



Introduction to **STEP-NC**

*The STEP-NC Backbone:
Workpiece and Features*

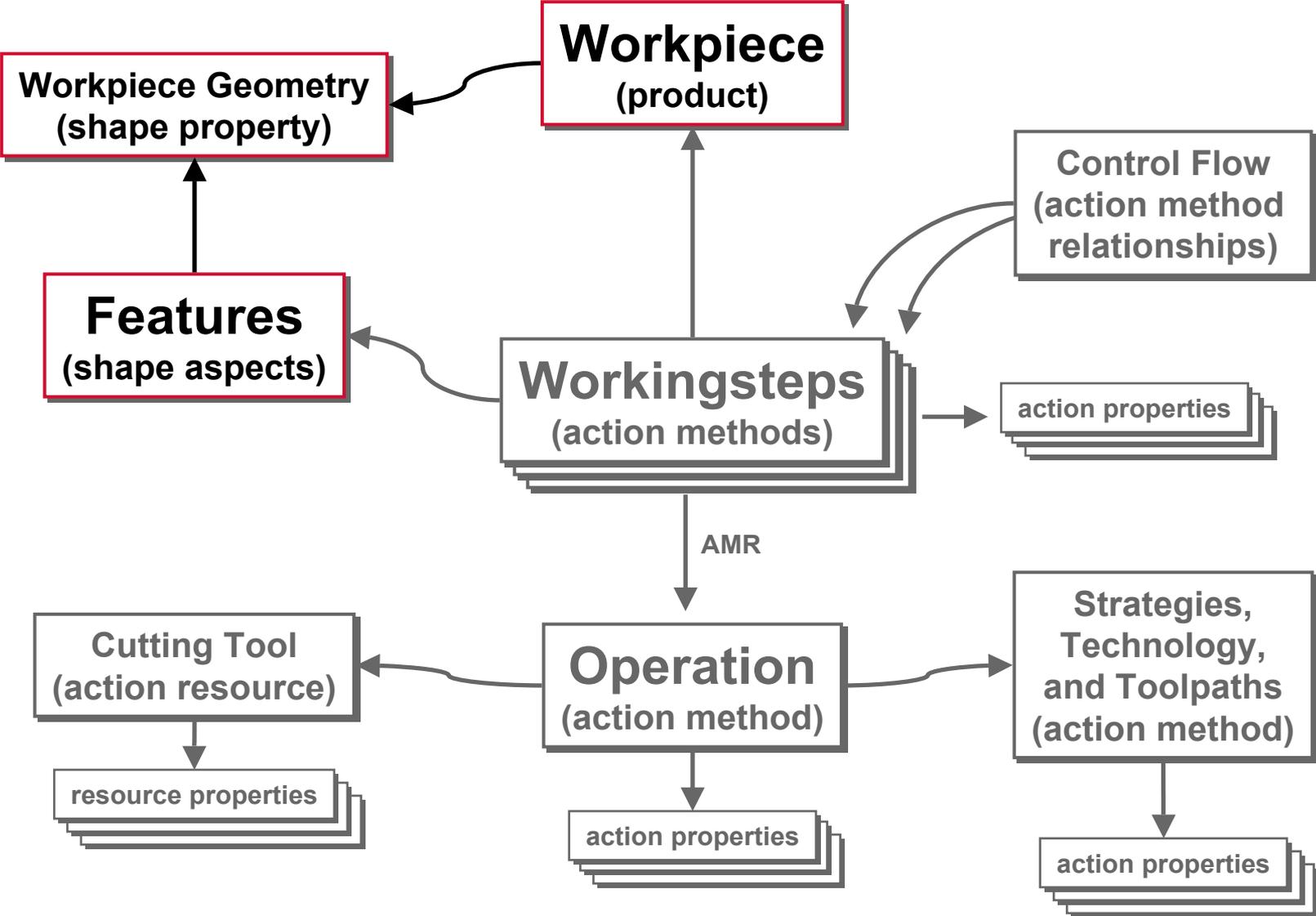


STEP Tools, Inc.

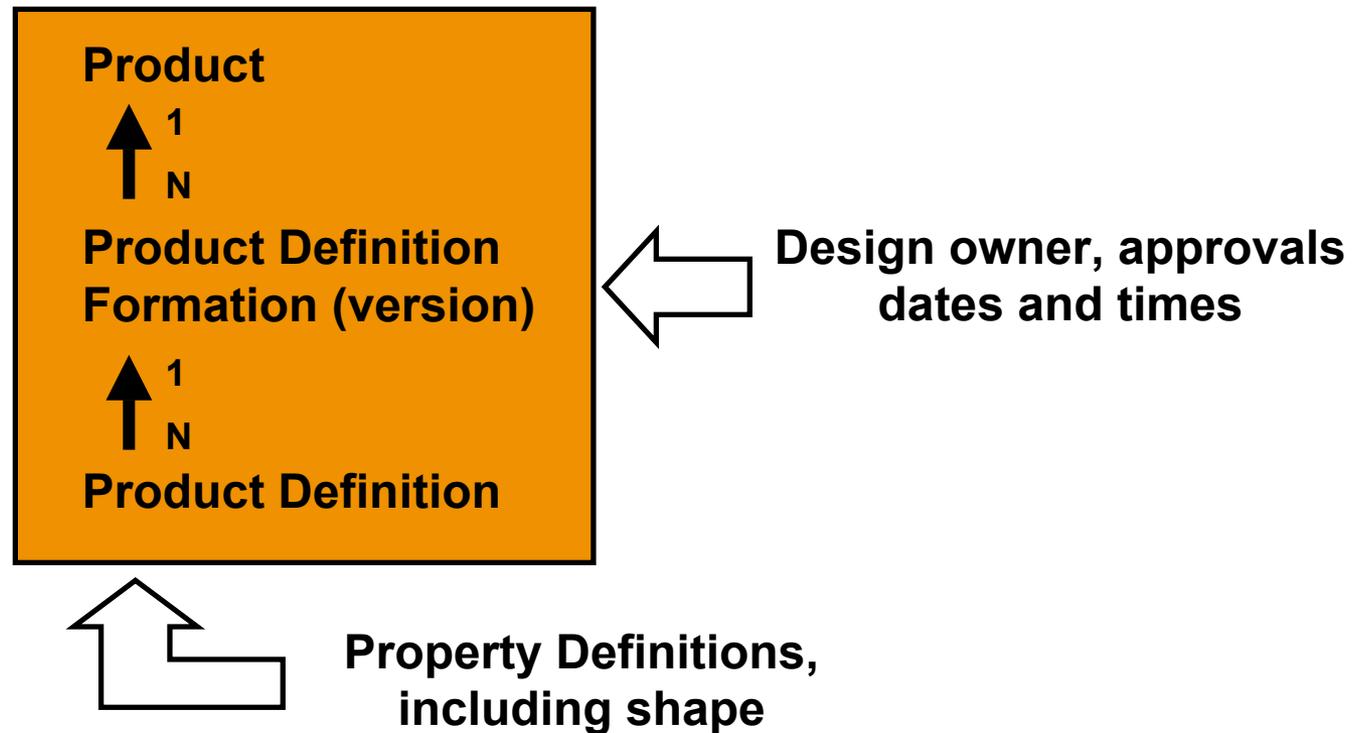
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- **Workpiece and Features**
 - Describe the final result of the operation and manufacturing features on that.
- **Questions**
 - How is the workpiece represented?
 - How do we find the shape of the workpiece?

