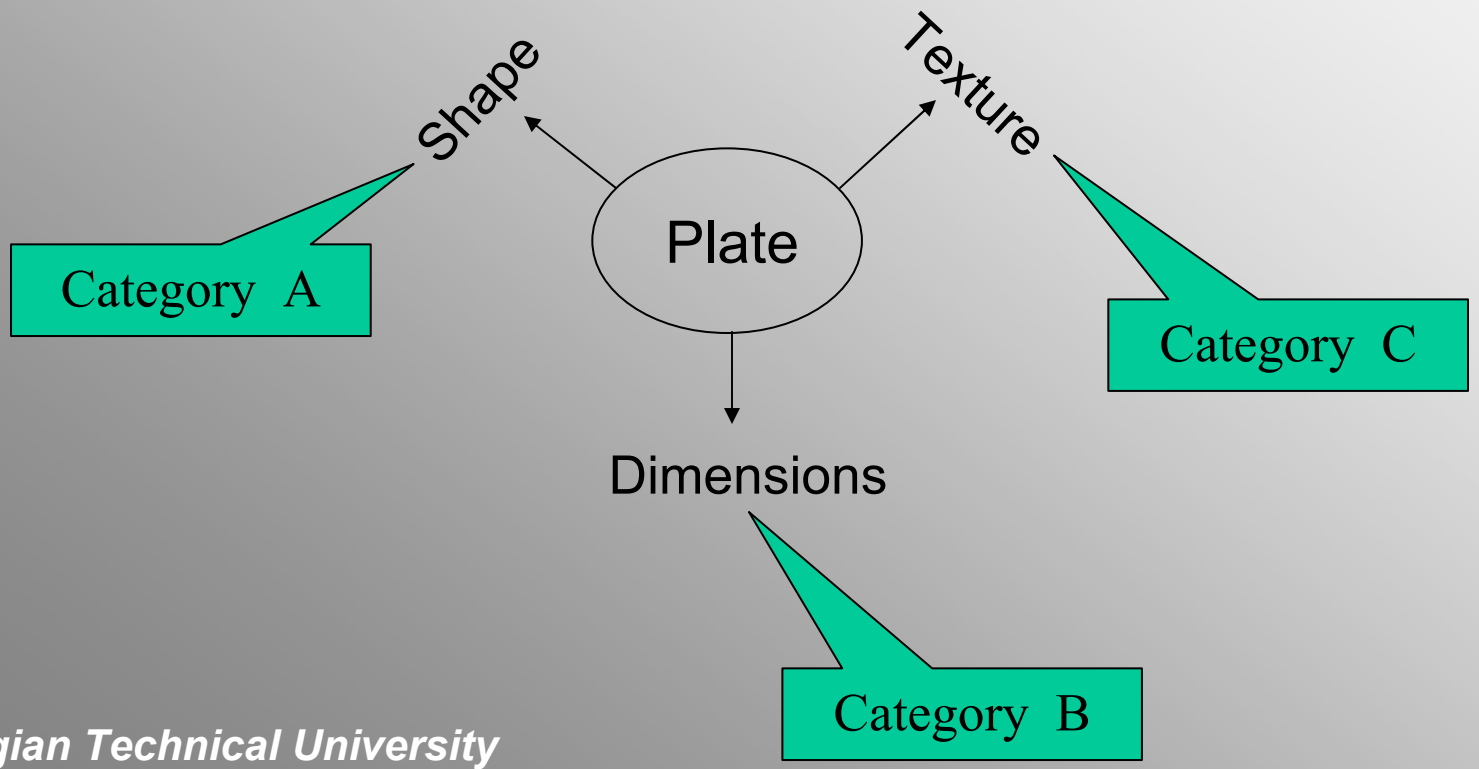


"Sasaxle"

"Sopeli"

Classes of Decoration Plates

Decoration Plates are characterized by 3 main features:



