Modalys Reference Manual
Finite element objects

September 22, 2003

Abstract

Modalys is a sound synthesis software developed at Ircam for research and musical applications. This software allows one to build virtual instruments based on physical models to obtain the most entire range of expressive variations in the instrument in response to intuitive controls. An instrument, as a complex structure, is described by the mechanical/acoustical interaction of its components (strings, tubes, resonators, soundboard,...).

Some new research have been done recently to extend the sound prediction to three-dimensional objects with the help of numerical methods. In particular, theoretical and numerical treatment of the unilateral and frictionless dynamic contact between two arbitrary elastic bodies was studied and highlighted by simulations implemented in Modalys.

This manual presents the new functions dedicated to finite element objects. In order to visualize the generated meshes, the *medit* application must be downloaded at http://www-rocq1.inria.fr/gamma/medit/medit.html

Contents

1 (compute-modes)

Description

This function calculate the mode of vibration of a finite element object. Mind the fact that each time a finite element object is defined, modes must be calculated in order to process a sound synthesis. This implies that the creation of a finite element object must be followed by the function **compute-modes**. It is not the case with other objects where this computation is implicitly done by *Modalys*.

Syntax

(**compute-modes** *my-finite-element-object*)

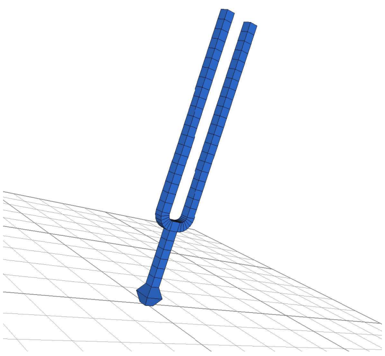
Parameters

my-finite-element-object	The modes of vibration will be computed for this object.

Example

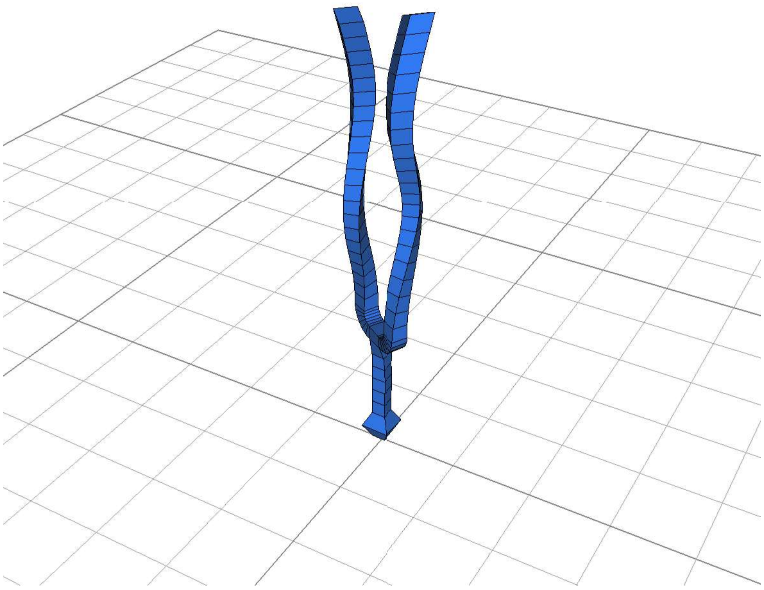
Read a file (for example `diapason.mesh`) in order to assign a mesh to a finite element object. Give the desired parameters (see the function **make-object 'finite-element...**) and visualize it:

```
(define diapason-mesh (make-mesh 'read-from-file "diapason.mesh"))
(define diapason-fem ( make-object 'finite-element (mesh diapason-mesh)
                                                    (modes 30)
                                                    (density 7700)
                                                    (young 2e11)
                                                    (poisson .3)
                                                    (freq-loss 0.1)
                                                    (const-loss 0.5)))
(view 'object diapason-fem)
```



Compute the modes of vibration and visualize one of them

```
(compute-modes diapason-fem)
(view 'mode diapason-fem 18 20 5)
```



In the *medit* application right click to obtain the main-menu and choose 'Play sequence' in the 'animation' sub-menu. Use also the 'm' key.

See also

view 'mode, make-object 'finite-element

2 (duplicate ’homothety)

Description

Constructs a mesh by duplication using an homothety. Points are extruded into lines, lines into quadrilaterals and quadrilaterals into hexahedras.

Syntax

(**duplicate ’homothety** *mesh rep. homothety-point homothety-amplitude*)

Parameters

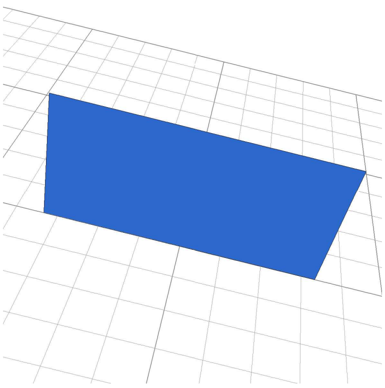
mesh	The mesh to be extruded by homothety. This mesh could be constituted by points, lines or quadrilaterals.
rep.	Number of extrusion.
homothety-point	Center homothety coordinates.
homothety-amplitude	Amplitude of the homthety

