



IRSES Project  
TUG - Graz, Austria  
June 2014



numsim  
Numerical simulation  
in technical sciences



# Computer Graphics for Engineering



**Luiz Fernando Martha**

**André Pereira**



# **Speakers**

A little bit about us...

# Research Group in Brazil



# About us...



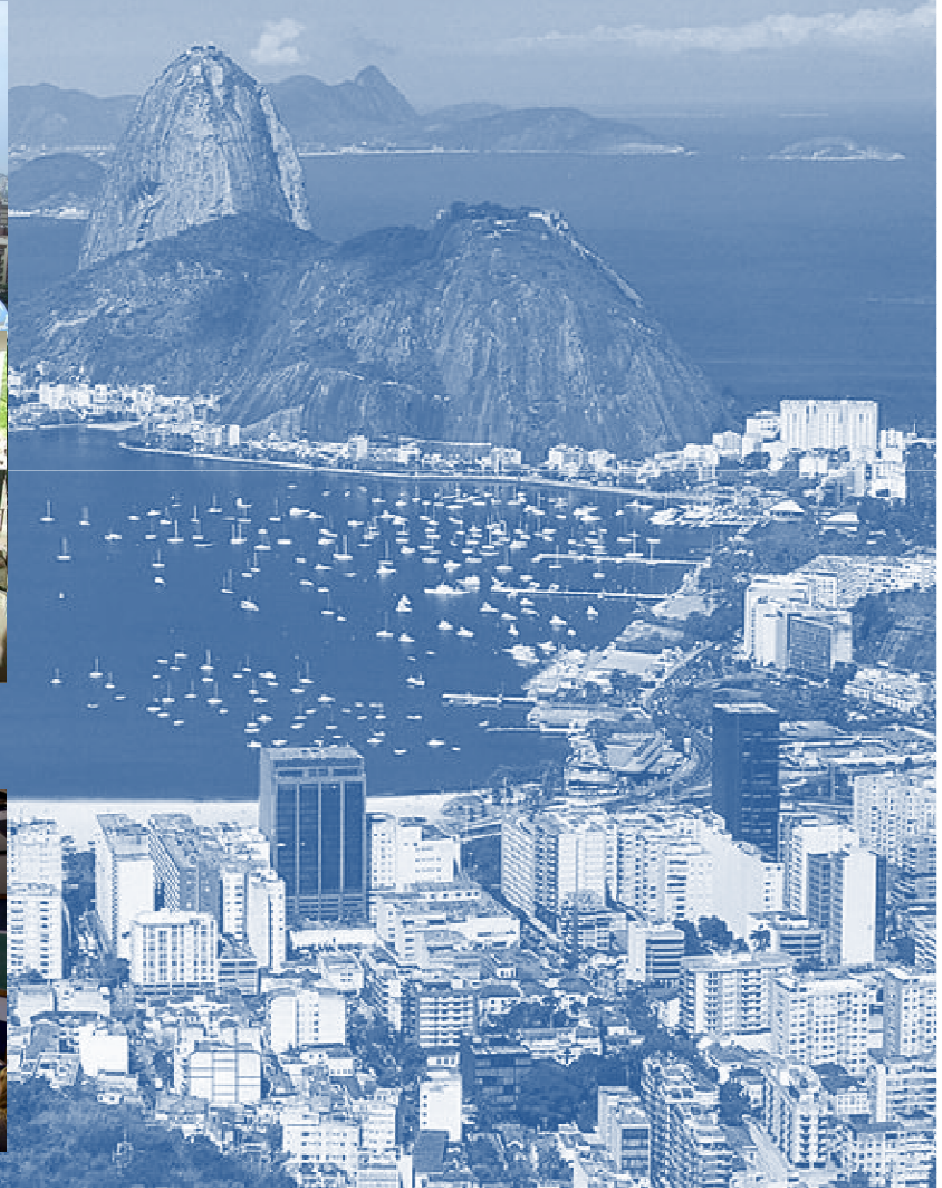


# About us...





# About us...





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# **Course**

## Schedule and Contents



# Course at TU Graz

1	MON 16/06	8:15 - 12:00	<ul style="list-style-type: none"><li>- Introduction to Computer Graphics for Engineering.</li><li>- Development Environment using QT. Development of a calculator with RPN in C/C++. Object Oriented Modeling of a calculator with RPN.</li><li>- Treatment of Colors. Two-dimensional Visualization with OpenGL. Standard/graphic library OpenGL.</li><li>- Programming in an event driven iterative graphical environment. Paradigms of signals &amp; slots of Qt. Geometric Transformation in 2D.</li></ul>
2	TUE 17/06	8:15 - 12:00	<ul style="list-style-type: none"><li>- Digital Representation of curves. Mouse Events on canvas.</li><li>- Introduction to Computational Geometry. Tessellation of 2D regions. Predicates of computational geometry: proximity tests e points inclusion. Algorithms for line-line intersections. Exact and Adaptive arithmetic.</li><li>- Geometric Modeling (2-manifold and non-manifold). Topological data structures. Half-edge data structure.</li></ul>
3	WED 18/06	8:15 - 12:00	<ul style="list-style-type: none"><li>- Finite element mesh generation: mapping algorithms, advancing front and Delaunay triangulation. Management of modeling attributes.</li><li>- Computational simulations with finite and boundary elements. Introducing a 2D modeler with mesh generation and attributes.</li><li>- Visualization of finite and boundary element results (2D).</li></ul>

# Course at PUC-Rio

1	13 - 16	Introducing the Development Environment - Visual Studio 2008 e Qt. Development of a simple program: addition of two numbers
2	13 - 16	Introduction to Computer Graphics for Engineering. Development of a calculator with RPN in C/C++.
3	13 - 16	Introduction to Object Oriented Programming. Object Oriented Modeling of a calculator with RPN.
4	13 - 16	Treatment of Colors. Two-dimensional Visualization with OpenGL. Standard/graphic library OpenGL.
5	13 - 16	Programming in an event driven iterative graphical environment. Paradigms of signals & slots of Qt. Geometric Transformation in 2D.
6	13 - 16	Mouse Events on canvas. Digital Representation of curves.
7	13 - 16	Introduction to Computational Geometry. Tessellation of 2D regions. Predicates of computational geometry: proximity tests and points inclusion.
8	13 - 16	Algorithms for line-line intersections. Exact and Adaptive arithmetic.
9	13 - 16	Geometric Modeling (2-manifold e non-manifold). Topological data structures. Half-edge data structure.
10	13 - 16	Finite element mesh generation: mapping algorithms, advancing front and Delaunay triangulation.
11	13 - 16	Management of modeling attributes. Computational simulation with finite and boundary elements. Introducing a 2D modeler with mesh generation and attributes.
12	13 - 16	Visualization of finite and boundary element results (2D).