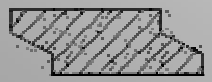
Classes of Decoration Plates

Category A

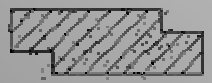
Representation of Shape

Class A_1 – rectangular

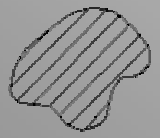
Class A_2 – non-rectangular



Class $A_{2\text{-}1}$ – A_2 with left-right edge#1



Class $A_{2\text{-}2}$ – A_2 with left-right edge#2



Class $A_{2\text{-}3}$ – A_2 with free form plates

Classes of Decoration Plates

Category B

Representation of Dimensions

Class B_1 – A_1 with free high and width

Class B_2 – A_1 with fixed high and free width

Class B_3 – $A_{2\text{-}1}$ with fixed high and free width

Class B_4 – $A_{2\text{-}2}$ with fixed high and free width

Class B_5 – $A_{2\text{-}3}$ with 18 different dimensions

Classes of Decoration Plates

Category B

Representation of Dimensions (continue)

Class B_{1-1} – B_1 with 13 different dim.

Class B_{1-2} – B_1 with 11 different dim.

Class B_{2-1} – B_2 with 2 different dim.

Class B_{2-2} – B_2 with 2 different dim.

Class B_{2-3} – B_2 with 3 different dim.

Class B_{3-1} – B_3 with 3 different dim.

Class B_{4-1} – B_4 with 1 different dim.

Classes of Decoration Plates

Category C

Representation of Texture

Class C_1 – “Sasaxle”, $B_{1\text{-}1}$ with 48 texture

Class C_2 – “Tlili”, $B_{1\text{-}2}$ with 38 texture

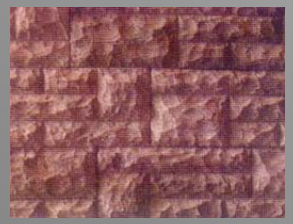
Class C_3 – “Meseri”, $B_{2\text{-}1}$ with 11 texture

Classes of Decoration Plates

Class C_4 – “Sopeli”, $B_{2\text{-}2}$ with 22 texture

Class C_5 – “Shatili”, $B_{2\text{-}3}$ with 17 texture

Class C_6 – “Eleganti”, $B_{3\text{-}1}$ with 27 texture

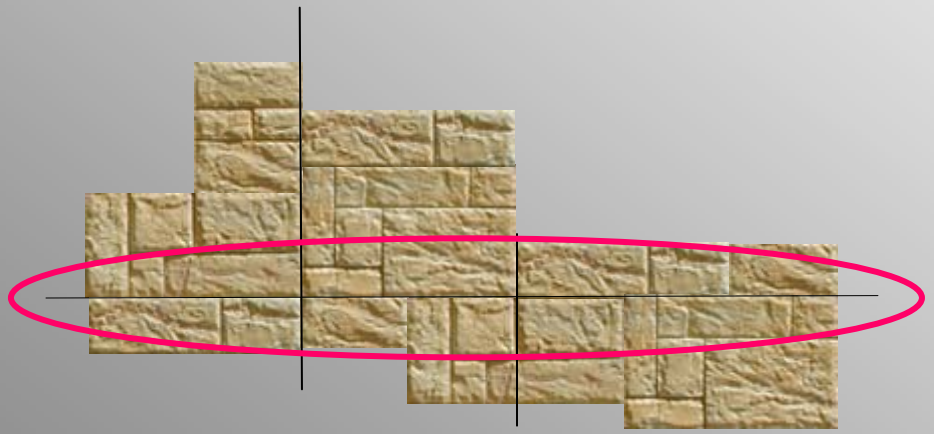


Class C_7 – “Pikali”, $B_{4\text{-}1}$ with 9 texture

Heuristic Rules of Decoration

Requirements: Receive composition with maximum natural vision

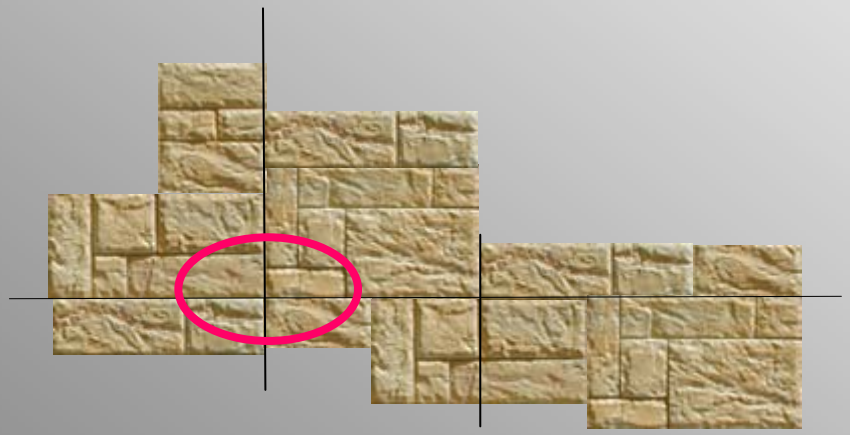
Rule#1: Minimize length of plates vertical and horizontal conjunction lines