Example

Duplicate a quadrilateral into hexahedras by homothety

Define a mesh named `my-mesh` which contains a single quadrilateral (see **duplicate ’translation** for details) and visualize it

```
(define my-mesh ( make-mesh ’single-point (vector 0 0 0)))
(duplicate ’translation my-mesh 1 (vector 1 0 0))
(duplicate ’translation my-mesh 1 (vector 0 0 0.5))
(view ’mesh my-mesh)
```



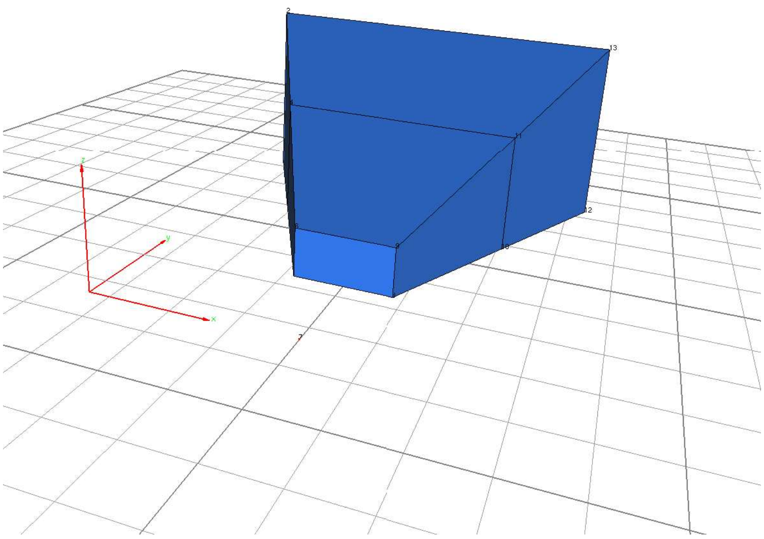
Duplicate the quadrilateral into hexahedras by an homothety

```
(duplicate ’homothety my-mesh 2 (vector 0.5 -1 0) 1.5 )
```

The mesh `my-mesh` contains now 2 hexahedras obtained by an homothety of center (x=0.5, y=1, z=0) with an amplitude 1.5. To see the result with the homothety center, define a mesh which contains the homothety point and add it to the previous mesh

```
(define center ( make-mesh 'single-point (vector 0.5 -1 0)))
(define my-mesh (make-mesh 'add (list my-mesh center)))
(view 'mesh my-mesh)
```

In the *medit* application use keys 'P' and 'g'.



See also

transform 'homothety, make-mesh, view.

3 (duplicate ’reflection)

Description

Constructs a mesh by duplication using a reflection. Points are extruded into lines, lines into quadrilaterals and quadrilaterals into hexahedras.

Syntax

(**duplicate ’reflection** *mesh normal invariant-point*)

Parameters

mesh	The mesh to be extruded by reflection. This mesh could consist of points, lines or quadrilaterals.
normal	The vector normal to the symetry plane.
invariant-point	Any point in the symetry plane.

Example

Duplicate a point into a line by reflection with the plane $z = 0$

Define a point

```
(define my-mesh ( make-mesh ’single-point (vector  0 0 1)))
```

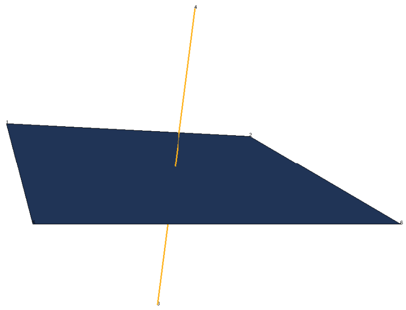
Duplicate the point into a line by reflection

```
(duplicate ’reflection my-mesh (vector 0 0 1) (vector 0 0 0))
```

The mesh `my-mesh` is now line of length 2 meters. To visualize the result with the symetry plane, construct a quadrilateral in the plane $z = 0$ and add it to the mesh line (see **duplicate ’translation** for details)

```
(define plane ( make-mesh ’single-point (vector  -1 -1 0)))
(duplicate ’translation plane 1 (vector  2 0 0))
(duplicate ’translation plane 1 (vector  0 2 0))
(define my-mesh (make-mesh ’add (list my-mesh plane)))
(view ’mesh my-mesh)
```

In the *medit* application use keys ’P’ and ’g’.



See also

transform 'reflection, make-mesh, view.

4 (duplicate 'rotation...)

Description

Constructs a mesh by duplication using a rotation. Points are extruded into lines, lines into quadrilaterals and quadrilaterals into hexahedras.

Syntax

(**Duplicate 'rotation** *mesh rep. rotation-axis orig angle*)

Parameters

mesh	The mesh to be extruded by rotation. This mesh could be made of by points, lines or quadrilaterals.
rep.	Number of extrusion.
rotation-axis	Axis of rotation. For instance the z-axis can be given by the vector `(vector 0 0 1)`.
orig	Origin of the rotation. The origin (x=0, y=0, z=0) is specified by `(vector 0 0 0)`.
angle	Angle of rotation in degrees.

