Implementation of the MM into a Computer Code

The next step in the numerical solution of this static plate problem is the translation (& implementation) of this MM mathematical procedure into a workable computer code.

In matrix form, the MM approximated integral eqn. solution can be written as

$$[l_{mn}][\alpha_n] = [g_m]$$

The required data for a numerical sol'n is in the matrix $[l_{mn}]$ & the excitation vector $[g_m]$.

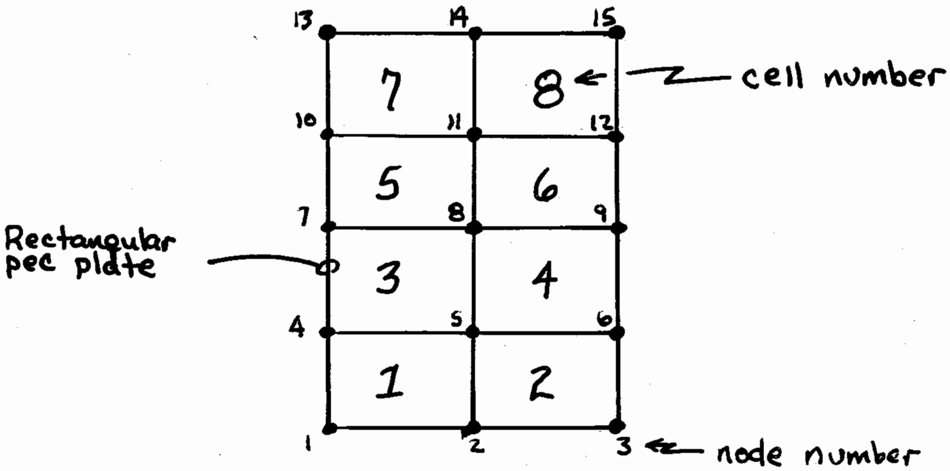
Referring back to the expressions derived earlier for l_{mn} and g_m it can be seen that, as far as this numerical sol'n is concerned, the only geometry information needed is:

(1) position vector of each node in the model,
&, (2) position vector of the centroid of each cell in the model.

For the g_m, only the applied potential is required.

These 3 quantities are the only pieces of information which must be supplied to the computer code.

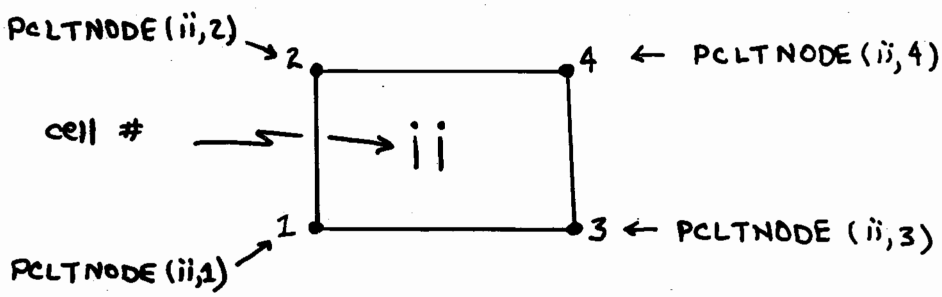
Take for example the model -



There are 8 cells (basis functions) and -

$$(\text{NUMXCELL} + 1)(\text{NUMYCELL} + 1) = \text{NNODES}$$

For a prototypical cell,



an integer array serves as a pointer from the cell # to the four nodes which define the cell. The numbering scheme shown here is used to define the array

[point cell to node] PCLTNODE (ii, 4)

More geometry data –

The <u>position vector</u> of each node in the model is stored in the array R(ii,2) where:
- R(ii,1) = x location of iith node
- R(ii,2) = y location of iith node.

The <u>centroid</u> of each cell is stored in the array RCENT(ii,2) using the same convention as for R.