Homework 1: Calculator with Qt

Homework 2: Two-dimensional Visualization with Qt and OpenGL performing transformations

Homework 3: Library of graphic primitives and collecting curves

Homework 4: Geometric modeler with line-line intersections and explicit creation of regions

Homework 5: Mesh Generation



# Aim and Scope

Introduction of concepts and algorithms of **Computer Graphics** for students that intend to **develop** and **customize** technical and scientific graphics software.

## » Fundamentals of Computer Graphics

### » Tools and Libraries

- Creation of Simple Apps using Visual Studio and Qt.
- Object Oriented Program in C++: graphic primitives (points, curves, polygons).
- OpenGL with examples of visualization of graphic primitives.
- Introduction to Computational Geometry: curve libraries.

### » Geometric Modeling

- Motivation: graphic modeler x geometric modeler.
- Topological data structure.
- Applications with the Half-edge data structure.

### » Mesh Generation

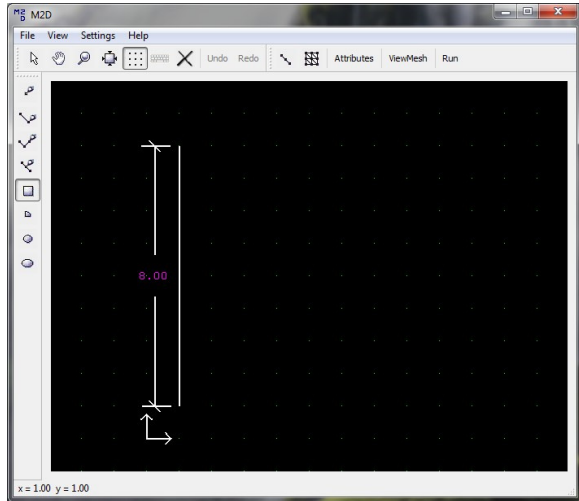
- Strategies and algorithms.
- Usage of libraries.

### » Visualization

- Post-processing of finite and boundary element results.

## Geometric Modeling

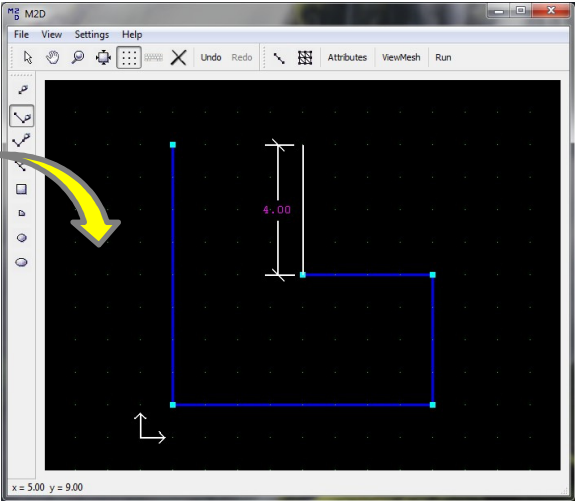
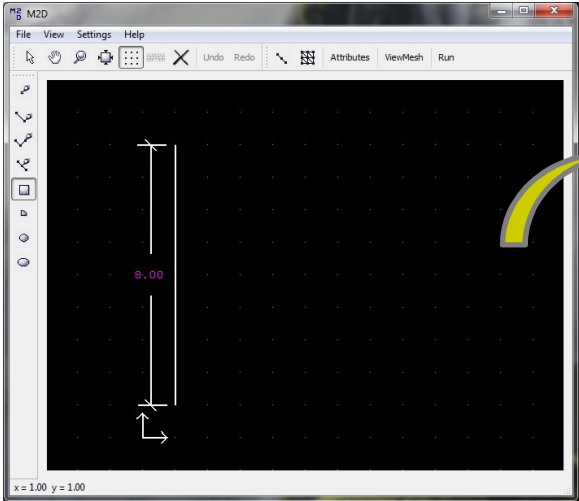
# Our Goal





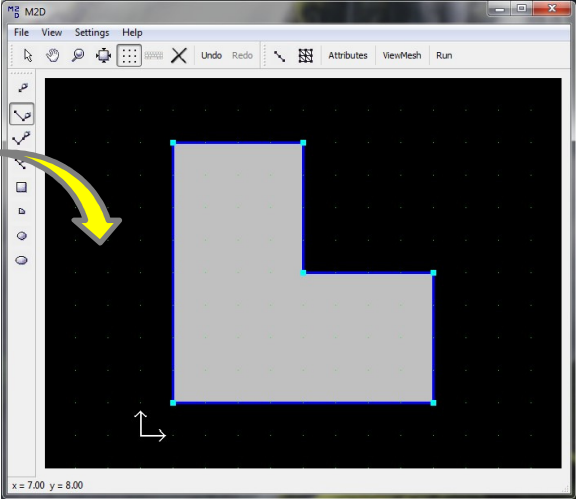
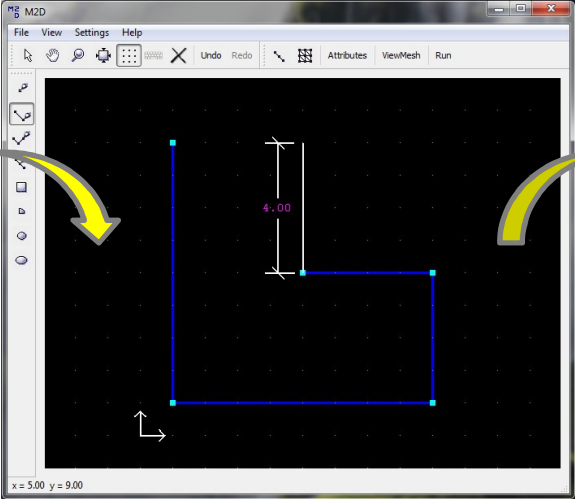
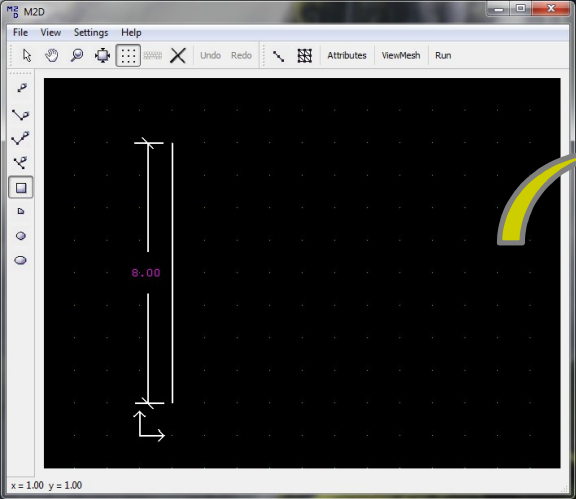
# Geometric Modeling