Examples

Duplicate a point into lines by rotation

Define a mesh named `my-mesh` which contain a single point giving its coordinates:

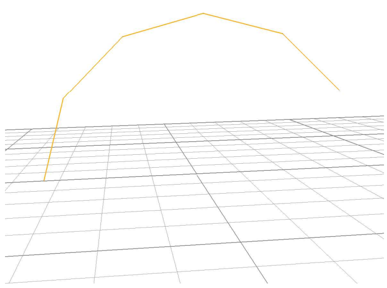
```
(define my-mesh ( make-mesh 'single-point (vector 0.1 0 0)))
```

Here the coordinates of the point are (x=0.1, y=0, z=0). Duplicate the point into lines

```
(duplicate 'rotation my-mesh 5 (vector 0 1 0)  (vector 0 0 0) 30)
```

The mesh `my-mesh` is now an arc which contains 5 lines generated by rotation of angle 30 degrees around the y-axis. Visualize the mesh:

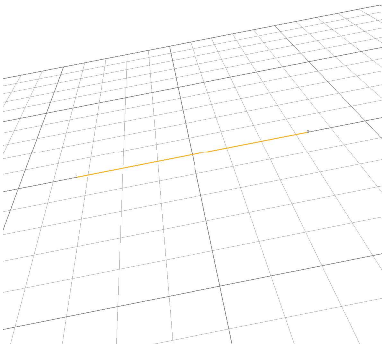
```
(view 'mesh my-mesh)
```



Duplicate a line into quadrilaterals

Define a line by translation of a point (see **duplicate 'translation. . .**).

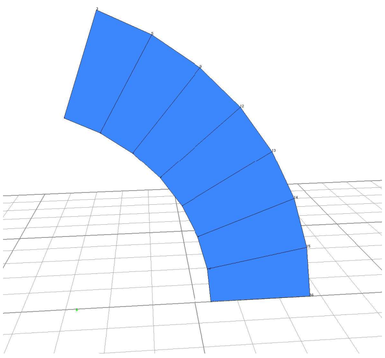
```
(define my-mesh ( make-mesh 'single-point (vector 0 0.1 0)))
(duplicate 'translation my-mesh 1 (vector 0 0.05 0))
(view 'mesh my-mesh)
```



Duplicate this line into quadrilaterals

```
(duplicate 'rotation my-mesh 7 (vector 1 0 0) (vector 0 0 0) 10)
(view 'mesh my-mesh)
```

The mesh `my-mesh` is now a surface which contains 7 quadrilaterals generated by rotation of angle 10 degrees around the x-axis.

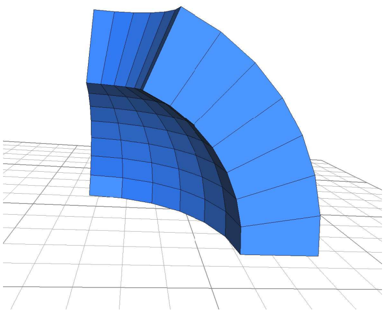


Duplicate quadrilaterals into hexahedras

Using the quadrilaterals from the previous example generate hexahedras by rotation

```
(define my-mesh ( make-mesh 'single-point (vector 0 0.1 0)))
(duplicate 'translation my-mesh 1 (vector 0 0.05 0))
(duplicate 'rotation my-mesh 7 (vector 1 0 0) (vector 0 0 0) 10)
```

```
(duplicate 'rotation my-mesh 6 (vector 0 0 1) (vector 0 0 0) 15)
(view 'mesh my-mesh)
```



The mesh `my-mesh` is now a volume which contains 42 hexahedras generated by rotation of angle 15 degrees around the z-axis.

See also

duplicate 'translation, make-mesh, transform, view.

5 (duplicate ’translation. . .)

Description

Constructs a mesh by duplication using a translation. Points are extruded into lines, lines into quadrilaterals and quadrilaterals into hexahedras.

Syntax

(**Duplicate ’rotation** *mesh rep. translation-vector*)

Parameters

mesh	The mesh to be extruded by translation. This mesh could be conatin points, lines or quadrilaterals.
rep.	Number of extrusion.
translation-vector	vector of translation. For instance translation in the z-direction of length O.1 meter is given by the vector `(vector 0 0 0.1)`.

Examples

Duplicate a point into lines by translation

Define a mesh named `my-mesh` which contain a single point giving its coordinates:

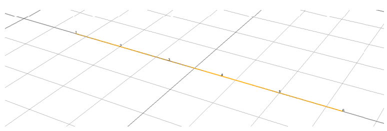
```
(define my-mesh (make-mesh ’single-point (vector 0.1 0 0)))
```

Here the coordinates of the point are (x=0.1, y=0, z=0). Duplicate the point into lines

```
(duplicate ’translation my-mesh 5 (vector 0 0.1 0))
```

The mesh `my-mesh` is now a line which contains 5 segments of length 0.1 meter generated by translation along the y-axis. Visualize the mesh:

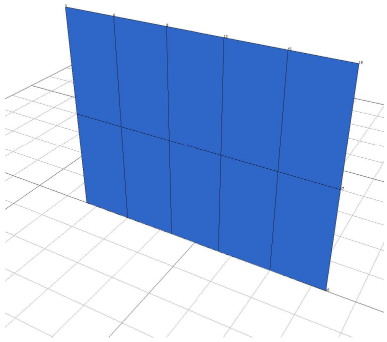
```
(view ’mesh my-mesh)
```



Duplicate the previous line into quadrilaterals

```
(duplicate ’translation my-mesh 2 (vector 0 0 0.2))
(view ’mesh my-mesh)
```

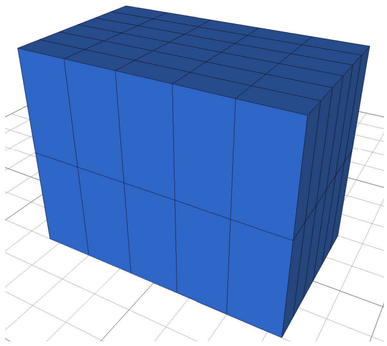
The 5 segments generate, in the z-direction, a surface mesh named `my-mesh` of 10 quadrilaterals (5×2). Each quadrilateral has a surface of 0.1×0.2 meter^2.



Duplicate the previous quadrilaterals into hexahedras

Take the quadrilaterals from the previous example and generate hexahedras by translation

```
(duplicate ’translation my-mesh 6 (vector -0.05 0 0))
(view ’mesh my-mesh)
```



The mesh `my-mesh` is now a volume which contains 60 hexahedras generated by translation of the previous surface in the x-direction.

See also

duplicate ’rotation, make-mesh, transform, view.

6 (make-mesh ’add)

Description

Add two or several meshes.

Syntax

(**make-mesh ’add** *list-of-meshes*)

Parameters

list-of-meshes The meshes to be added together.

Example

```
(define sum-mesh (make-mesh ’add (list mesh1 mesh2 mesh3)))
(view ’mesh sum-mesh)
```

See also

duplicate ’reflection

7 (make-mesh ’copy)

Description

Copy a mesh

Syntax

(**make-mesh ’copy** *mesh*)

Parameters

mesh	The mesh to be copied.

Example

```
(define my-mesh2 (make-mesh ’copy my-mesh1))
```

See also

fem-example

8 (make-mesh 'read-from-file...)

Description

Syntax

(**make-mesh 'read-from-file** *filename*)

Parameters

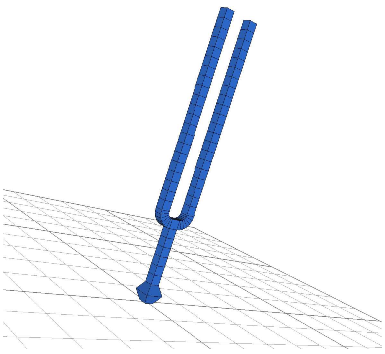
filename Name of mesh data file in quotes, *i.e.*"my-mesh". The mesh file must conform to the INRIA mesh format to be able to visualize it with *Modalys*. (see the web page dedicated to *medit* http://www-rocq1.inria.fr/gamma/medit/medit.html).

Discussion

For the time being, *Modalys* is able to deal with only one type of finite element: hexahedra. To create an object with an external mesh file, you must eventually end with mesh containing only hexahedras. In the future, extensions will be made to use other types of finite element.

Example

```
(define my-mesh ( make-mesh 'read-from-file "diapason.mesh"))
(view 'mesh my-mesh)
```



See also

view, make-mesh, medit.
See also the GTS GNU project located at http://gts.sourceforge.net/samples.html.

9 (make-mesh ’restrict-edge)

Take an edge (or several edges) from a mesh to make a new mesh. This function is helpful to extract a sub mesh from an original mesh. The result is an edge (or a list of edges).

Description

Syntax

(**make-mesh ’restrict-edge** *mesh edges*)

Parameters

mesh	The original mesh from which a sub mesh is extracted.
edge(s)	The edges to be extrated given by a vector of number of nodes

Example

```
(define sub-mesh (make-mesh ’restricted-edge (vector 1 2 3 4 1)))
```

See also

For details see **make-mesh ’restricted-point**

10 (make-mesh ’restrict-plane)

Description

Take all the quadrilaterals that belong in a plane from a mesh. This function is helpful to extract a sub mesh from an original 3D mesh. The result is a mesh of quadrilaterals.

Syntax

(**make-mesh ’restrict-plane** *mesh normal invariant-point*)

Parameters

mesh	The original mesh from which a sub mesh is extracted.
normal	The vector normal to the plane.
invariant-point	Any point in the plane.

Example

```
(define sub-mesh (make-mesh ’restrict-plane my-mesh
(vector 1 0 0) (vector 0 0 0)))
```

See also

For details see **make-mesh ’restrict-point, make-mesh ’finite-element.**

11 (make-mesh ’restrict-point)

Description

Take a point (or several points) from a mesh to make a new mesh. This function is helpful to extract a sub mesh from an original mesh.