We can use the position array and the pointer from cells to nodes to find the <u>absolute position</u> of a <u>relative node</u>. ⊛ <u>Assuming</u> the <u>basis function number</u> is designated by the <u>cell number</u>, then to obtain the x & y location of node 5 in the model on the previous page –

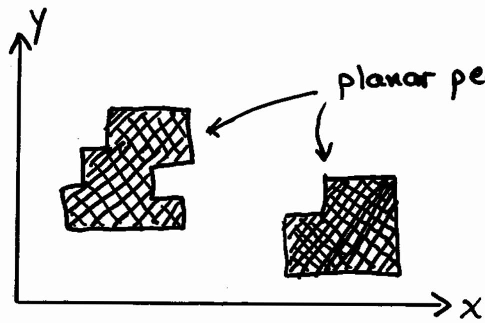
x location, node 5 = R(PCLTNODE(4,1),1)
y location, node 5 = R(PCLTNODE(4,1),2)

or/

x location, node 5 = R(PCLTNODE(2,2),1)
y location, node 5 = R(PCLTNODE(2,2),2)

⋮ etc...

At first glance, this methodology for geometry storage may seem redundant. In this example, it is! However, by organizing the main program in this fashion more general types of structures can <u>easily</u> be analyzed. For example, 2 plates both lying in the $z=0$ plane –



When writing a MM code, it is important to structure your program such that it can solve all types of geometries within the class of problems you are addressing.

Generality is the "name of the game."

A good Computational Electromagnetic analyst will construct his/her code in such a fashion so that only the geometry description varies from problem to problem rather than modifications to the main code.

For example:
- perforated plate
- multiple plates
- non rectangular geometries

} same code, different geometries.

A possible topology of codes which achieves this generality goal is –

1 program

Pre-processing

- Geometry input, dimensions
- Excitation specifications
- Basis fct. descritization density
- Generate MM model, pointers

STPLTGM1

These are provided for static plate example.

STPLATE1

Processing

- Geometry translation
- MM matrix fill
- Excitation vector fill
- Solve for unknowns
- calculate observables

The same program or two or more.