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# Geometric Modeling

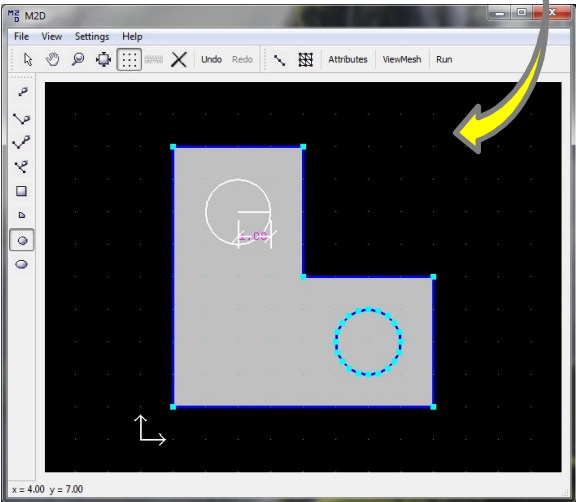
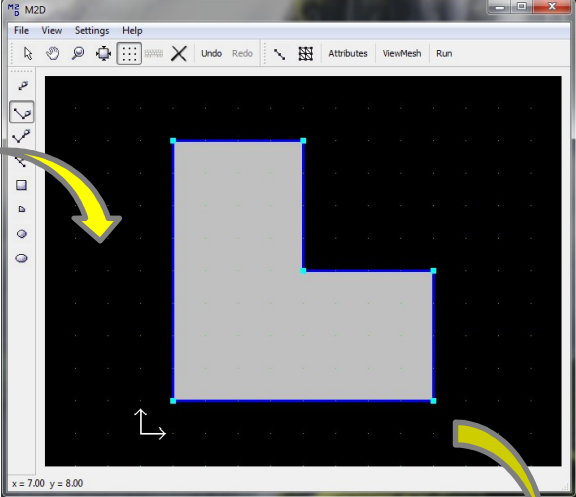
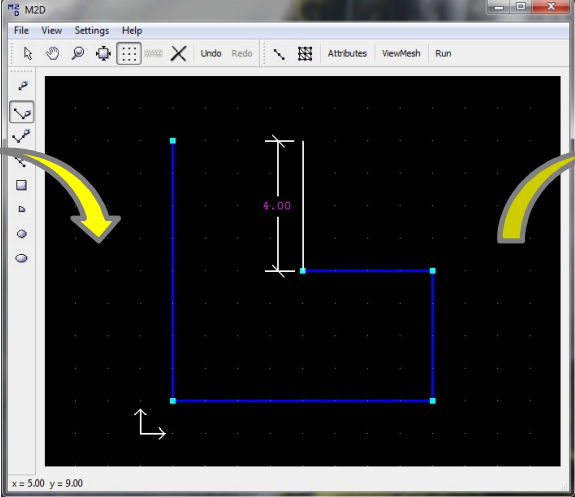
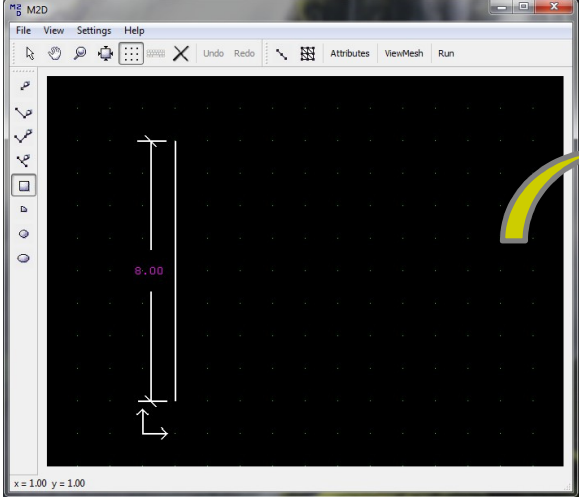
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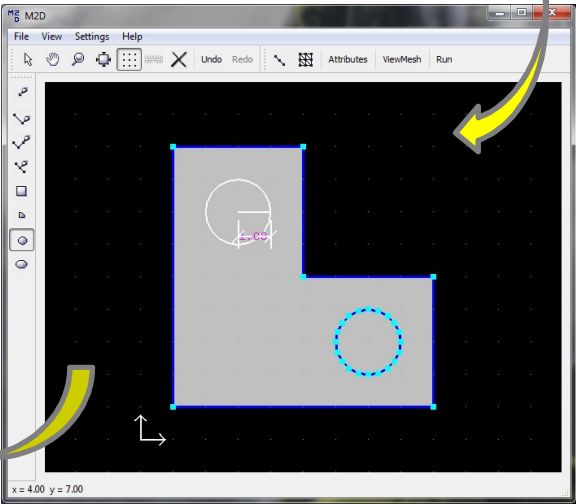
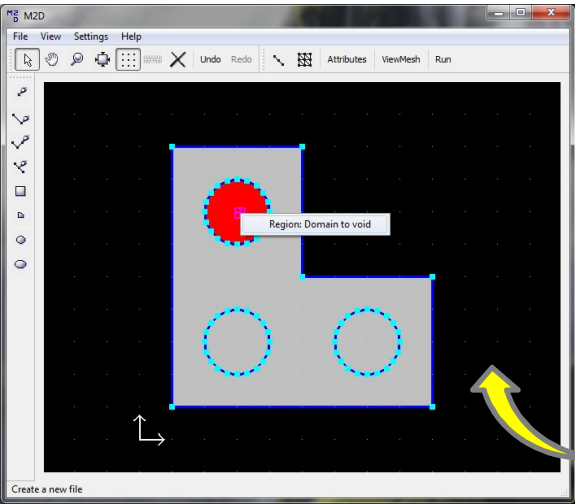
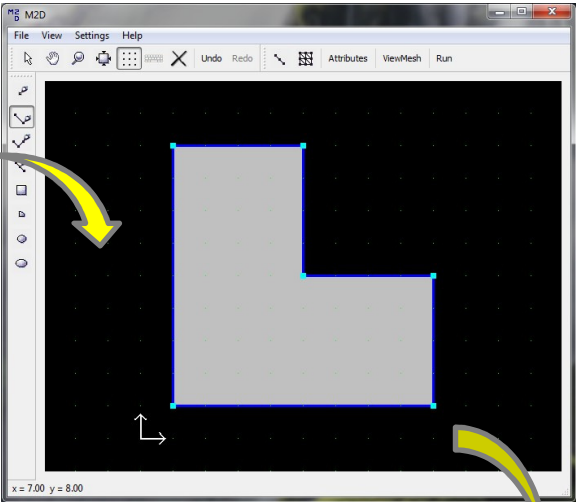