Syntax

(**make-mesh ’restrict-point** *mesh point(s)*)

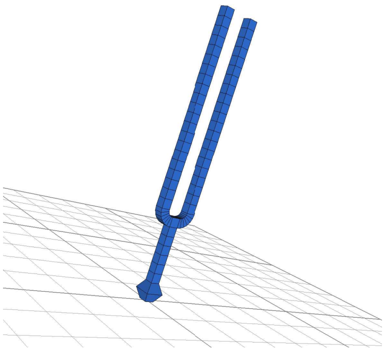
Parameters

mesh	The mesh from which the point (or list of point) is (are) extracted.
point(s)	The point (or a list of point) given by its (their) number(s) in the mesh (see **wiew ’mesh** to visualize the numbering).

Example

Build your own mesh using the mesh tools: **duplicate. . . , add, make-mesh. . .**) or simply read a file (for example `diapason.mesh`) and visualize it

```
(define diapason (make-mesh ’read-from-file "diapason.mesh"))
(view ’mesh diapason)
```



Extract a point

```
(define point3 (make-mesh ’restrict-point diapason 3))
```

or a list of point

```
(define points (make-mesh ’restrict-point diapason (vector 1 2 3)))
```

to define two finite element objects blocked by different ways

```
(define fem1 (make-object ’finite-element (mesh diapason) (block point3)))
(define fem2 (make-object ’finite-element (mesh diapason) (block points)))
```

Visualize the objects

```
(view 'object fem1)
(view 'object fem2)
```

Use the key 'c' and 'g' in the *medit* application to see the choosen boundaries.

See also

make-mesh, duplicate, add, .

12 (make-mesh ’restrict-quadrilateral)

Take an quadrilateral from a mesh to make a new mesh. This function is helpful to extract a sub mesh from an original mesh. The result is a quadrilateral.

Description

Syntax

(**make-mesh ’restrict-quadrilateral** *mesh quadrilateral*)

Parameters

mesh	The original mesh from which a sub mesh is extracted.
quadrilateral(s)	The quadrilateral to be extrated given by a vector of its nodes

Example

```
(define sub-mesh (make-mesh ’restricted-quadrilateral (vector 1 2 3 4)))
```

See also

For details see **make-mesh ’restricted-point**

13 (make-mesh ’single-point)

Description

Syntax

(**make-mesh ’single-point** *position-vector*)

Parameters

position-vector	This parameter gives the coordinates of a point relative to an orthogonal Cartesian coordinate system Oxyz.

Discussion

Starting from a point, a complex finite element mesh can be obtain using the **duplicate**, **transform** and **add** functions (see example numero).

Example

Define a mesh named `my-mesh` which contain a single point giving its coordinates:

```
(define my-mesh ( make-mesh ’single-point (vector 0.1 0 0)))
```

Here the coordinates of the point are (x=0.1, y=0, z=0).

See also

duplicate, transform, add.

14 (make-object ’finite-element)

Description

This function is used to create a finite element object. Its sound properties depend on the geometry (mesh), on the material parameters (density, young’s modulus , poisson ration, loss parameters) and on boundary conditions (the fixed part of the mesh). The dynamical behavior of this object is described by the modal theory: the number of requested modes can be specified by the user.

Syntax and default

(**make-object ’finite-element** *(key value)*)

```
(make-object ’finite-element (mesh my-mesh)
                             (block my-sub-mesh)
                             (modes 40)
                             (density 7800)
                             (young 2e11)
                             (poisson 0.3)
                             (freq-loss 1)
                             (const-loss 1)))
```

Parameters

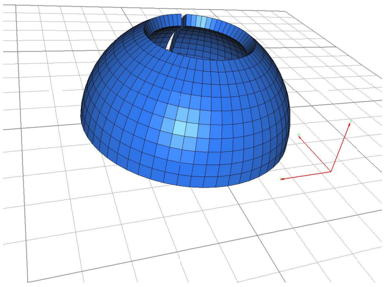
key	Value
mesh	The mesh of the finite element object. This mesh can be obtained using the function **make-mesh** and the *Modalys*’s mesh tools: **duplicate, transform**. For the time being, *Modalys* is able to deal with only one type of finite element: hexahedra. Thus, the user must give here a mesh which contains only hexahedras. In the future, extensions will be made to extend the types of handled finite elements (tetrahedras, beams, plates etc)
block	The part of the mesh to be constrained. A part (or all) of the surface of the finite element mesh (points, edges or plane) can be fixed during the sound synthesis. The dynamic behavior of an objet (and thus its sound) can be completly different depending on the definition of this fixed topology. This sub mesh can be defined using the function **make-mesh ’restrict. . .** .