Heuristic Rules of Decoration

Requirements: Receive composition with maximum natural vision

Rule#2: Minimize number of cross conjunctions



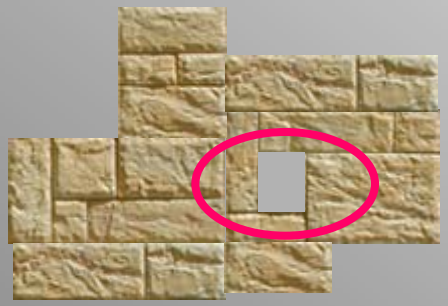
Heuristic Rules of Decoration

Requirements: Receive composition with maximum natural vision

Rule#3: Maximum randomization of plates

Rule#4: Minimize number of trimmed plates

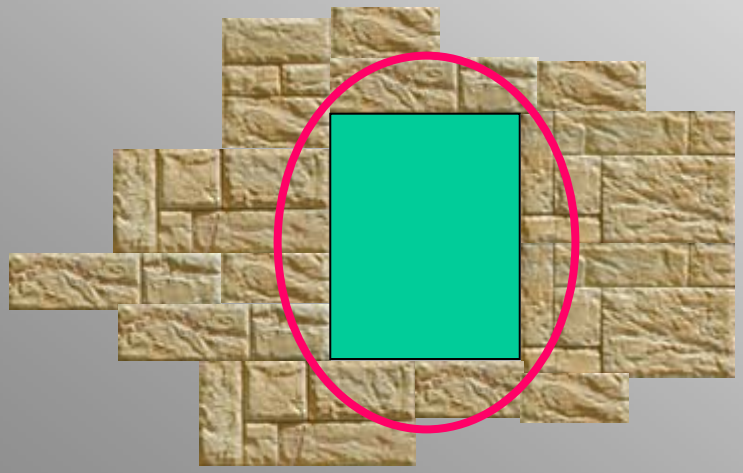
Rule#5: Minimize “black holes”, zones which are not covered by plate



Heuristic Rules of Decoration

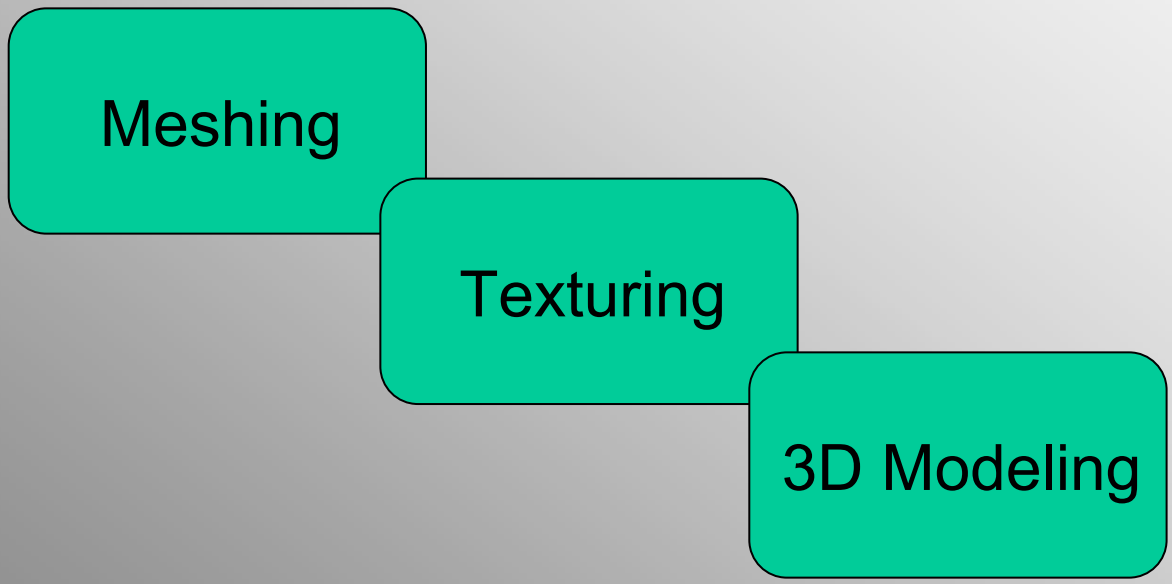
Requirements: Receive composition with maximum natural vision

