Maya

Internal Structure
Programming Interfaces

- MEL - Maya Embedded Language
  - Scripting language
  - Interpreted
  - Fast prototyping, slow execution
- C++
  - Powerful, fast
  - Class libraries
Maya Architecture

Graphical User Interface

MEL Command Engine

Dependency Graph
Dependency Graph (DG)

- Data flow model
  - Data manipulated by series of operations
  - Pipeline
  - Push-pull model
- DG - heart of Maya
  - Data and operations represented as nodes
  - Network of nodes to perform task
  - Add functionality by defining new node
The Scene

- Entire 3D graphics state - the DG
  - Models
  - Animations
  - Textures
  - Lights
  - cameras
- Programming interfaces hide much of DG complexity
Data Flow

- Nodes
- *Attributes* - properties of a node
- Input/output
- *Compute function*

```
| time           | NurbsSphere1_translateX | nurbsSphere1 |
```
**NODE**

- **node**
- **input**
- **output**
- **Compute()**
Node attributes

<table>
<thead>
<tr>
<th>node</th>
</tr>
</thead>
<tbody>
<tr>
<td>size(float)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>node</th>
</tr>
</thead>
<tbody>
<tr>
<td>pointA (compound)</td>
</tr>
<tr>
<td>x (float)</td>
</tr>
<tr>
<td>y (float)</td>
</tr>
<tr>
<td>z (float)</td>
</tr>
</tbody>
</table>
Node

- points (array)
  - [0] point compound
    - x (float)
    - y (float)
    - z (float)
  - [1] point compound
    - x (float)
    - y (float)
    - z (float)
  - [...] point compound
Custom attributes can be added
e.g., mass, velocity

Window->Attribute editor
Attributes->Add Attributes
Connecting attributes

Window->General Editors->Connection editor
OR
MEL: connectAttr sphere.tx cone.ty

Driven keys as explained by technical group
Compute Function

- Output = compute(input0, ..., inputN)
- Input and output attributes are LOCAL
- Black box
- Interface: input and output attributes
Dependent Attributes

- Volume = compute(sphereSize)
- attributeAffects( sphereSize, volume)
Time

- Example of node that only holds data
- Current time in time node named time1
- Moving frame slider or click on Play sets time

<table>
<thead>
<tr>
<th>time</th>
</tr>
</thead>
<tbody>
<tr>
<td>outTime (time)</td>
</tr>
</tbody>
</table>
Connecting Nodes

- Connect nodes by connecting node attributes
- Attribute can only connect to attribute of same type
- Maya handles flow of data; node not ‘aware’ of connections
- Connections: one-to-many mappings
- When connections broken, node retains value
DAG nodes

- Directed Acyclic Graph
- DAG nodes form Shape-Transform hierarchy
- DAG nodes are in DG - they are DG nodes
  - Some DAG nodes connect to non-DAG DG nodes
  - Some DAG nodes may not be connected to any non-DAG nodes
- Maya shows either DAG hierarchy or connected DG nodes, not both simultaneously
Shape Nodes

- Meshes
- NURBS curves and surfaces
- Springs
- Camera
- Lights
- Particles
- Etc.
Transform Nodes

- Shape node can’t exist without a transform node
- Shape node holds the data
- Transform node transforms from objects space to world space
Dependent Attributes

- attributeAffects( width, areaOfTop)
- attributeAffects( depth, areaOfTop)
- attributeAffects( areaOfTop, volume)
- attributeAffects( height, volume)
Transform Hierarchy

- Head
  - Torso
    - right arm
    - right leg
    - left leg
    - left arm
Animation

Expressions – expression editor
Baking simulations
Record output of expressions
Makes each frame a single frame

Connecting attributes

Handling complexity
• Layers
• Groups
• Reference & proxy files