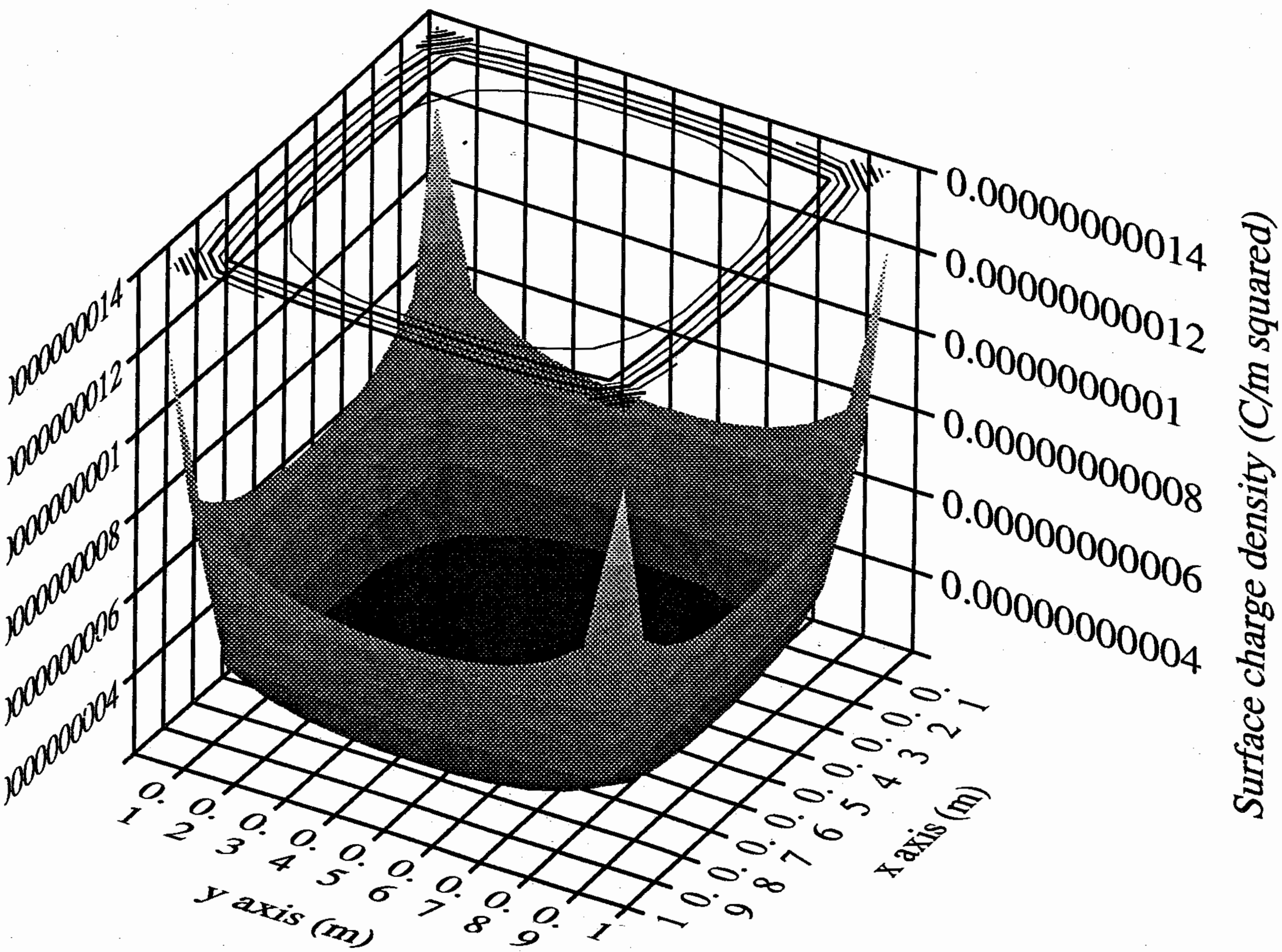
Post-processing

- Plot unknowns
- calculate other observables using output data from processing job.