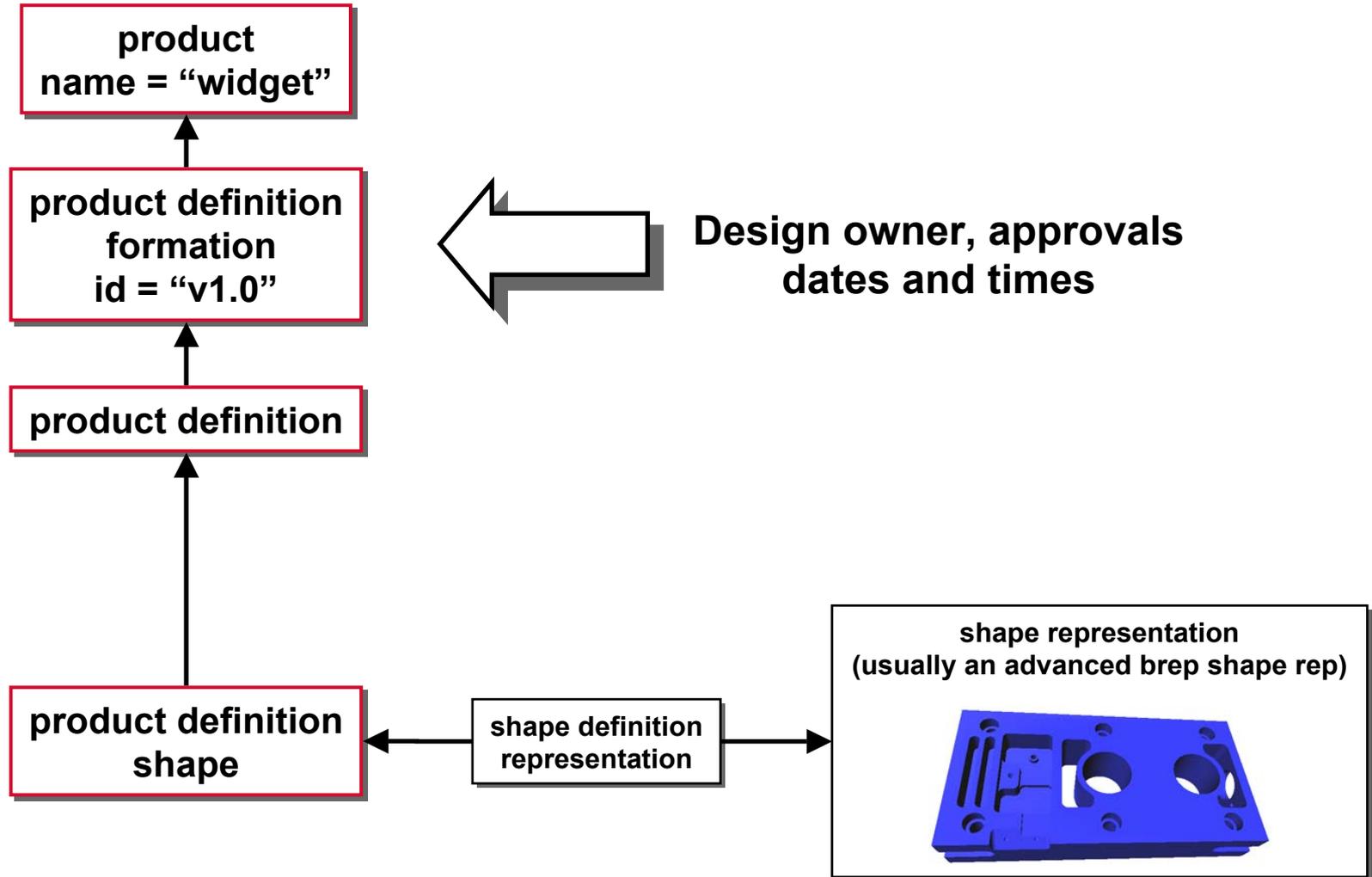
 - What features are available
 - How are features represented?
 - How are features associated with the workpiece shape?

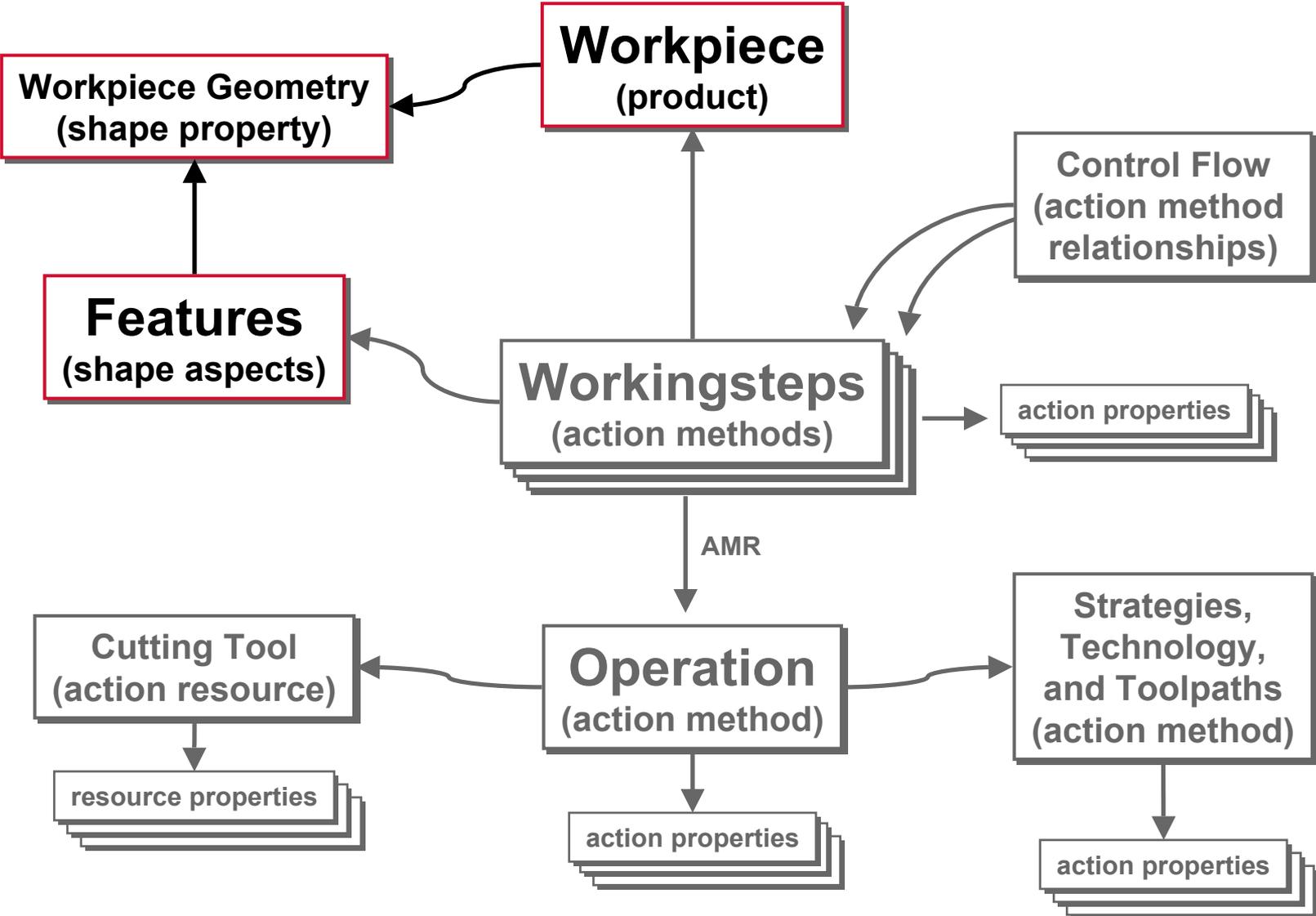


- **The workpiece is a STEP product**
 - All of the usual background information
 - Product, with a formation, with a definition
 - Product definition has associated geometry