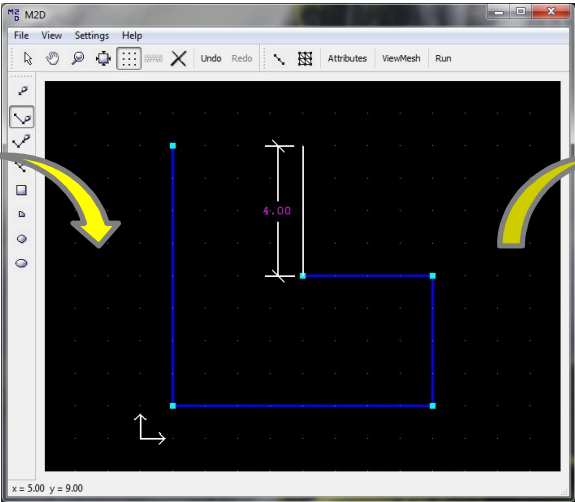
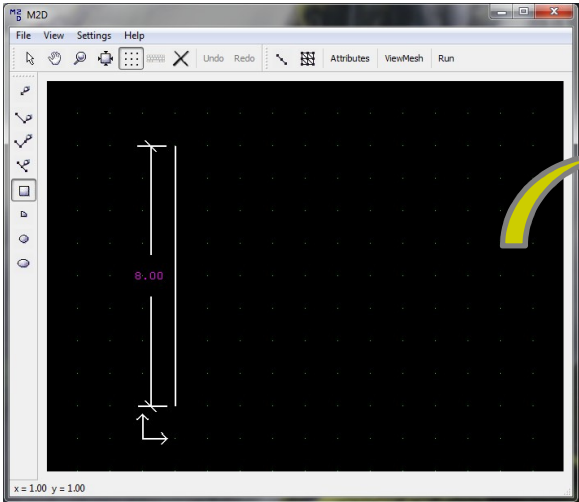
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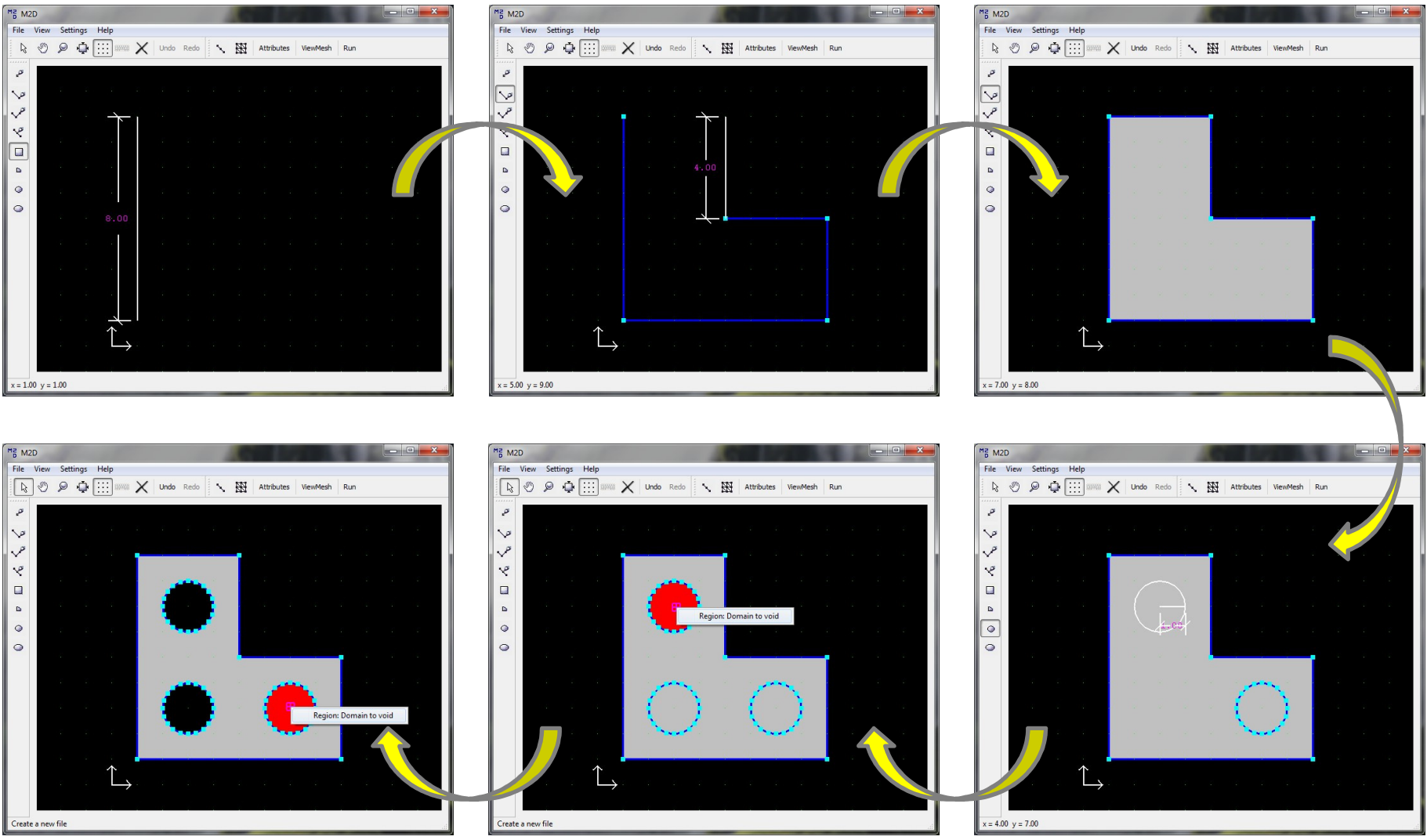
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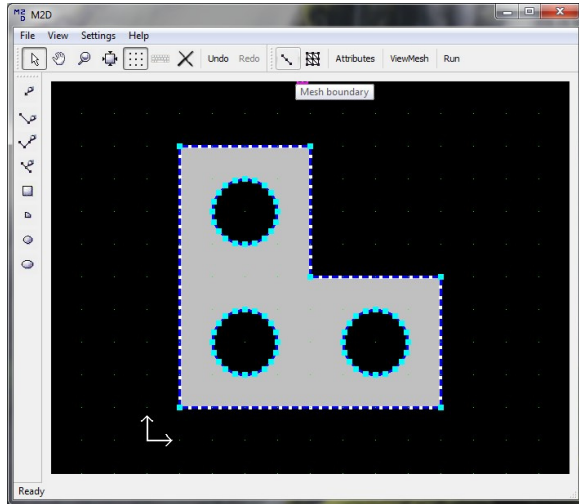
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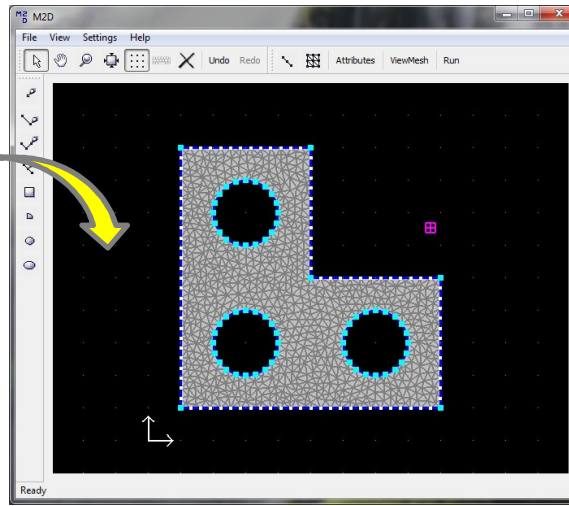
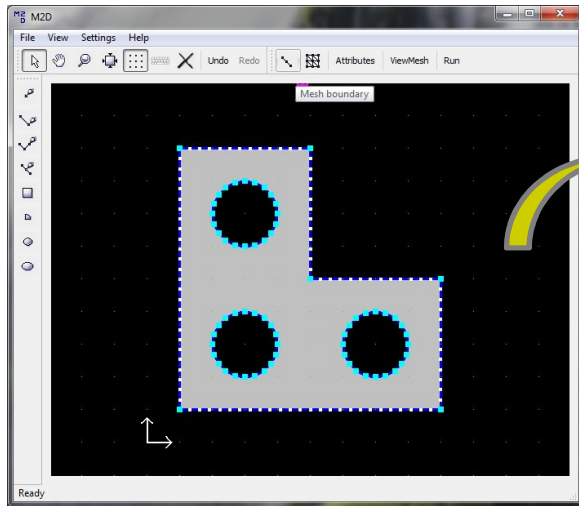
## Mesh Generation