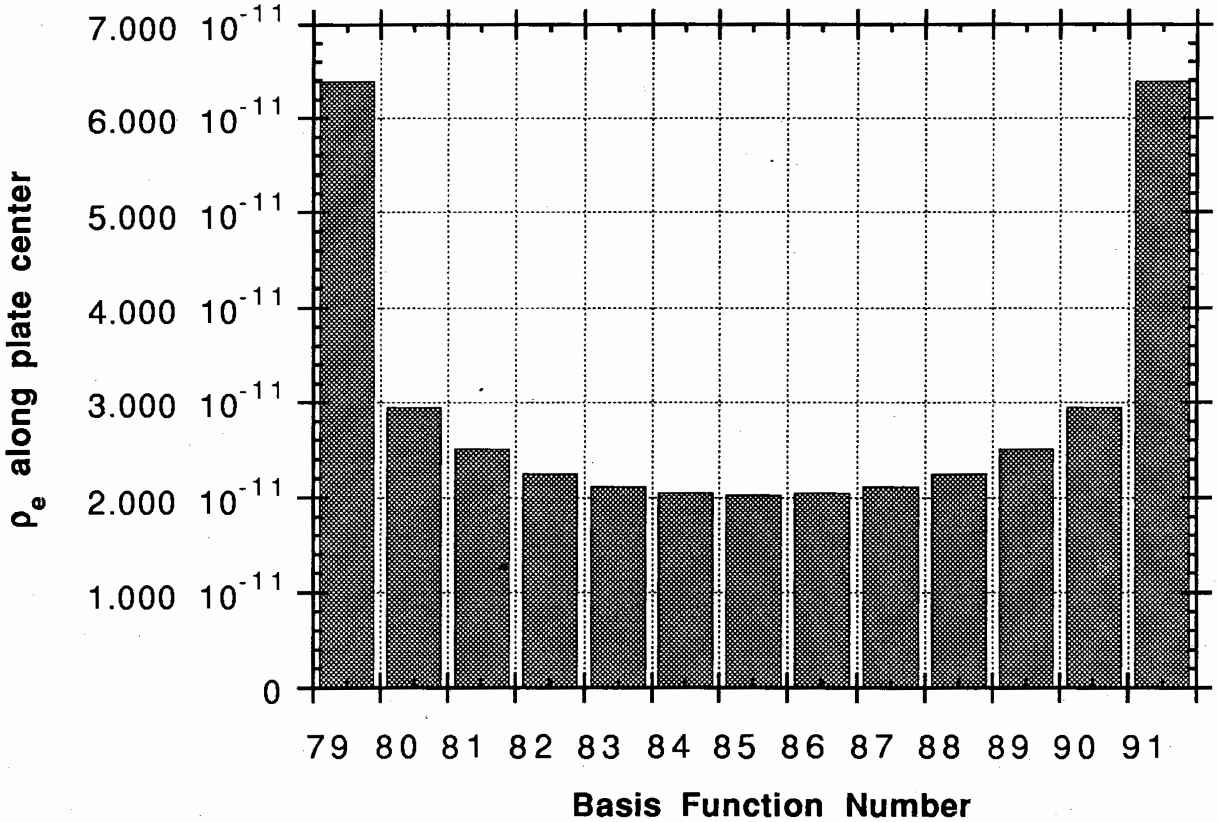
```
$ stpltgm1
 The plate is assumed to start at the origin and
 lies in the plane z=0

 Dimensions of the pec plate in the x and y?
  (in meters)
1.,1.
 Number of basis function cells in x and y?
13,13
$ timex stplate1
 Reading geometry input file SPGEOM.1  ....
    --> Number of basis functions =  169
 Impressed voltage on the plate (Volts)?
1.
 Computing MoM impedance matrix ....
 Solving for the current coefficients ....
 Capacitance =  3.97867E-11
  (total charge on plate =  3.97867E-11)
 Finished

real        10.75
user         6.48
sys          0.11
```



Approximate surface charge density on a square pec plate of dimensions 1x1 meter. The applied potential is 1 Volt. (Using MoM with 13x13 pulse basis functions.)



```
$ stpltgm1
 The plate is assumed to start at the origin and
 lies in the plane z=0

 Dimensions of the pec plate in the x and y?
  (in meters)
1.,1.
 Number of basis function cells in x and y?
3,3
$ stplate1
 Reading geometry input file SPGEOM.1  ....
    --> Number of basis functions =  9
 Impressed voltage on the plate (Volts)?
1
 Computing MoM impedance matrix ....
 Solving for the current coefficients ....
 Capacitance =  3.68384E-11
  (total charge on plate =  3.68384E-11)
 Finished
$ more stplate1.z
 1 1 1.05621E+10     self-cell
 1 2 3.10991E+09
 1 3 1.51320E+09
 1 4 3.10991E+09
 1 5 2.17113E+09
 1 6 1.35143E+09
 1 7 1.51320E+09
 1 8 1.35143E+09
 1 9 1.06498E+09
 2 1 3.10991E+09
 2 2 1.05621E+10     Self-cell
 2 3 3.10991E+09
 2 4 2.17113E+09
 2 5 3.10991E+09
 2 6 2.17113E+09
 2 7 1.35143E+09
 2 8 1.51320E+09
 2 9 1.35143E+09
 3 1 1.51321E+09
 3 2 3.10991E+09
 3 3 1.05621E+10     self-cell
 3 4 1.35142E+09
 3 5 2.17113E+09
 3 6 3.10991E+09
 3 7 1.06498E+09
 3 8 1.35142E+09
 3 9 1.51321E+09
 4 1 3.10991E+09
 4 2 2.17113E+09
 4 3 1.35143E+09
 4 4 1.05621E+10
```

l_{mn}

n = source basis #

m = o.b. basis #