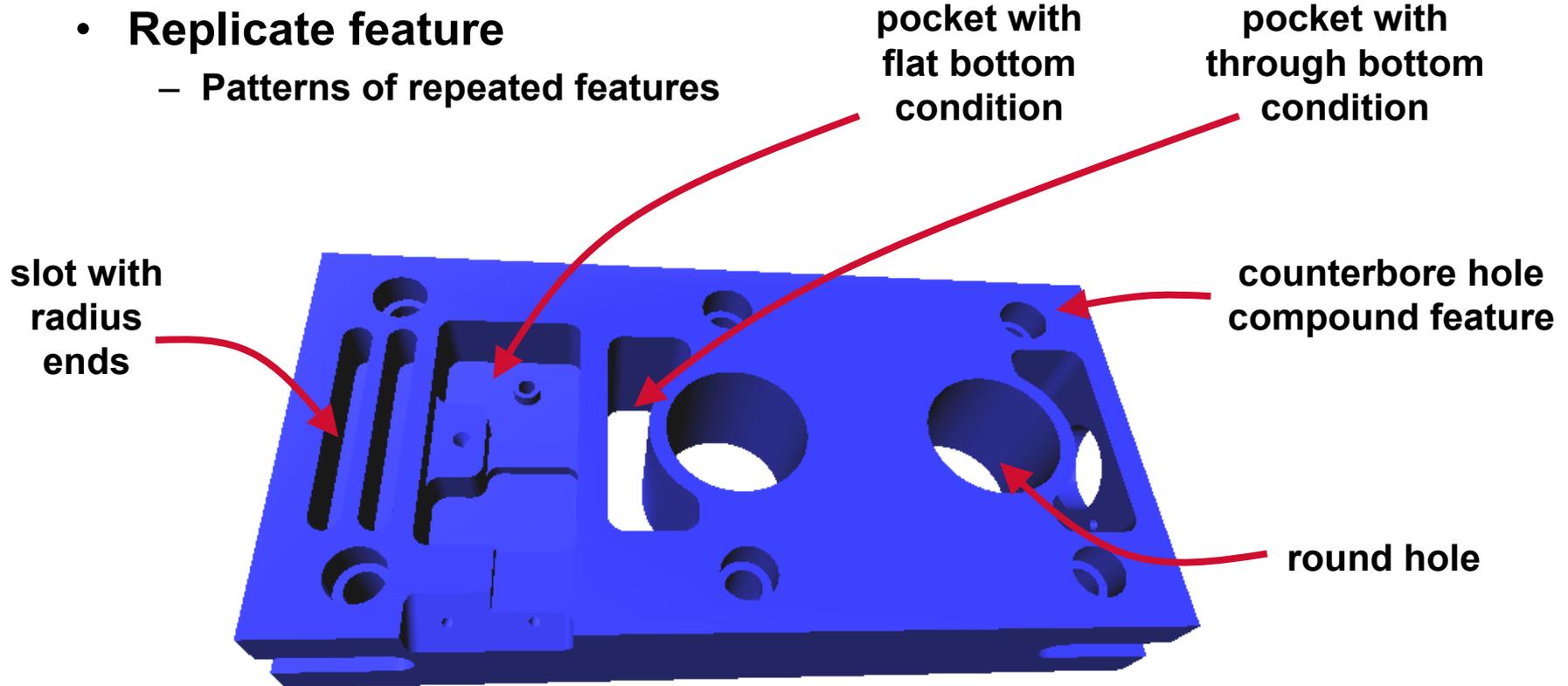
The Workpiece



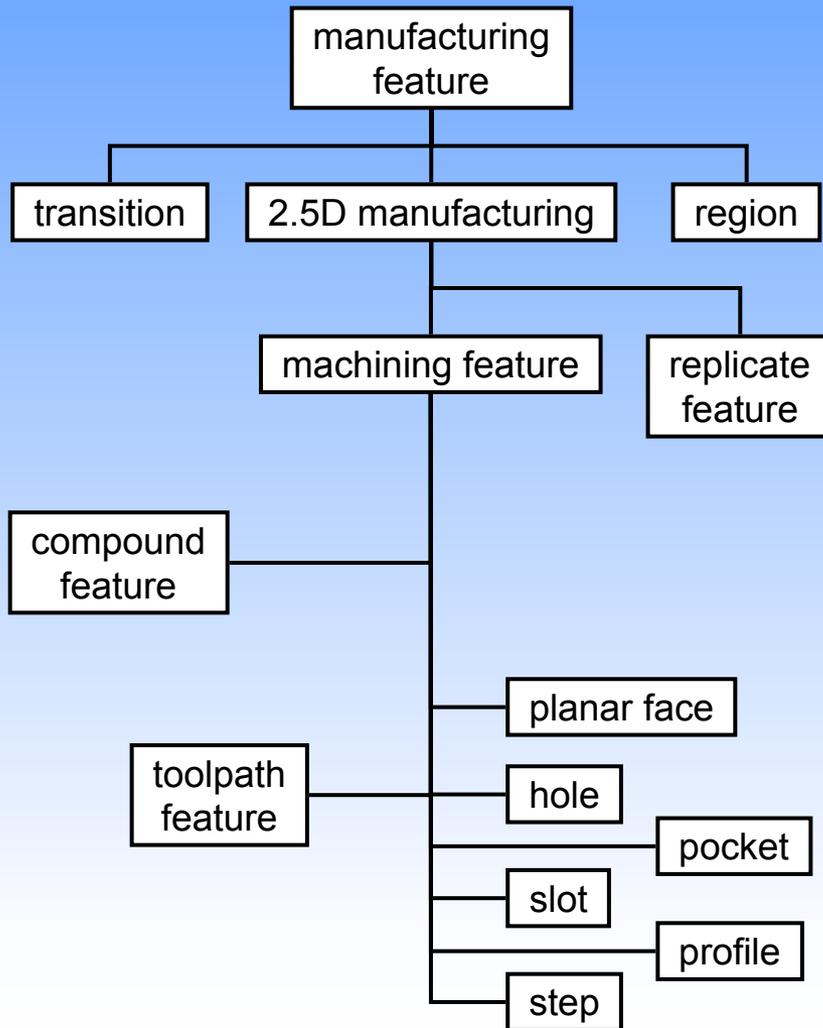


- **Features describe material removal areas on a workpiece.**
 - These are manufacturing features, well-defined set.
 - Not design features, which can be anything!
- **Features describe the desired result of a machining process.**
 - Features describe “what”, the controller will decide “how”
 - Tool paths describe “how”, no one really knows “what”

- **2.5D milling features**
 - Hole, pocket, slot, step, etc
- **Transition features**
 - Edge round and chamfer
- **Replicate feature**
 - Patterns of repeated features
- **Region features**
 - Surfaces for freeform milling



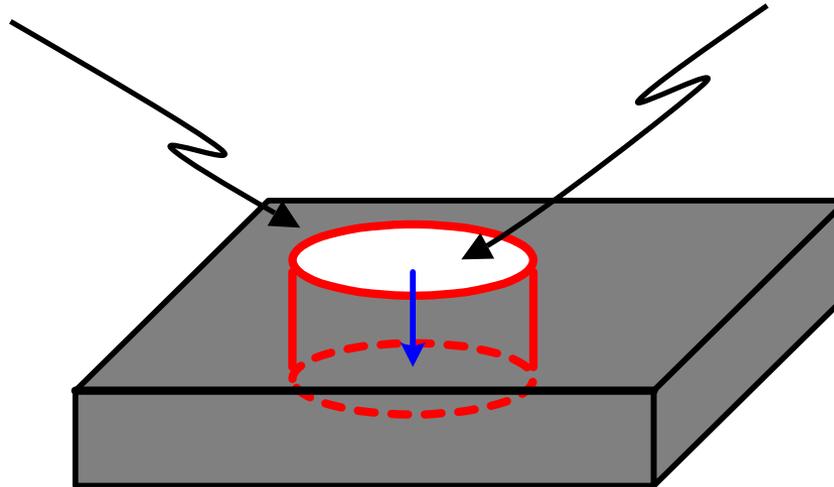
STEP-NC Features

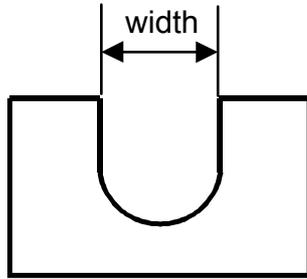


Explicit geometry, points out a surface for freeform milling (5 axis and such)

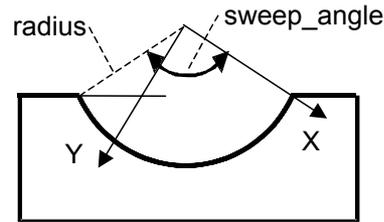
Implicitly described using profile and path parameters, not explicit geometry

- **Features are described parametrically using a combination of Profiles and Paths**
 - A Profile is swept over the entire length of a Path
 - Profiles described by key parameters, like length, radius.
- **For example, a round_hole is defined by a Complete_circular_profile and a Linear_path**

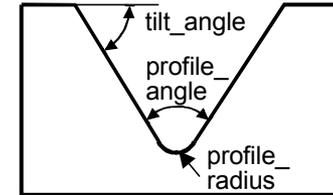




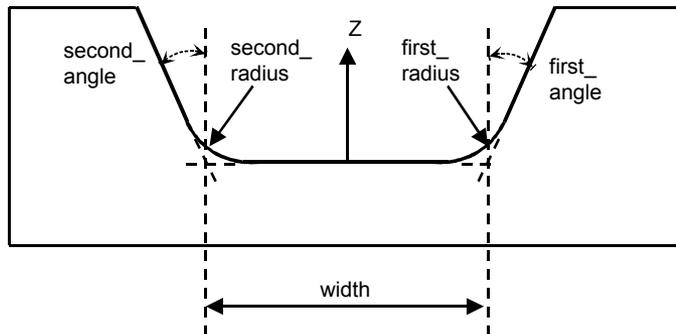
Rounded "U"



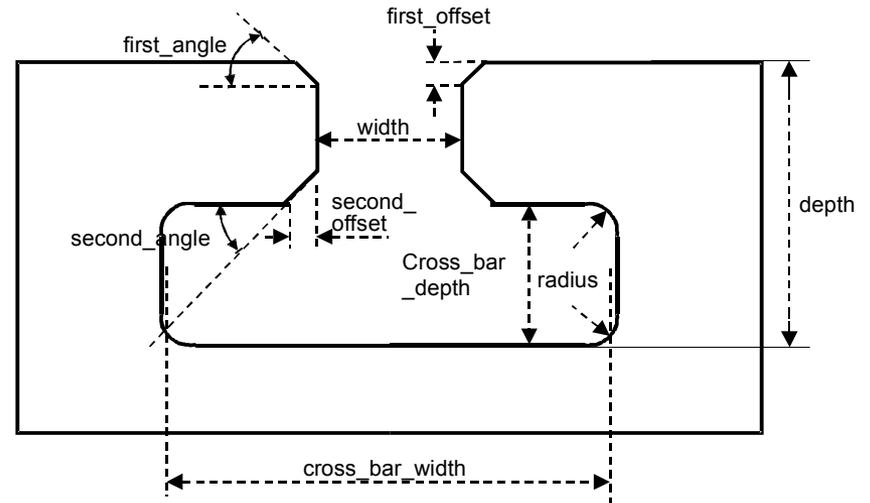
**Partial
Circular**



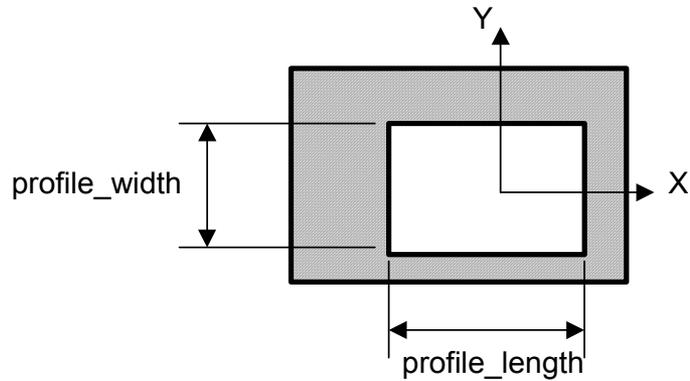
"Vee" Profile



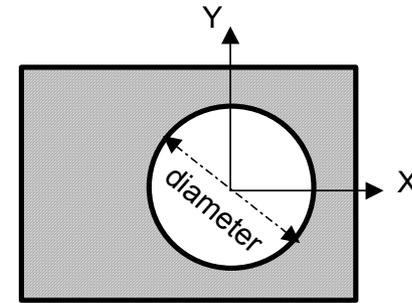
Square "U"