# Our Goal



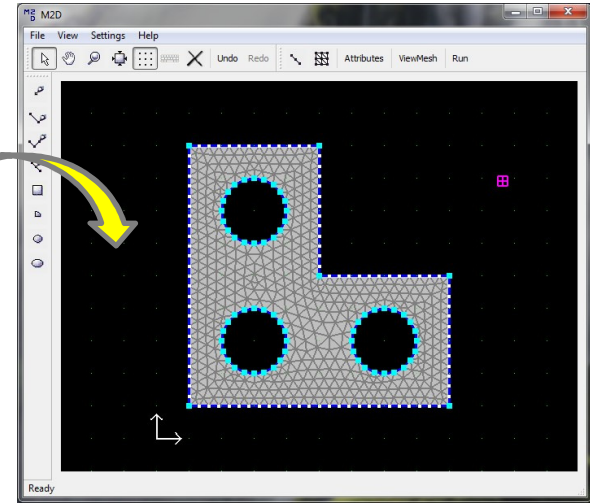
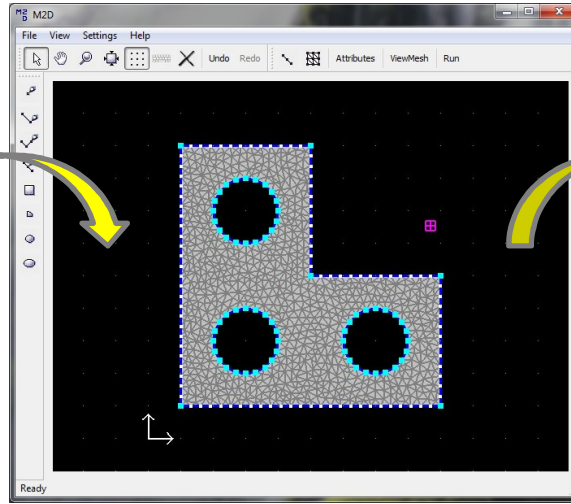
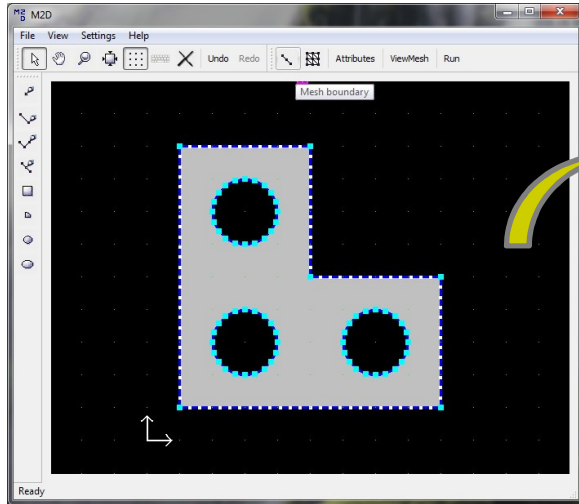
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