<table>
<tr><td>key</td><td>Value</td></tr>
<tr><td>modes</td><td>This value determines the number of modes of vibration computed in the simulation of the object. As this number is increased, higher partials are added to the resultant sound. Thus, if ten modes are declared, the lowest ten frequencies produced by the vibration of the object are computed (see funcnamecompute-modes). Maximum detail is obtained when the number of modes is high enough so that all frequency below the Nyquist frequency are accounted for.</td></tr>
<tr><td>density</td><td>Density of the material in kg/m^3. Some typical values are
<table>
<tr><td>Oak</td><td>720</td><td>Brass</td><td>8500</td></tr>
<tr><td>Glass</td><td>2300</td><td>Nickel</td><td>8800</td></tr>
<tr><td>Quartz</td><td>2650</td><td>Copper</td><td>8900</td></tr>
<tr><td>Aluminium</td><td>2700</td><td>Silver</td><td>10500</td></tr>
<tr><td>Steel</td><td>7700</td><td></td><td></td></tr>
</table></td></tr>
<tr><td>young</td><td>Young'smodulus, in N/m^2. This parameter is related to the elasticity of the material. A rigid material gets higher values. Some typical values are
<table>
<tr><td>Glass</td><td>6.2e10</td><td>Brass</td><td>1.04e11</td></tr>
<tr><td>Quartz</td><td>7.9e10</td><td>Nickel</td><td>2.1e11</td></tr>
<tr><td>Aluminium</td><td>7e10</td><td>Copper</td><td>1.2e11</td></tr>
<tr><td>Steel</td><td>2e11</td><td>Silver</td><td>7.8e10</td></tr>
</table></td></tr>
<tr><td>poisson</td><td>Poisson ratio of the material, from 0 to 1. With a value of 1 the material keep a constant volume when a deformation occurs (imagine a ballon plenty of water). Lowered values authorize a loss in the total volume when a compression is done on the material.</td></tr>
<tr><td>freq-loss</td><td></td></tr>
<tr><td>const-loss</td><td></td></tr>
</table>

Example

Define a mesh named `my-mesh` to declare a finite element object (see **make-mesh, duplicate**)

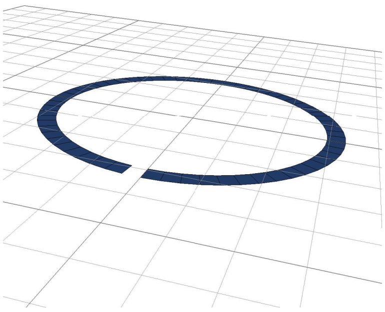
```
(define my-mesh (make-mesh 'single-point (vector 0.1 0 0)))
(duplicate 'translation my-mesh 1 (vector .013 0 0))
(duplicate 'rotation my-mesh 10 (vector 0 1 0) (vector 0 0 0) 6 )
(duplicate 'rotation my-mesh 59 (vector 0 0.0 1) (vector 0 0 0) 6 )
(view 'mesh my-mesh)
```



Select a part of the mesh `my-mesh`

```
(define my-sub-mesh (make-mesh 'restrict-plane my-mesh (vector  0 0 1)
(vector 0 0 0)))
(view 'mesh my-sub-mesh)
```

The mesh named `my-sub-mesh` represents the plane of equation $z = 0$ (the ground here) restricted to the mesh `my-mesh`



Define a finite element objet using the mesh `my-mesh`, block the sub mesh `my-sub-mesh` and ask for 30 modes

```
(define my-fem (make-object 'finite-element (mesh my-mesh)
(block my-sub-mesh) (modes 30)))
(view 'object my-fem)
```

To visualize the mesh and the sub mesh use 'c' and 'e' in the *medit* application (see Fig 1). Note that here the material parameters (density, young, poisson) and the losses are given by default.

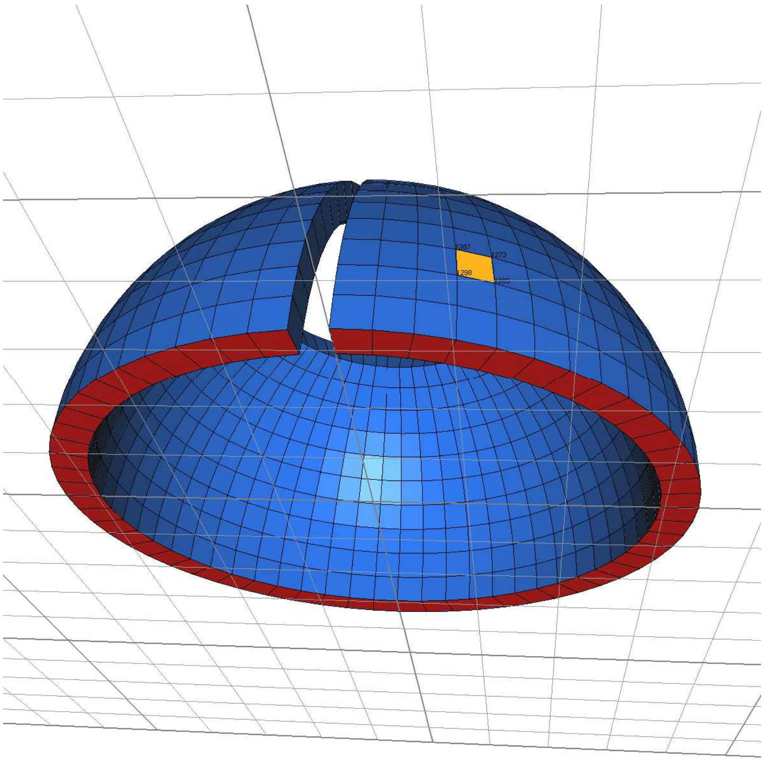


Figure 1: To obtain the number of a node, visualize the finite element object using the **view 'object** command and *shift click* the facet of interest