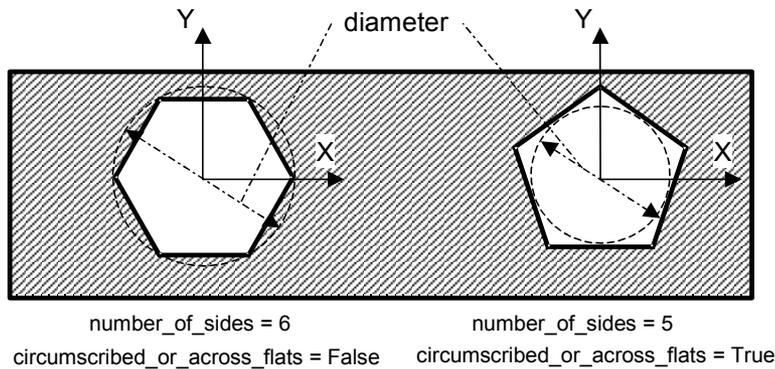
"Tee" Profile



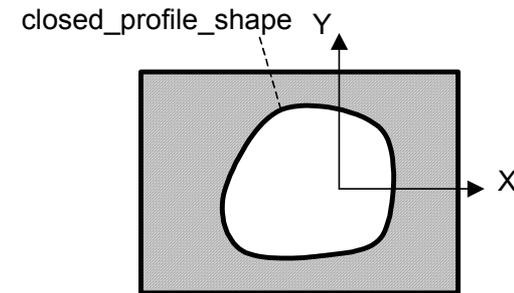
Rectangular



Circular

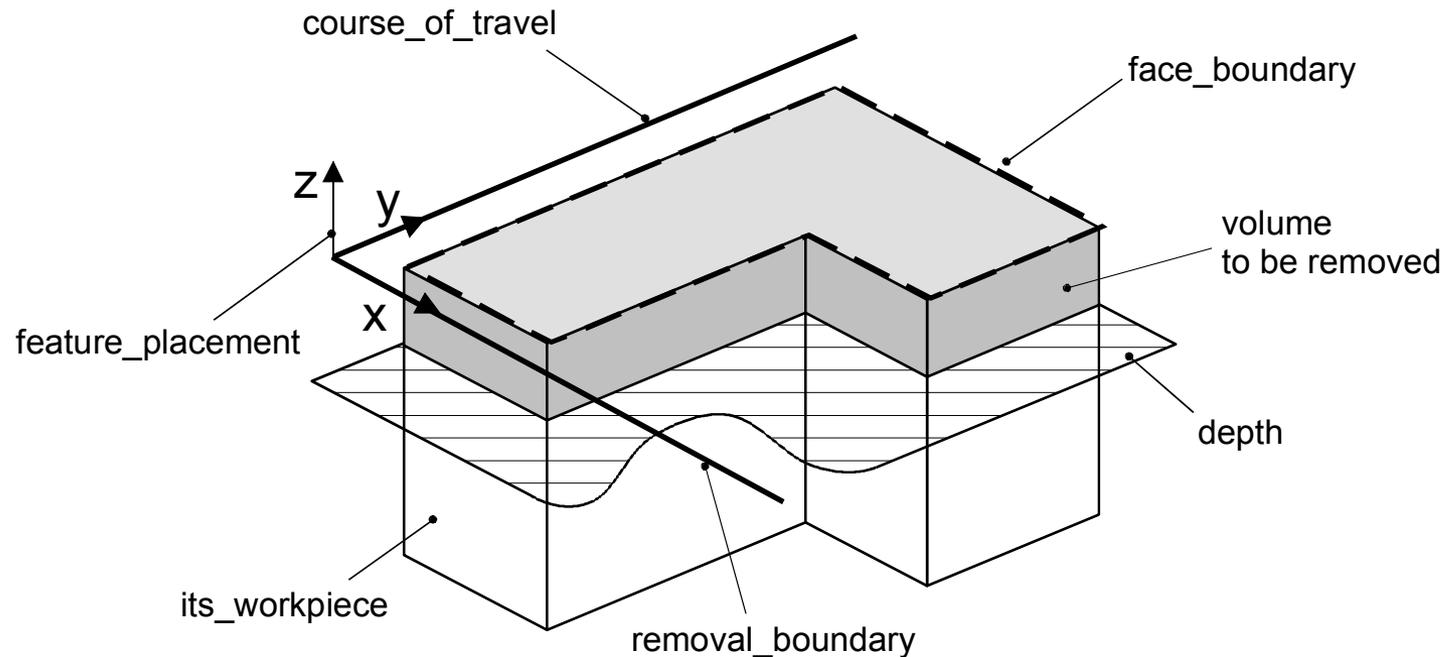


N-Gon

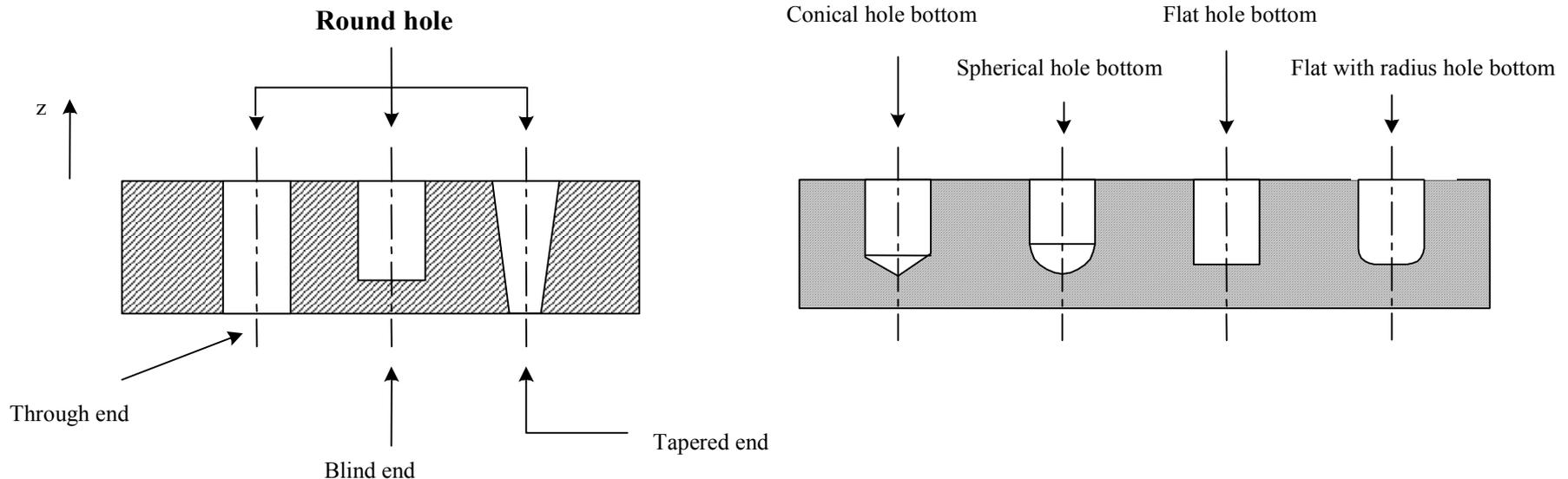


General

- A planar face sweeps a linear profile along a linear path

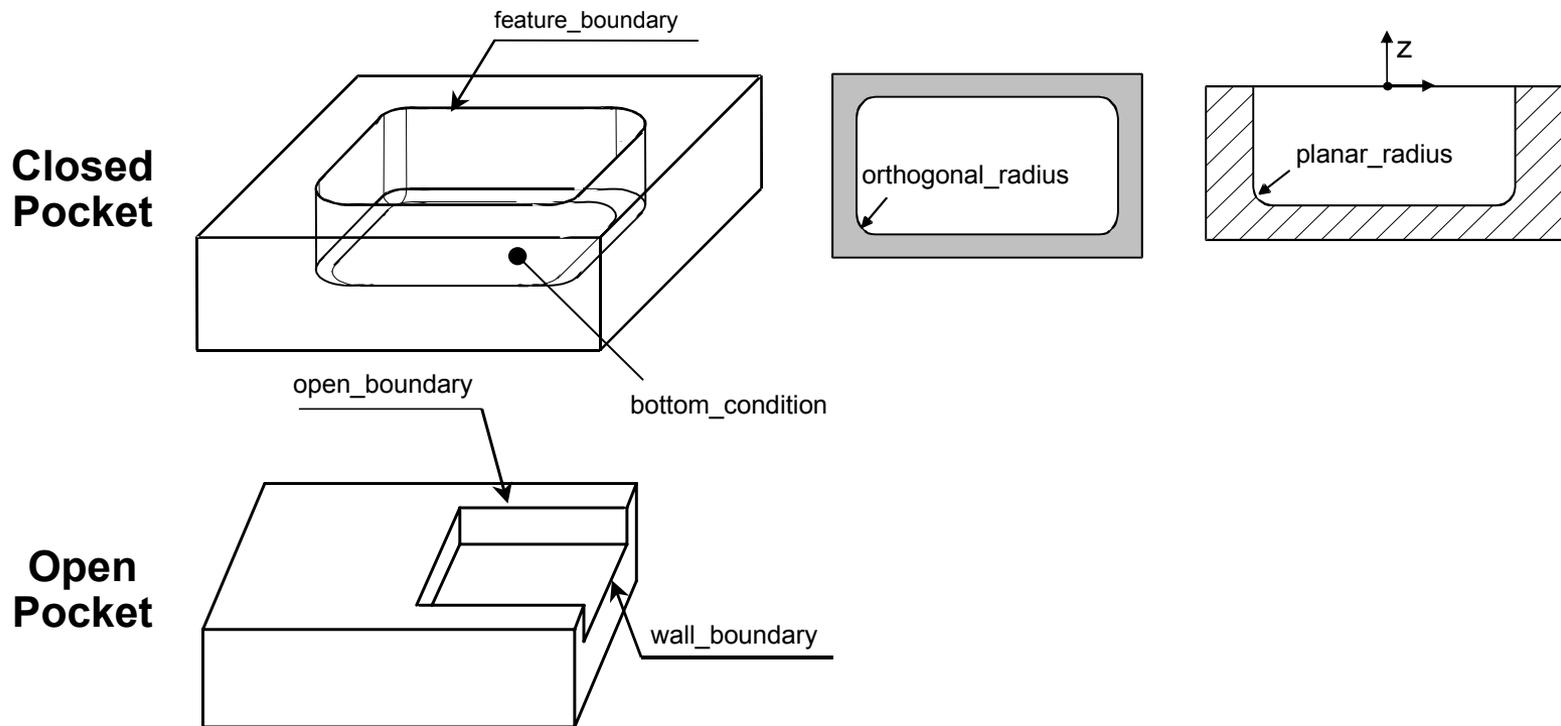


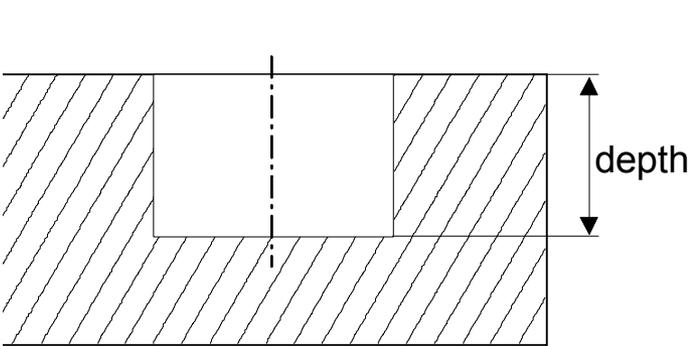
- **A Round Hole sweeps a circular profile down a linear path**
 - Also can have taper and bottom conditions
 - Special counterbore and countersunk hole types