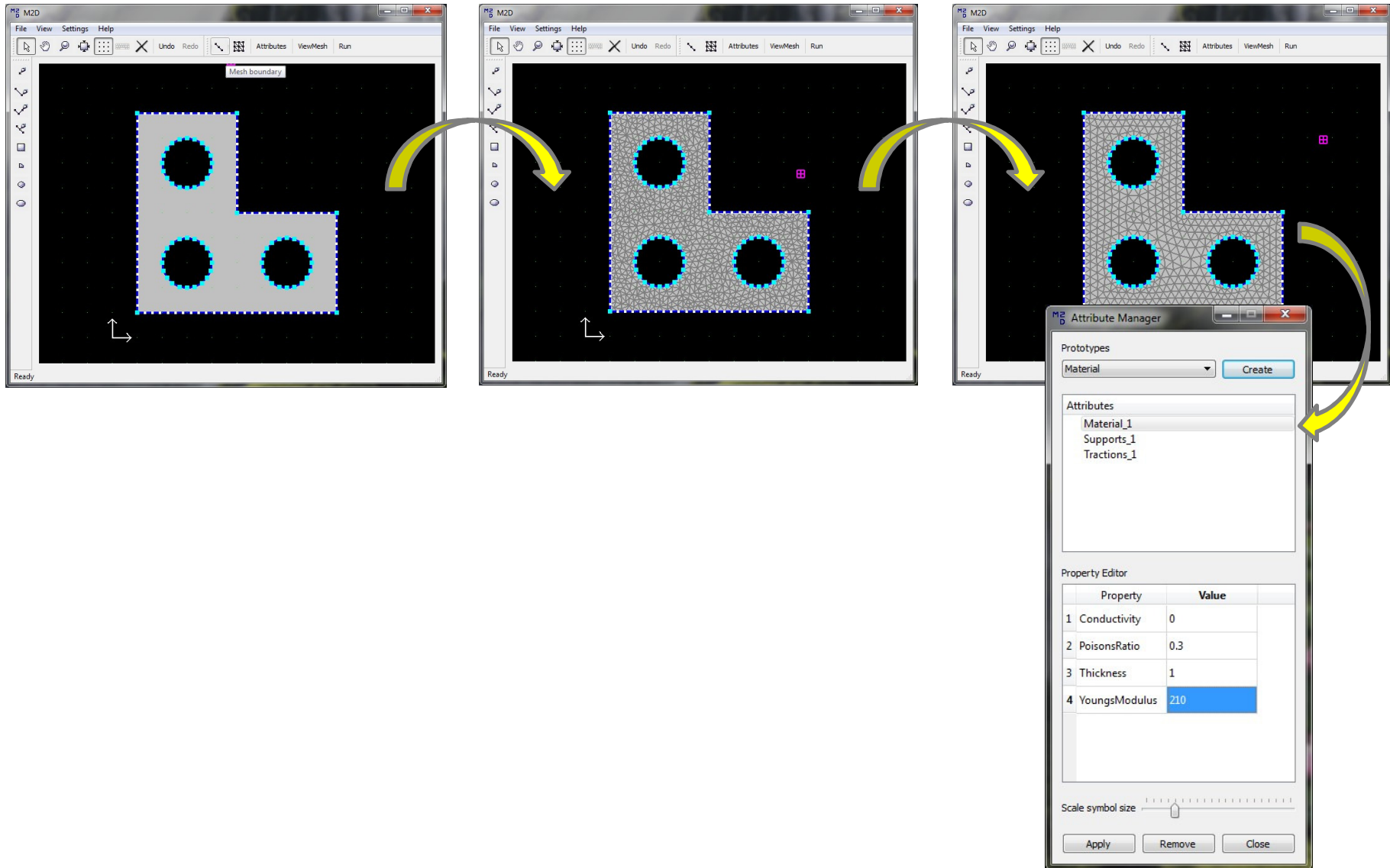
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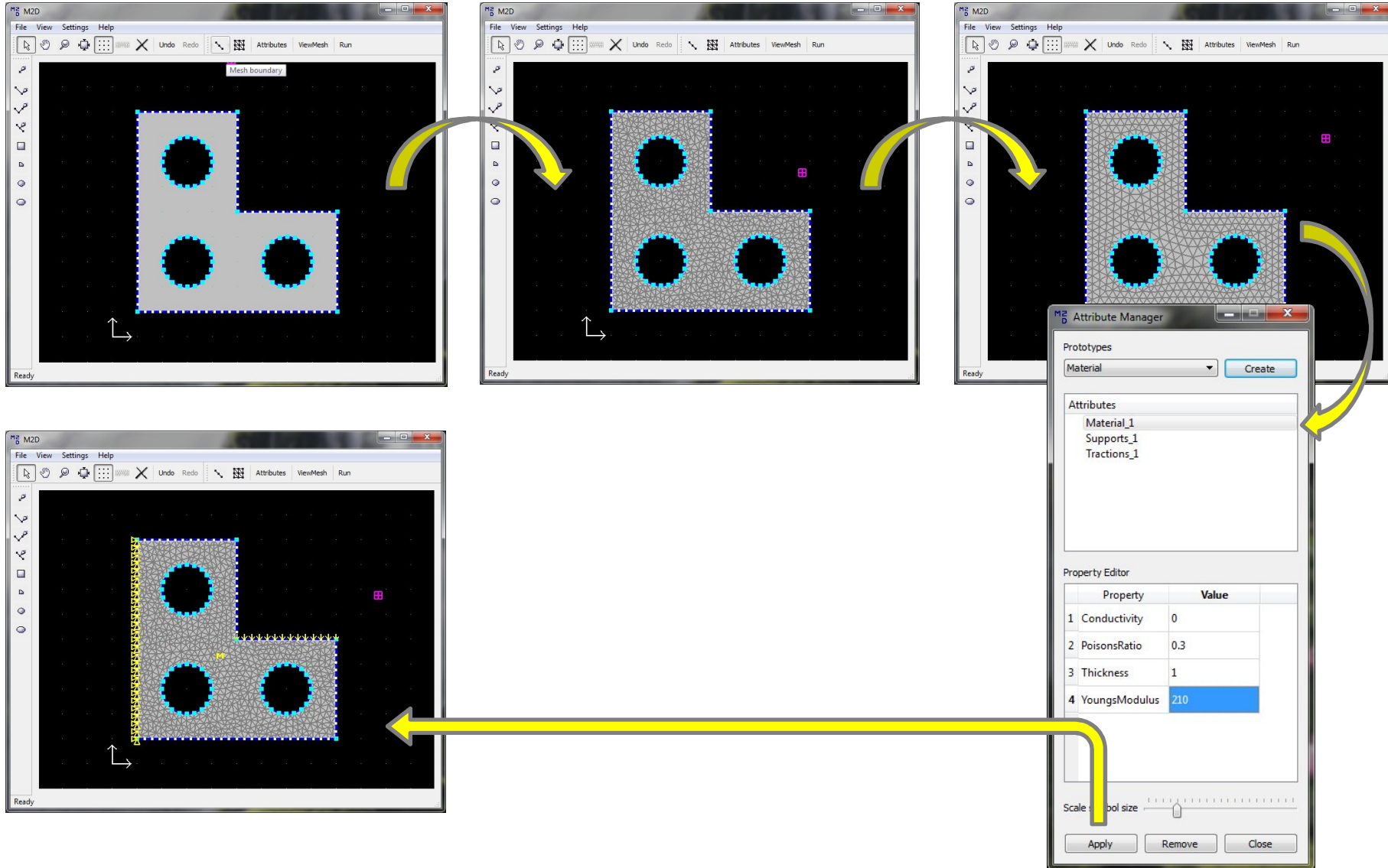
# Attribute Management

