Intelligent Constraints

- *Dual constraints*
  - Support limited two-way constraints for nonhierarchical groups (e.g., siblings)
  - Specified by geometry (point, line, or polygon) and *normal vector* (pointing away from object)
Intelligent Constraints

- **Dual constraints**
  - Build group: When object $A$ is moved, if one of its dual constraints is sufficiently close to an appropriately shaped dual constraint of another object $B$
    - $A$ and $B$ are snapped together such that geometries of the dual constraints are coincident and normal vectors are opposite
  - Maintain group: When object $A$ is moved
    - All grouped objects in contact in direction of motion are moved with $A$
  - Break group: When object $A$ is moved
    - All grouped objects *not* in contact in direction of motion do not move, are broken off from $A$, and form new group(s)

Push against = build group
Push with = maintain group
Push away = break group

How can this approach be generalized for motion in an arbitrary direction?
Intelligent Constraints


- Dual constraint graph
  - Specifies direction of connectivity of grouped objects based on normal vectors
  - Supports intuitive splitting of dual groups by generalizing "objects in contact in direction of motion"
  - When selected object A is moved, of those objects currently grouped with A,
    - The only objects that move with A and remain grouped with A are those connected to A in a direction within 90° + tolerance (e.g., 10°) of movement direction, and those that recursively meet that requirement
    - Remaining objects are broken off from A and form new fully connected group(s)

http://ws.ist.sfu.ca/videos/mive_duals.mpg
Realism vs. Magic

- Realism isn't always desirable
- Can violate realistic metaphor to improve functionality
  - E.g., K. Herndon et al., "Interactive Shadows," UIST 92

Figure 5: Fully-rendered shadows are used to display surfaces of objects that are not directly visible from the user’s point of view. Note that in the mirror view, one can see that the landing gear is aligned with the landing gear bay.

- Shadows are fully rendered (similar to reflections)
- Manipulating shadow manipulates its object