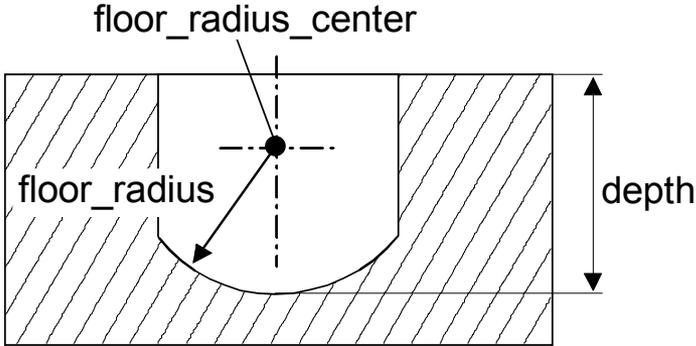
Hole Taper and Bottom Conditions

- **A pocket sweeps a boundary profile down to a depth**
 - Also can have bottom condition and bosses
 - Bosses have a profile for their top

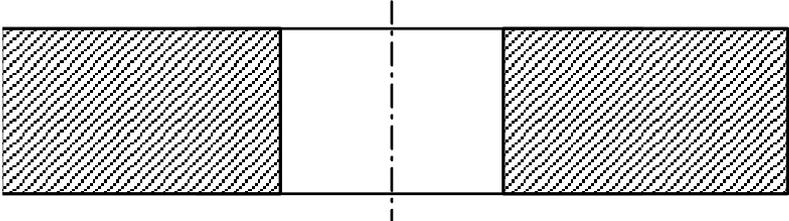




Flat

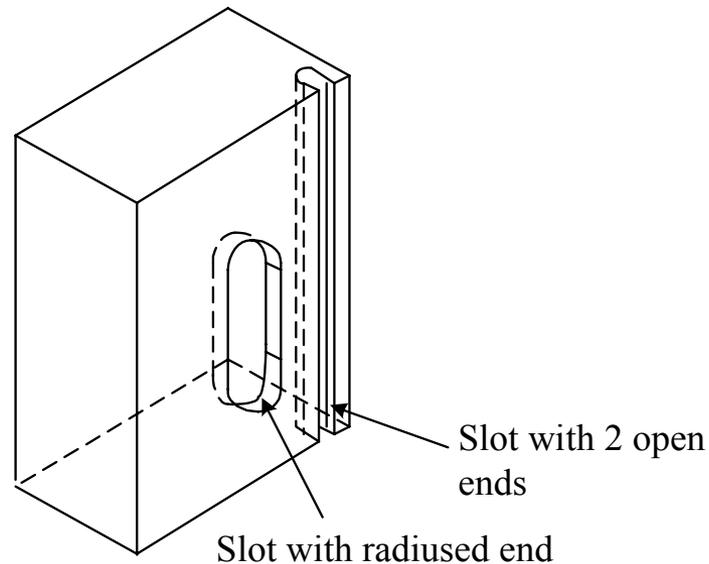


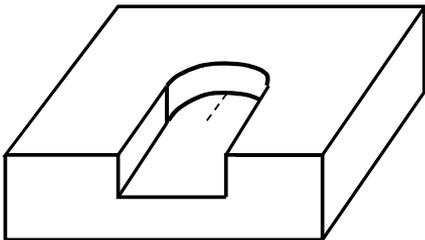
Radiused



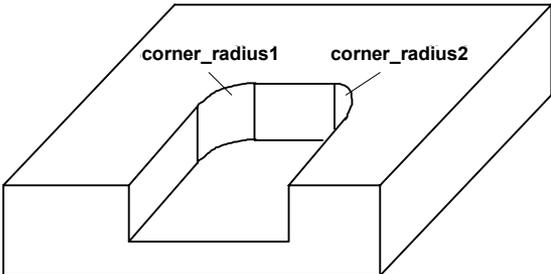
Through

- **A Slot sweeps an open profile along a path**
 - Also has an end type for each end