# Our Goal



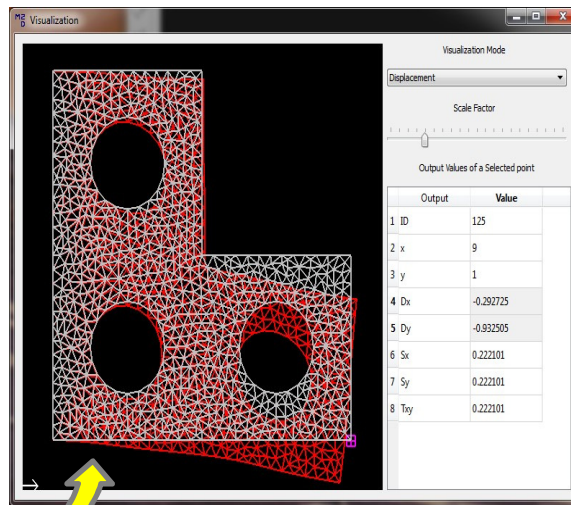
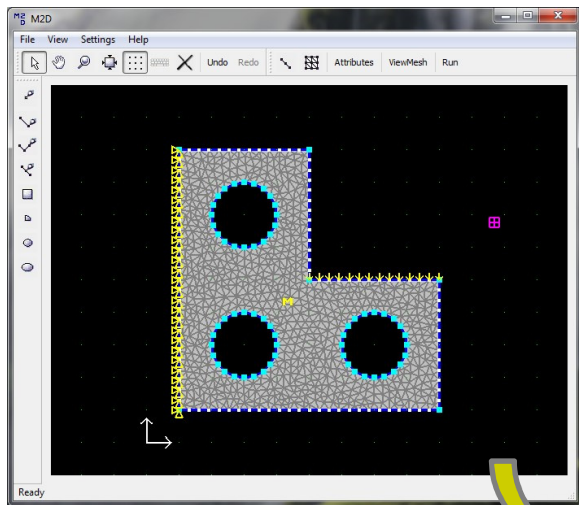
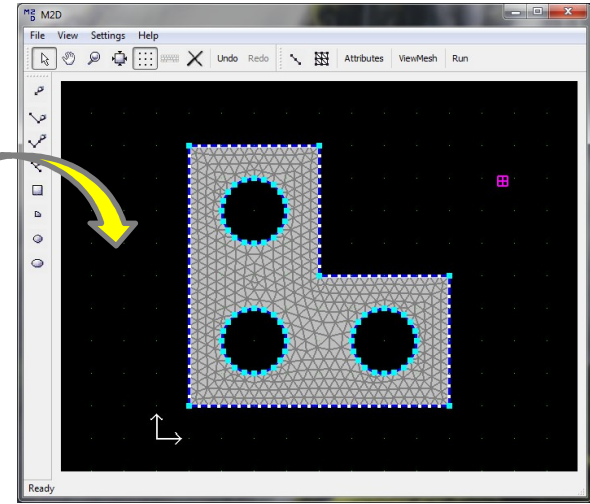
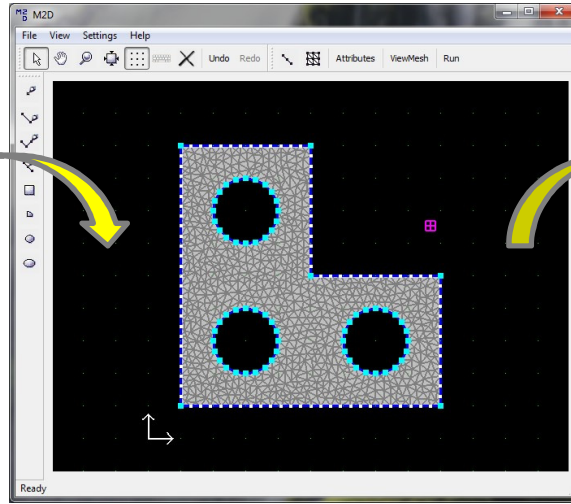
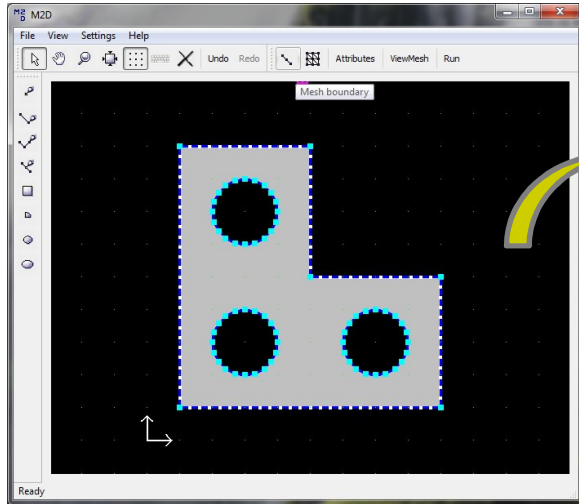
# Our Goal