Rule#6: Consideration of fixed plates – plates, which position is preliminary defined and unchangeable

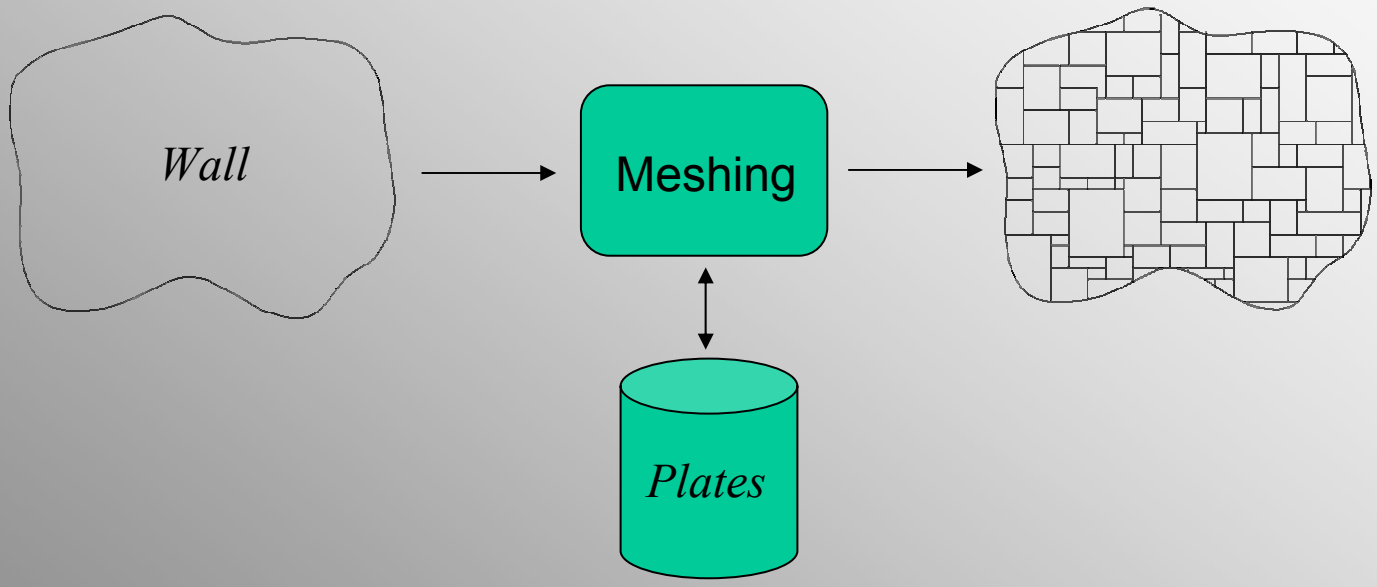


Consideration of Decoration Algorithm

Virtual decoration is carried out in 3 main steps:



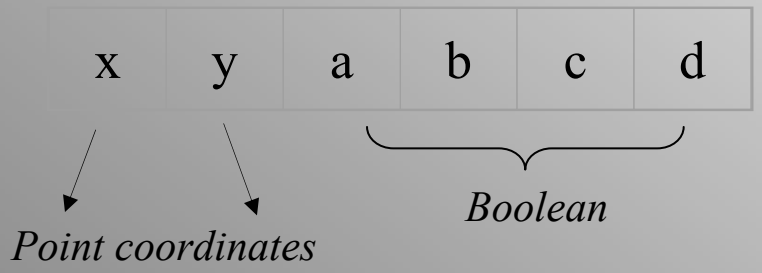
Meshing → Texturing → 3D Modeling

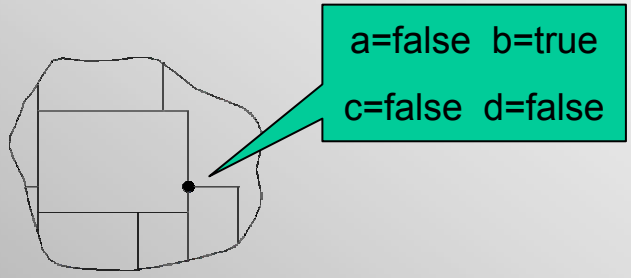


Meshing → Texturing → 3D Modeling

Two Objects permit to identify the current condition of meshing

Object “POINT” describes each point of plate in mesh



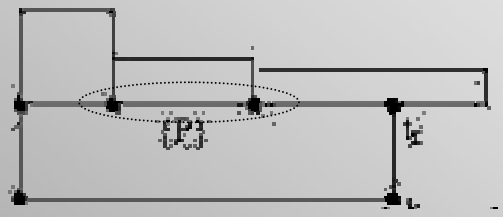


a	b
c	d

Meshing → Texturing → 3D Modeling

Object “STONE” describes each plate in mesh

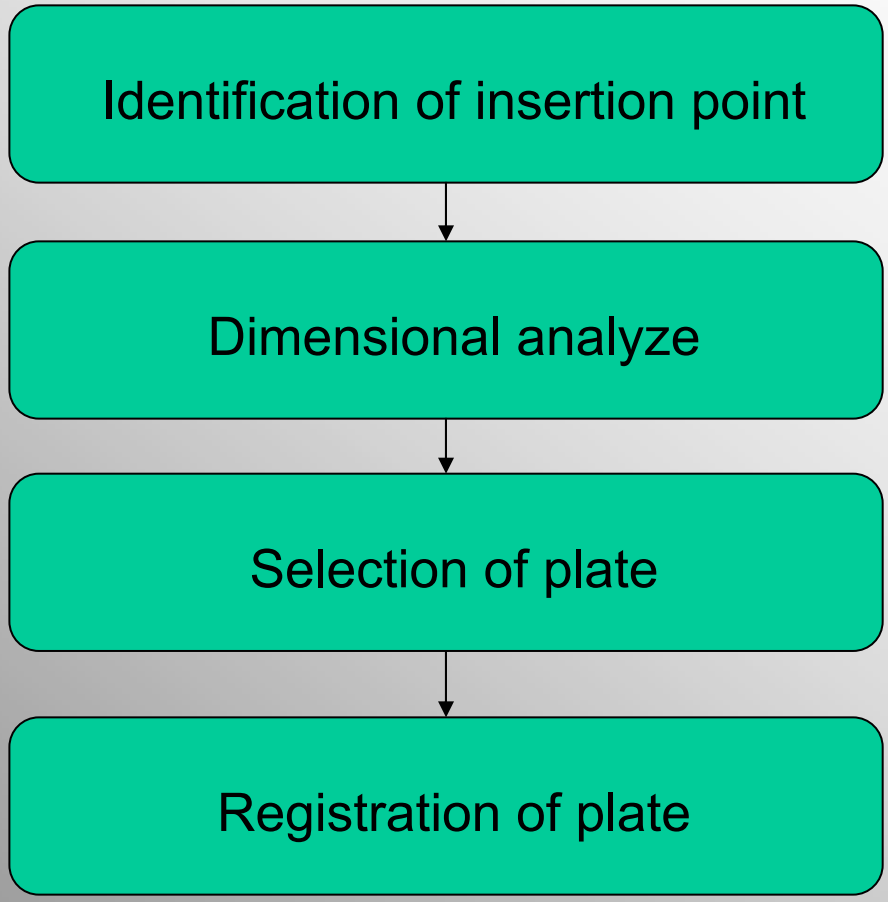
Id	t_l	t_r	b_l	b_r	{P}



Meshing → Texturing → 3D Modeling

Insertion is carried out in *four* main steps:

The meshing algorithm restricts plates combination according to heuristic rules and makes maximum randomization in rest of the cases.