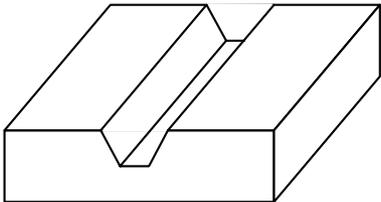




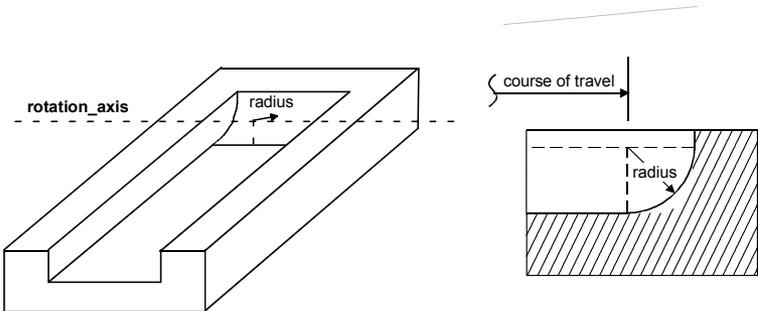
Radius



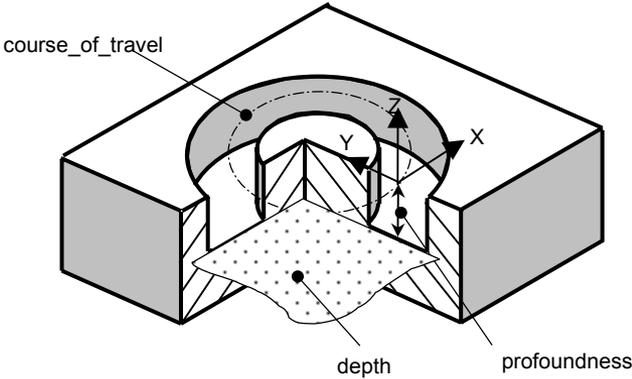
Flat



Open

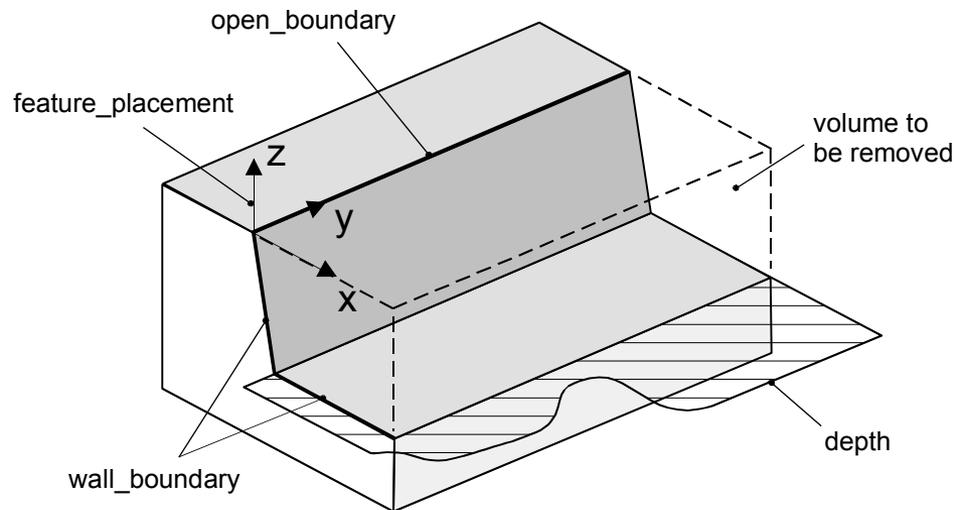


Woodruff

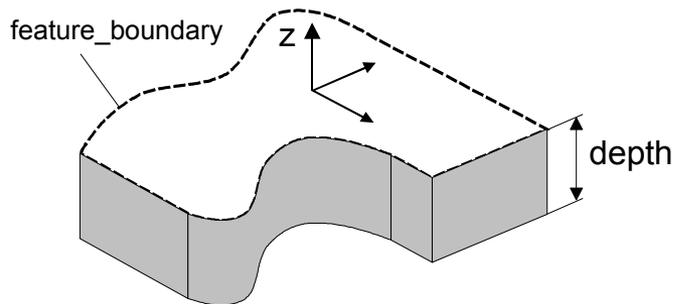


Loop

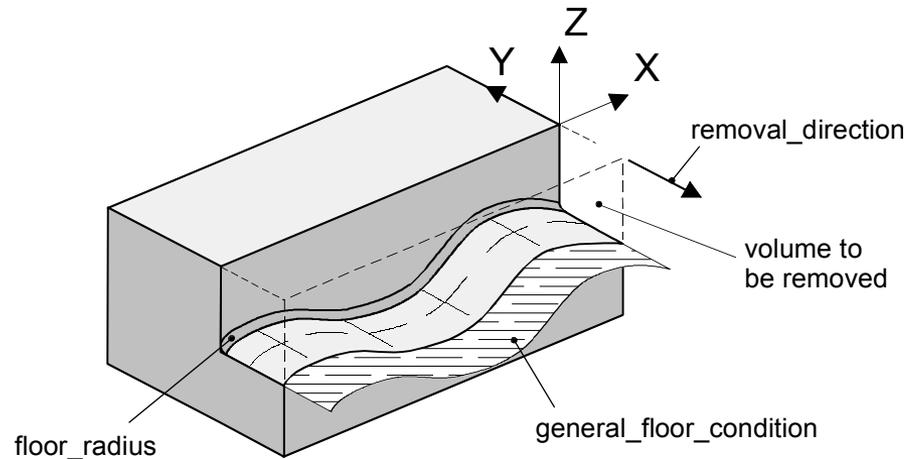
- **A Step sweeps a Vee profile along a linear path**
 - Often a right angle, but could be other angles



- **Two kinds of profile features**
 - A general outside profile sweeps a line along a profile (which could be either implicit or explicit geometry)
 - A shape profile sweeps a line along a profile leaving a floor condition.



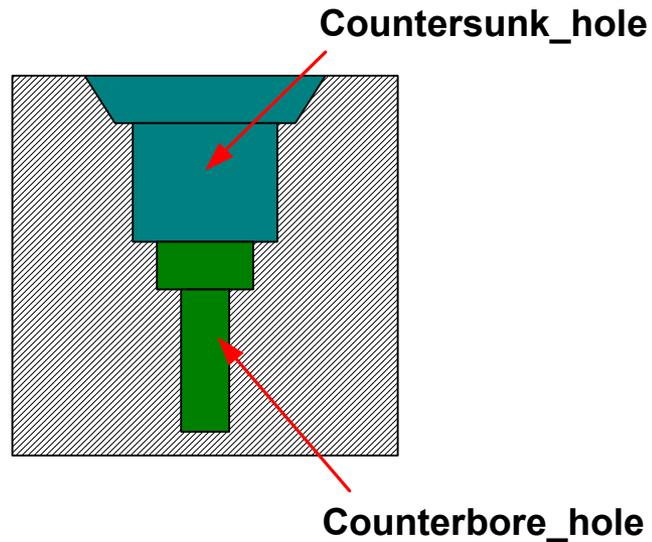
Outside Profile



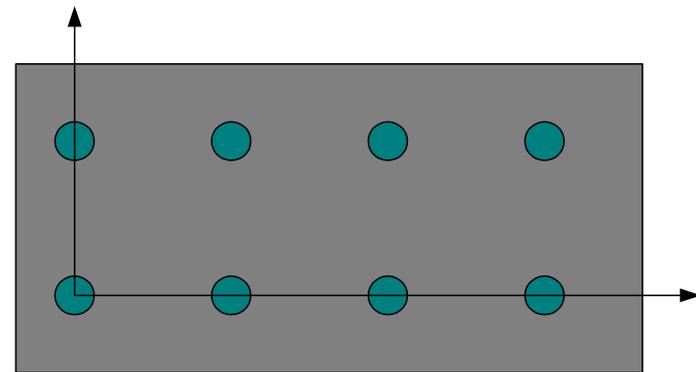
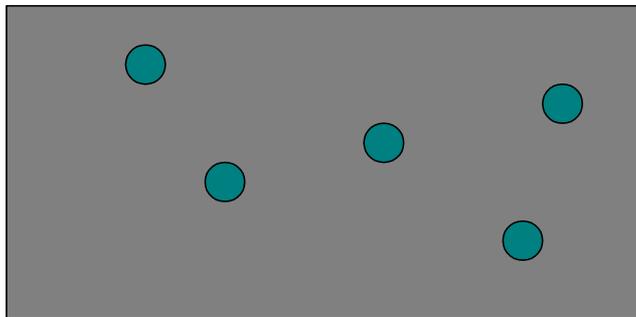
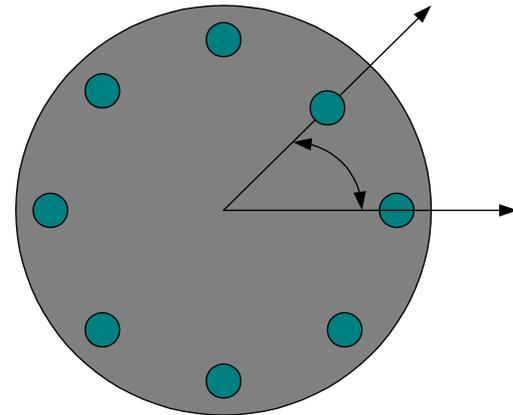
Shape Profile

- **Region Feature**
 - Region can call out specific geometry types (swept surface, geometrically bounded bag of surfaces, and open shell)
 - Used for freeform milling
- **Toolpath Feature**
 - Just a “marker” to associate a location on the part with a pre-computed tool path — no other information.
- **Compound Feature**
- **Replicate Feature**
- **Transition Feature**

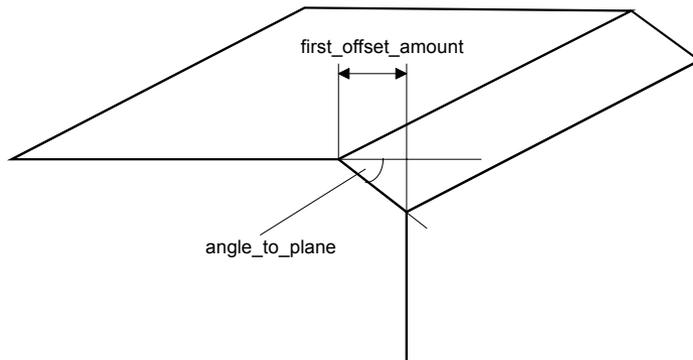
- **Union of one or more features to create a more complex feature definition.**
 - For example, a counterbore hole in the bottom of a countersunk hole.