## Attribute Management



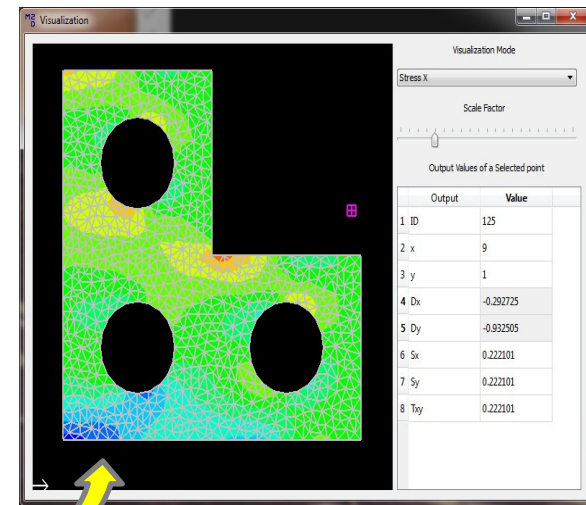
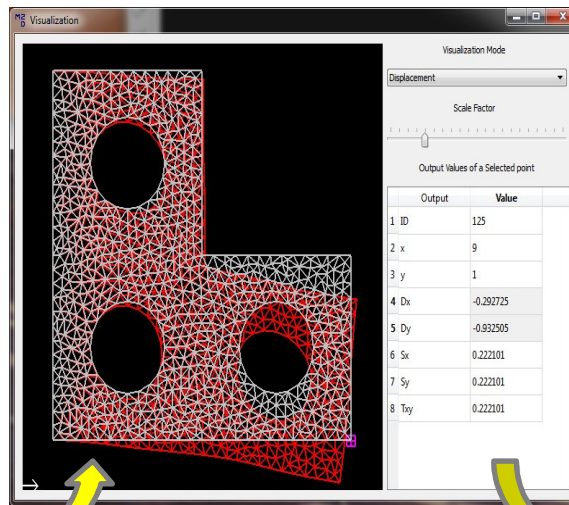
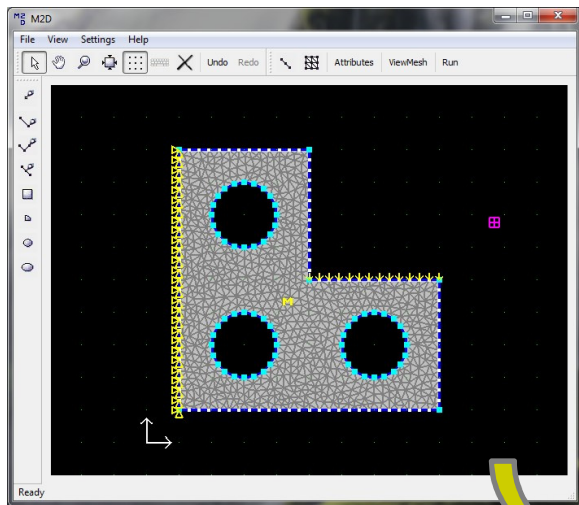
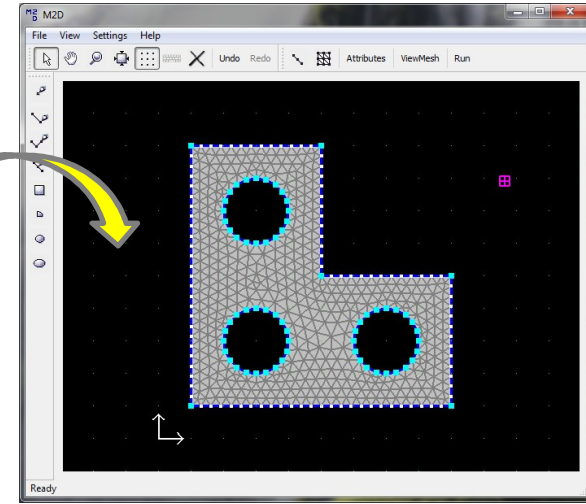
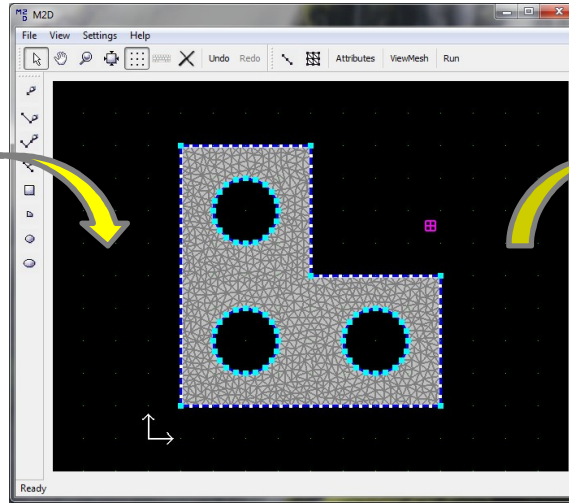
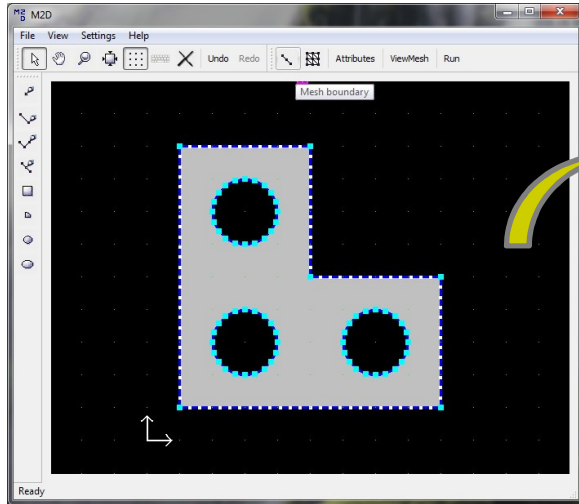
# Our Goal

## Visualization of Results



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## Visualization of Results







**Questions?**