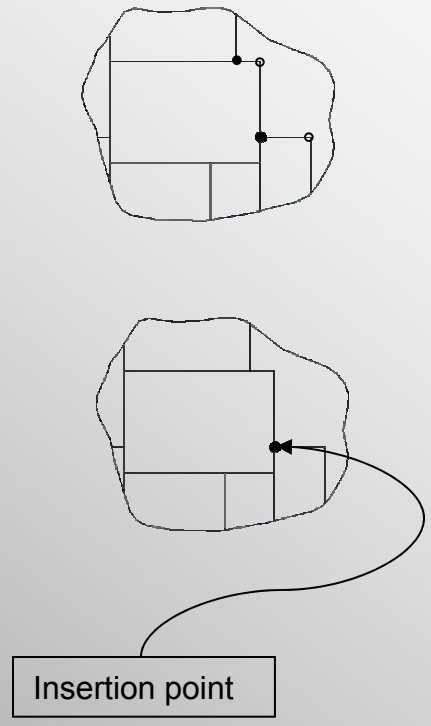


Meshing → Texturing → 3D Modeling

Identification of insertion point:

Selection of those points from the “stone” object which have only *one* free face

Selection of point which is nearest to the left button corner of the wall

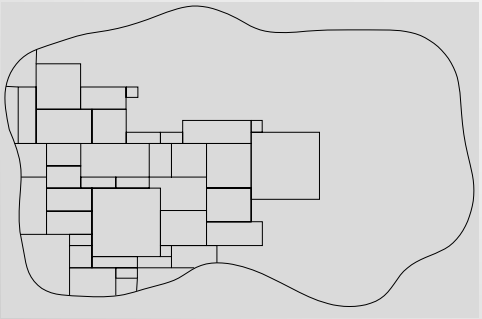


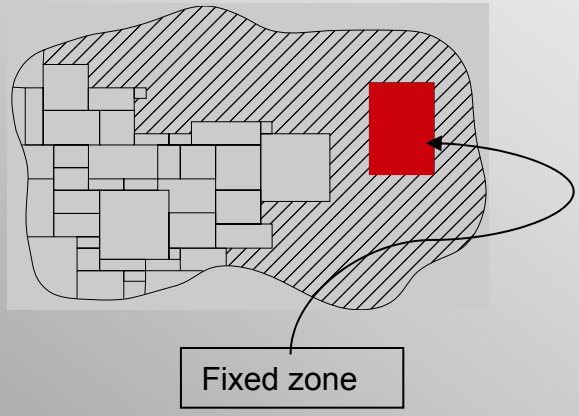
Meshing → Texturing → 3D Modeling

Within dimensional analyze unmeshed area with restricted zones are identified

Separation of full unmeshed area

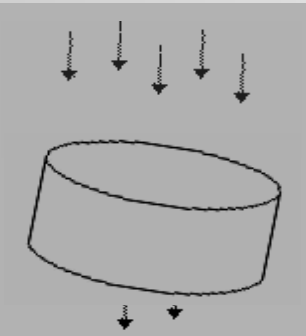
Identification of dimensional restrictions according to rule#6





Meshing → Texturing → 3D Modeling

Selection of new plate is carried out in *three* steps:



I. Exception

II. Separation

Plates

III. Randomization

Meshing → Texturing → 3D Modeling

1st exception is done according to rule#3, while plates which are placed around the insertion point have not to be considered.