Notes

The function **make-access** (see *Modalys Reference*) can be used on a finite element object. Three direction can be declared: `'normal`, `'trans0` or `'trans1`. For example the instruction

```
(define my-fem-access1( make-access my-finite-element
(const 1298) 'normal ))
```

make an access on the 1298th node of the finite element mesh in a direction normal to its surface. An access can be declared in the tangential direction of the surface giving two node numbers:

```
(define my-fem-access1( make-access my-finite-element
(const 1298 1285) 'trans0 ))
```

An access is created at node 1298 in the tangent plane pointing through the node 1285. Using `'trans1` the access is still in the tangent plane but point in the perpendicular direction.
To obtain a node number, see the figure 1). The *medit* application can return, in the console, the coordinates of the vertex involved in a facet and their numbers within the mesh:

```
 Picking result :
  Quad    731 : 1298, 1287, 1273, 1285    ref : 0 [DEFAULT_MAT]
```

```
vertex    1298 : 0.105121 0.034156 0.023494   ref 0
vertex    1287 : 0.102209 0.033210 0.034919   ref 0
vertex    1273 : 0.098178 0.043712 0.034919   ref 0
vertex    1285 : 0.100975 0.044957 0.023494   ref 0
```

All the functions **make-connection ...** can be used with a finite element object (except **make-connection 'hole** that does not make sens). A finite element object can be stroke, bowed, plucked, ... with an other *Modalys* object included an other finite element object.

See also

make-mesh, set-physical, view 'object.

15 (save-mesh)

Description

Save the mesh data in a file

Syntax

(**save-mesh** *mesh filename*)

Parameters

mesh	Name of the mesh to be saved
filename	name of destination file (in quote)

Example

Create a mesh named `my-mesh` using the mesh tools (see **duplicate 'rotation** for example) and save the mesh

```
(save-mesh my-mesh "rotate.mesh")
```

Mind the fact that the file format is the INRIA mesh format (see the web page dedicated to *medit* http://www-rocq1.inria.fr/gamma/medit/medit.html).

See also

make-mesh 'read-from-file

16 (set-physical)

Description

Set some material properties to a finite element object . This function can be used to avoid to redefine a finite element object. The function **compute-mode** must be apply in order to take into consideration the new material properties.

Syntax and default

(**set-physical** *modalys-object (key value)*)

```
(set-physical my-object (density 7800)
                        (young 2e11)
                        (poisson 0.3))
```

Parameters

modalys-object	The modalys object to be updated.
key	Value
density	Density of the material in kg/m^3. Some typical values are Oak 720, Brass 8500 Glass 2300, Nickel 8800 Quartz 2650, Copper 8900 Aluminium 2700, Silver 10500 Steel 7700
young	Young'smodulus, in N/m^2. This parameter is related to the elasticity of the material. A rigid material gets higher values. Some typical values are Glass 6.2e10, Brass 1.04e11 Quartz 7.9e10, Nickel 2.1e11 Aluminium 7e10, Copper 1.2e11 Steel 2e11, Silver 7.8e10
poisson	Poisson ratio of the material, from 0 to 1. With a value of 1 the material keep a constant volume when a deformation occurs (imagine a ballon plenty of water). Lowered values authorize a loss in the total volume when a compression is done on the material.

Density values:

Oak	720	Brass	8500
Glass	2300	Nickel	8800
Quartz	2650	Copper	8900
Aluminium	2700	Silver	10500
Steel	7700		

Young's modulus values:

Glass	6.2e10	Brass	1.04e11
Quartz	7.9e10	Nickel	2.1e11
Aluminium	7e10	Copper	1.2e11
Steel	2e11	Silver	7.8e10

See also

make-object 'finite-element

17 (transform ’homothety)

Description

Transform a mesh by homothety.

Syntax

(**transform ’homothety** *mesh homothety-point homothety-amplitude*)

Parameters

mesh	The mesh to be transformed by homothety.
homothety-point	Center homothety coordinates.
homothety-amplitude	Amplitude of the homthety.

Example

```
(transform ’homothety my-mesh (vector 0.5 -1 0) 1.5 )
```

See also

duplicate ’homothety

18 (transform ’reflection)

Description

Transform a mesh by reflection.

Syntax

(**transform ’reflection** *mesh normal invariant-point*)

Parameters

mesh	The mesh to be transformed by reflection.
normal	The vector normal to the reflection plane.
invariant-point	Any point in the reflection plane.

Example

```
(transform ’reflection my-mesh (vector 0 0 1) (vector 0 0 0))
```

See also

duplicate ’reflection

19 (transform ’rotation. . .)

Description

Transform a mesh by rotation.

Syntax

(**Transform ’rotation** *mesh rotation-axis orig angle*)

Parameters

mesh	The mesh to be transformed by rotation.
rotation-axis	Axis of rotation. For instance the x-axis can be given by the vector `(vector 1 0 0)`.
orig	Origin of the rotation. The origine (x=0, y=0, z=0) is specified by `(vector 0 0 0)`.
angle	Angle of rotation in degrees.

Example

```
(transform ’rotation my-mesh (vector 0 1 0)  (vector 0 0 0) 30)
```

See also

transform ’translation, make-mesh, transform, view.

20 (transform ’translation…)

Description

Transform a mesh by translation.

