Automatic Modification of Model Topology

Topological Changes

- We have previously studied parametric modeling and constraint solving in sketches. If we modify the value of a parameter or move geometry, then the values of other parameters and positions of other geometry also change accordingly.
- This lecture looks at changes involving the existence of entities and relationships in the design model.

Topological Changes

- Topological changes can be of 4 types
  - Entity added to model
  - Entity removed from model
  - Relationship added
  - Relationship removed

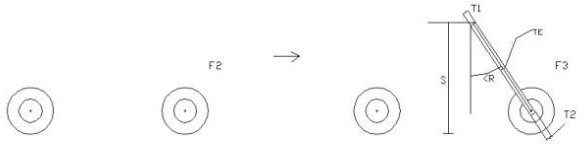
Automated Design Techniques

- We know that a designer can add features or remove features. We also know that parametric models can define the number of instances of a pattern or even turn features on and off.
- We will study one technique that automatically and continually modifies the topology of design models in order to achieve innovative resulting designs:
  - Shape grammars

Shape Grammars

- Productions are rules that contain a "before" pattern and an "after" pattern. If the "before" pattern matches the current design, the design is modified to match the "after" pattern.
- E.g.: Productions to reproduce the classic design of a Harley-Davidson motorcycle (Cagan, 2002; www.andrew.cmu.edu/org/CDL/):

4 Add front fork



Shape Grammars

- More productions (Cagan, 2002):

17 Engine: Create crankshaft & housing

18 Engine: Add Cylinders

25 Fuel Tank: Create fuel cap or speedometer

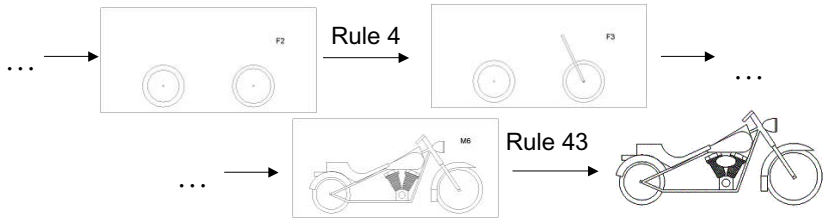
Shape Grammars

- Some productions are special:
  - Starting production detect empty design model

  - Terminating production terminates the application of productions

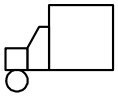
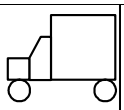
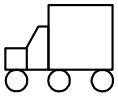
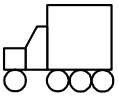
Shape Grammars

- The design is therefore built up by continuously trying to apply productions.
- Design variation occurs when more than one production is applicable at the same time. In that case some technique must be used to choose between designs.



Shape Grammars – Another Example

Rule #	Rules	User Inputs
1	Nothing → 	Position of Cab
2	 → 	Position of motor
3	 → 	Position of Cargo Box
4	 → 	Position of Wheel Set
5	 → 	Position of wheel Set

						
1) Rule 1 Applied	2) Rule 2 Applied	3) Rule 4 Applied	4) Rule 3 Applied	5) Rule 5 Applied	6) Rule 5 Applied	7) Rule 5 Applied