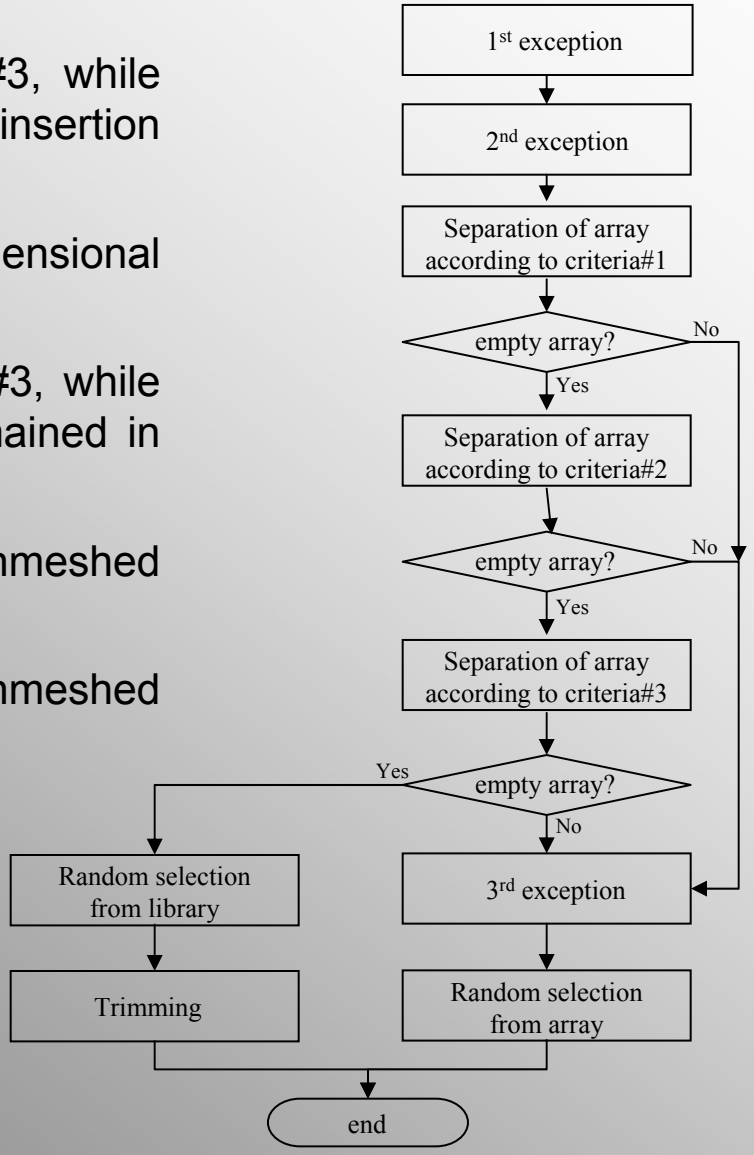
2nd exception is done in respect of dimensional restrictions coming from the rule#2.

3rd exception is done according to rule#3, while seldom-used plates have to be remained in selection

Criteria 1: Plates fully covered rest of unmeshed area

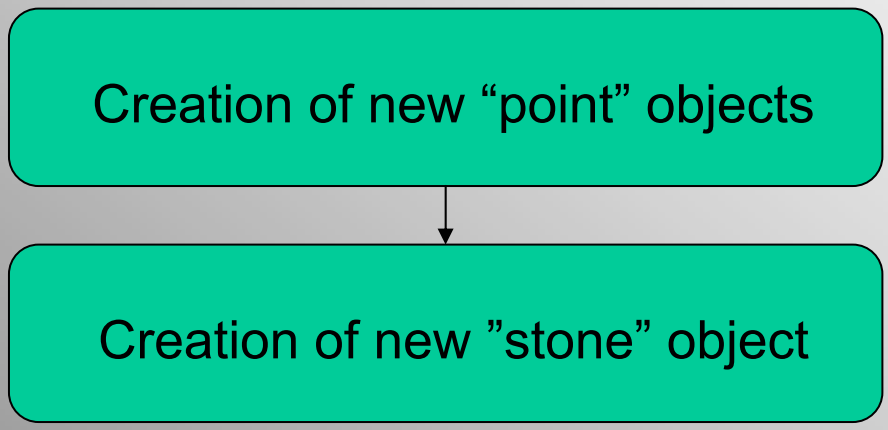
Criteria 2: Plates fully covered rest of unmeshed area along the *one* of the ***x*** or ***y***-axis

Criteria 3: Plates are shorter then rest of unmeshed area



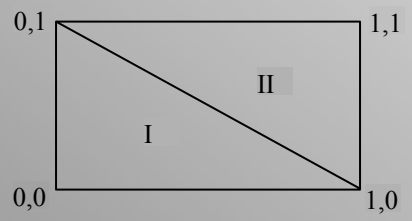
Meshing → Texturing → 3D Modeling

Registration is carried out in *two* main steps:



Meshing → Texturing → 3D Modeling

1. Random selection of texture for each plate from mesh
2. Representation of whole meshed wall as a one texture with its relative coordinates
3. Division of texture into triangles



Meshing → Texturing → 3D Modeling

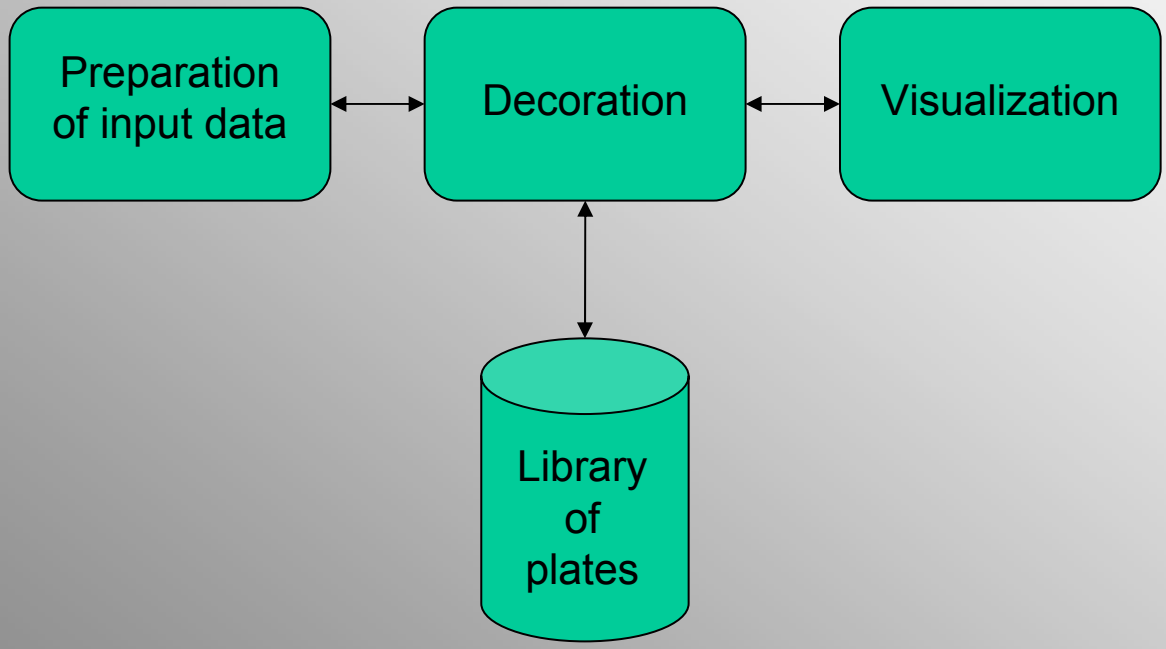
Selection of optimal resolution for DirectX

Recommended texture size for DirectX is 128x128 pixel
Max texture size is 1024x1024 pixel

Experimental results of modeling wall with dimensions 10m x 10m

Resolution	*Max. size of fragment*	*Number of fragments*	*Time for modeling (Pentium III processor)*
1 cm = 2 pixel	5m x 5m	4	48 sec
1 cm = 4 pixel	2.5m x 2.5m	16	192 sec
1 cm = 8 pixel	1.2m x 1.2m	64	768 sec

System Architecture



System Architecture – Input data Preparation Module

1. Identification of whole scene components
   - Number of walls
   - Floors
   - Columns
2. Scene composition
   - Definition of walls positions
   - Definition of columns positions and types
3. Identification of components geometry
   - Editing of walls dimensions
   - Definition of wall shapes
   - Editing of floor dimensions
   - Editing of columns dimensions
4. Selection of plates for the decoration of each component

System Architecture – Visualization Module

1. 3D visualization of whole scene by Direct X
2. Documentation
    - Creation of file representations
- Printing, mesh and 2D/3D models

Conclusions

1. Separation of restrictions, coming from the heuristic rules and possibilities for the maximum randomization of the solution have to be done in each case for creation of decoration algorithm
2. Considered algorithm can be used in the tasks of feature recognition in CAD
3. For the ordinary PC architecture, optimal solution of Direct X implementation is received for the resolution no more than 1 cm=4 pixel and texture size 1024 x 1024 pixel