Syntax

(**Transform ’rotation** *mesh translation-vector*)

Parameters

mesh	The mesh to be transformed by translation.
translation-vector	vector of translation. For instance translation in the y-direction of length 0.1 meter is given by the vector `(vector 0 0.1 0)`.

Example

```
(transform ’translation my-mesh (vector 0 0.1 0))
```

See also

duplicate ’rotation

21 (view ’mesh)

Description

Visualize a mesh. The *Modalys* application launch the *medit* application to visualize a mesh. This application can be downloaded at http://www-rocq1.inria.fr/gamma/medit/medit.html.

Syntax

(**view ’mesh** *mesh*)

Parameters

mesh	Name of the mesh to be visualized

Examples

Create a mesh named `my-mesh` using the mesh tools (see **duplicate ’rotation** for example) and visualize it

```
(view ’mesh my-mesh)
```

See also

view ’mode, view ’object

22 (view ’mode)

Description

Animate a mode of vibration.

Syntax

(**view ’mode** *finite-element-object num-mode num-frame rep. [amp]*)

Parameters

finite-element-object	The finite element object for which a mode is to be visualized
num-mode	Number of the mode to be animated
num-frame	Number of frame in the movie for one oscillation
rep.	Number of oscillation
[amp]	Amplication coefficient (optional). A default is computed to fit in the window

Example

See the command

```
(view ’mode diapason-fem 18 20 5)
```

in the **compute-mode** example. Right click in the *medit* application to obtain the main-menu. Choose ’Play sequence’ in the ’animation’ sub-menu.

See also

compute-mode

23 (view ’object)

Description

Visualize an object with the choosen boundaries.

Syntax

(**view ’object** *my-finite-element*)

Parameters

my-finite-element	The finite element object to be visualized.

Examples

```
(view ’object my-fem)
```

See also

For details see **make-object ’finite-element**

24 fem-example

```
(new)
(define side 0.002)
(define r 7 )
(define s 21 )
(define h (* 2.2 r side ))

(define base ( make-mesh ’single-point (vector side side 0) ))
(duplicate ’translation base 1 (vector (* -2 side) 0 0))
(duplicate ’translation base 1 (vector 0 (* -2 side)  0))
(duplicate ’homothety base 1 (vector 0 0 ( * 2 side)) 1 )
(define base_inv (make-mesh ’copy base ))
(transform ’reflection base_inv (vector 0 0 1) (vector 0 0 ( * -2 side )))
(define base (make-mesh ’add (list base base_inv)))

(define diapason (make-mesh ’single-point (vector side side 0)))
(duplicate ’translation diapason 1 (vector (* -2 side) 0 0))
(duplicate ’translation diapason 1 (vector 0 (* -2 side) 0))
(duplicate ’translation diapason r (vector 0 0 (* 2 side) ))

(define arc (make-mesh ’restrict-quadrilateral diapason
(vector (+ 4 (* 4 r )) (+ 2 (* 2 r)) (+ 1 (* 2 r)) ( + 3 (* 4 r)))))
(duplicate ’rotation arc 6 (vector 1 0 0) (vector 0 side h) 15)

(define branch (make-mesh ’restrict-plane arc (vector 0 0 1) (vector 0 0 h)))
(duplicate ’translation branch s (vector 0 0 (* 2 side)))

(define fork (make-mesh ’add (list arc branch)))
(define fork-copy (make-mesh ’copy fork))
(transform ’reflection fork-copy (vector 0 1 0) (vector 0 0 0))

(define diapason (make-mesh ’add (list base diapason fork fork-copy )))

(save-mesh diapason "diapason.mesh")

(view ’mesh diapason )


(define hold (make-mesh ’restrict-quadrilateral diapason
(vector 63 189 188 62)))

(define my-finite-element (make-object ’finite-element (mesh diapason)
                                                        (modes 25)
```

```
                                                      (block hold)
                                                      (young 19.5e10)
                                                      (density 7700)
                                                      (poisson 0.2)
                                                      (freq-loss 0)
                                                      (const-loss 0)))

;(view ’object my-finite-element )

(compute-modes my-finite-element )

(set-mode-freq! my-finite-element 0 0)
(set-mode-freq! my-finite-element 1 0)

(save-object my-finite-element "diapason.modal" )

(view ’mode my-finite-element 3 10 3 )

(define my-fem-access-in ( make-access my-finite-element
(const 120) ’normal ))
(define my-fem-access-out ( make-access my-finite-element
(const 15) ’normal ))

(define my-plectrum (make-object ’bi-two-mass))

;;;
;;; make pluck connection
;;;

(define my-plectrum-plk (make-access my-plectrum (const 1) ’trans0))

(make-connection ’pluck my-fem-access-in my-plectrum-plk 0 .1 (const 50))

;;;
;;; make position connection to push plectrum
;;;

(define my-plectrum-mov (make-access my-plectrum (const 0) ’trans0))

(make-connection ’position my-plectrum-mov
                 (make-controller ’envelope 1
                                  (list (list 0.00   .1)
                                        (list 0.50  -.5))))
```

```
;;;
;;; make listening point on string
;;;

(make-point-output my-fem-access-out)

;;;
;;; run the synthesis and play the sound
;;;

(run 2)    ;; make 2 seconds of sound

(play)

(save "diapason.aiff")
```