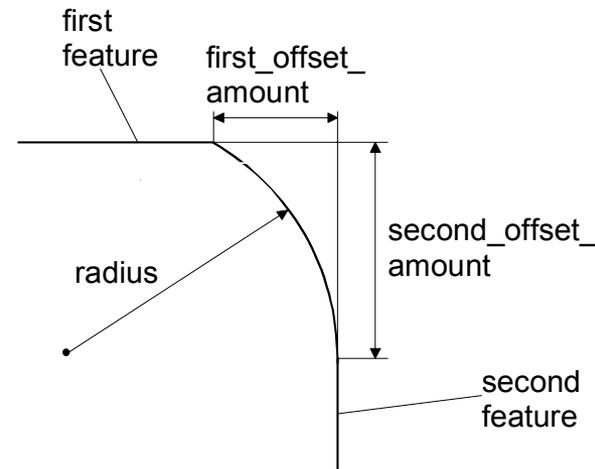
- Three different ways to replicate features
 - Circular_pattern
 - Rectangular_pattern
 - General_pattern



- **Chamfer and edge round relate two surfaces**
 - AP-224 also had a fillet, but in STEP-NC this is just the consequence of a particular tool choice.

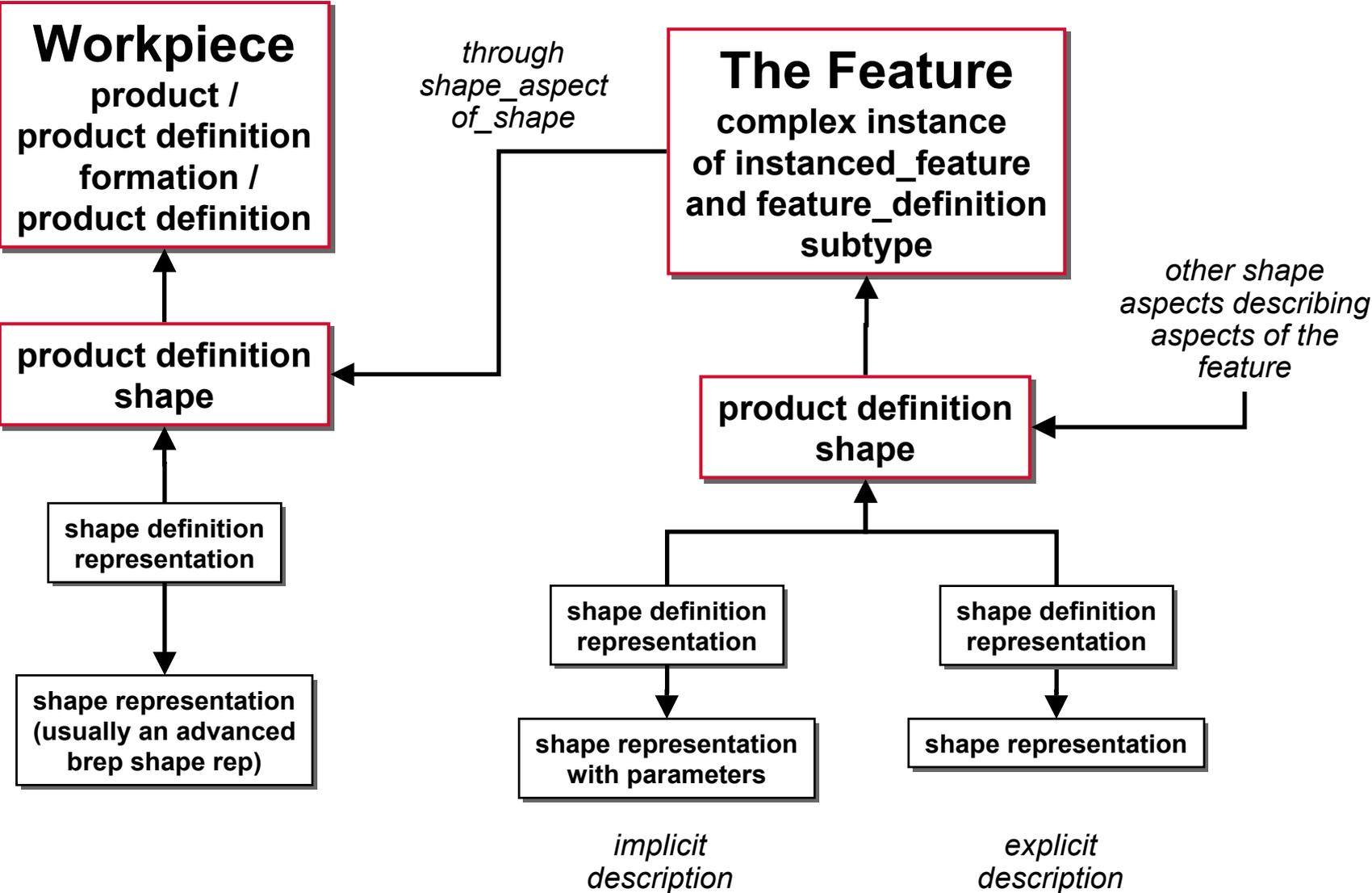


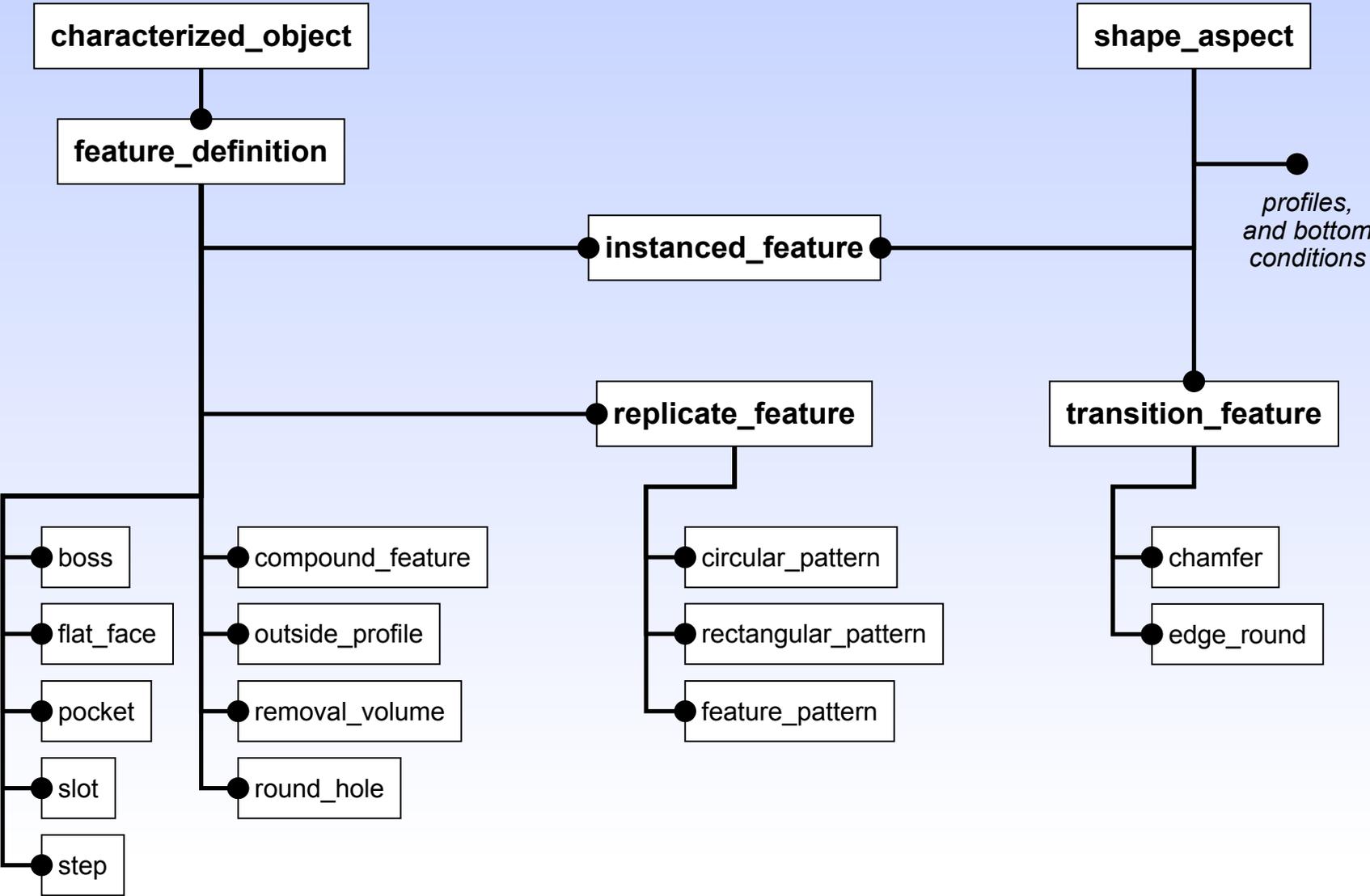
Chamfer

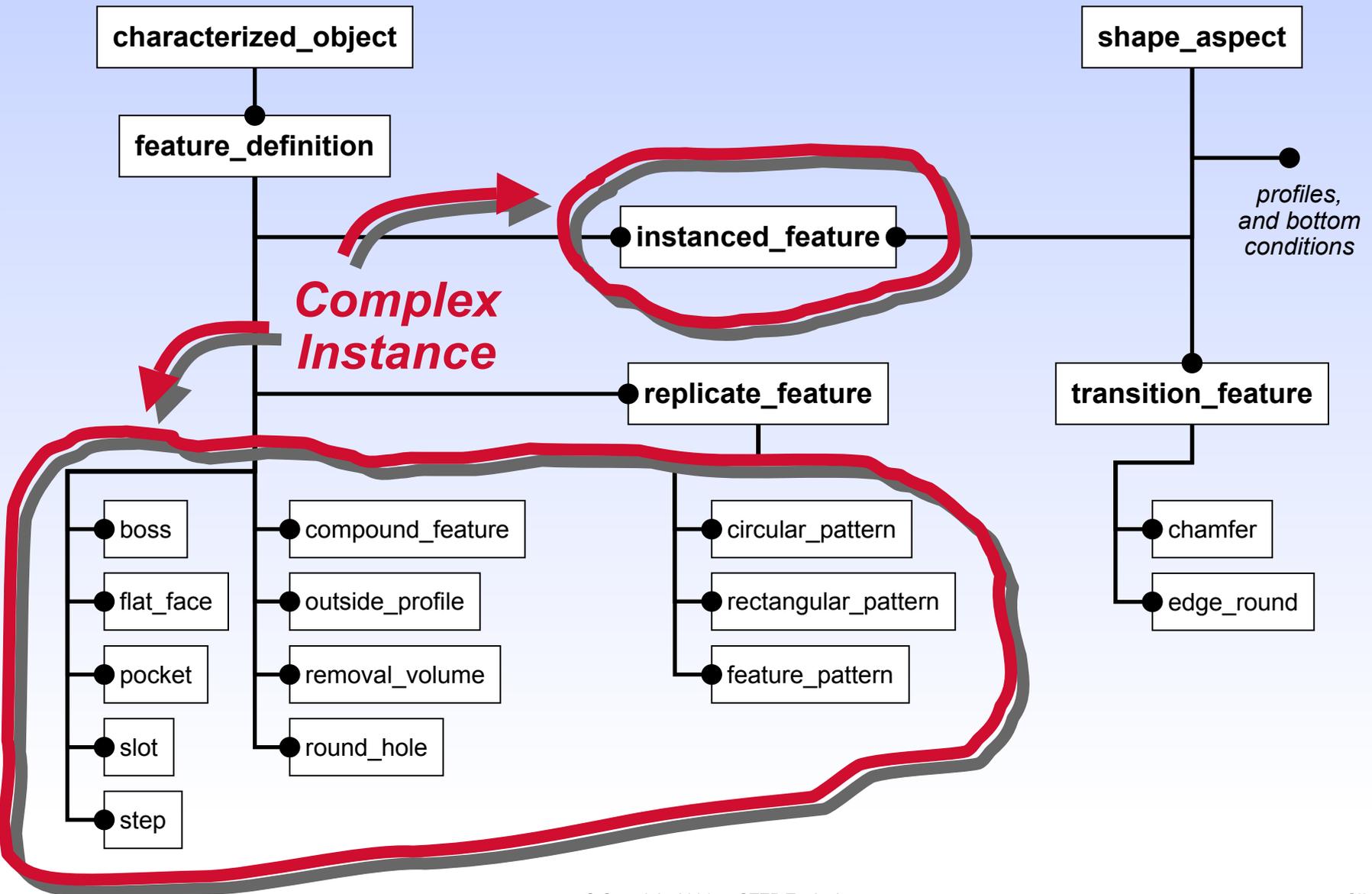


Edge Round

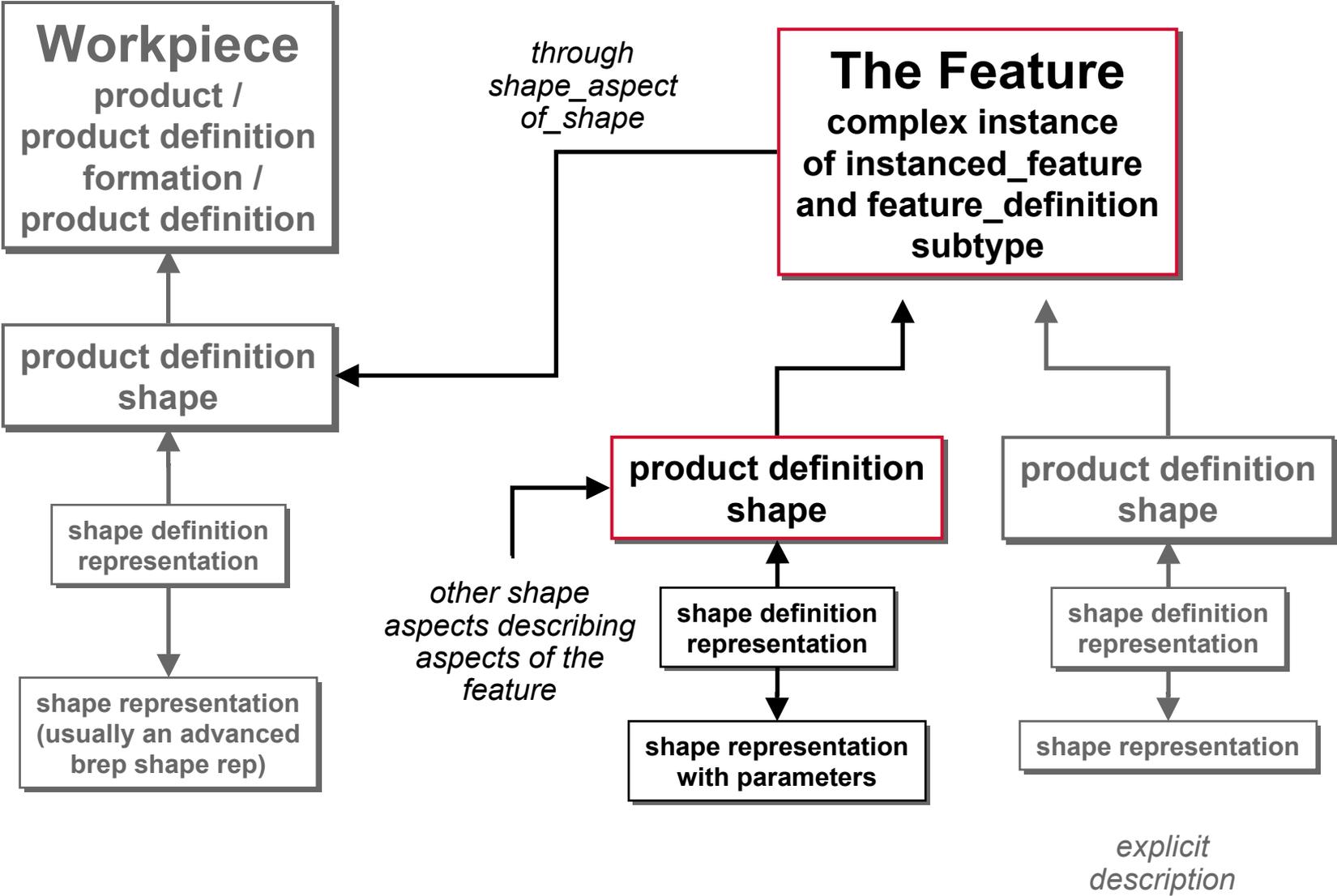
- **These are the ARM information requirements**
 - How are they represented in the AIM?
- **Features are shape aspects on the product shape**
 - Features can have both implicit and explicit descriptions of the shape
 - **Implicit uses shape_representation_with_parameters**
 - » captures how feature is formed with a constellation of associated shape aspects.
 - » representation items are measures for length, width, etc.
 - **Explicit uses shape_representation**
 - » uses surfaces also referenced by the workpiece shape
 - » representation items are Part 42 geometry

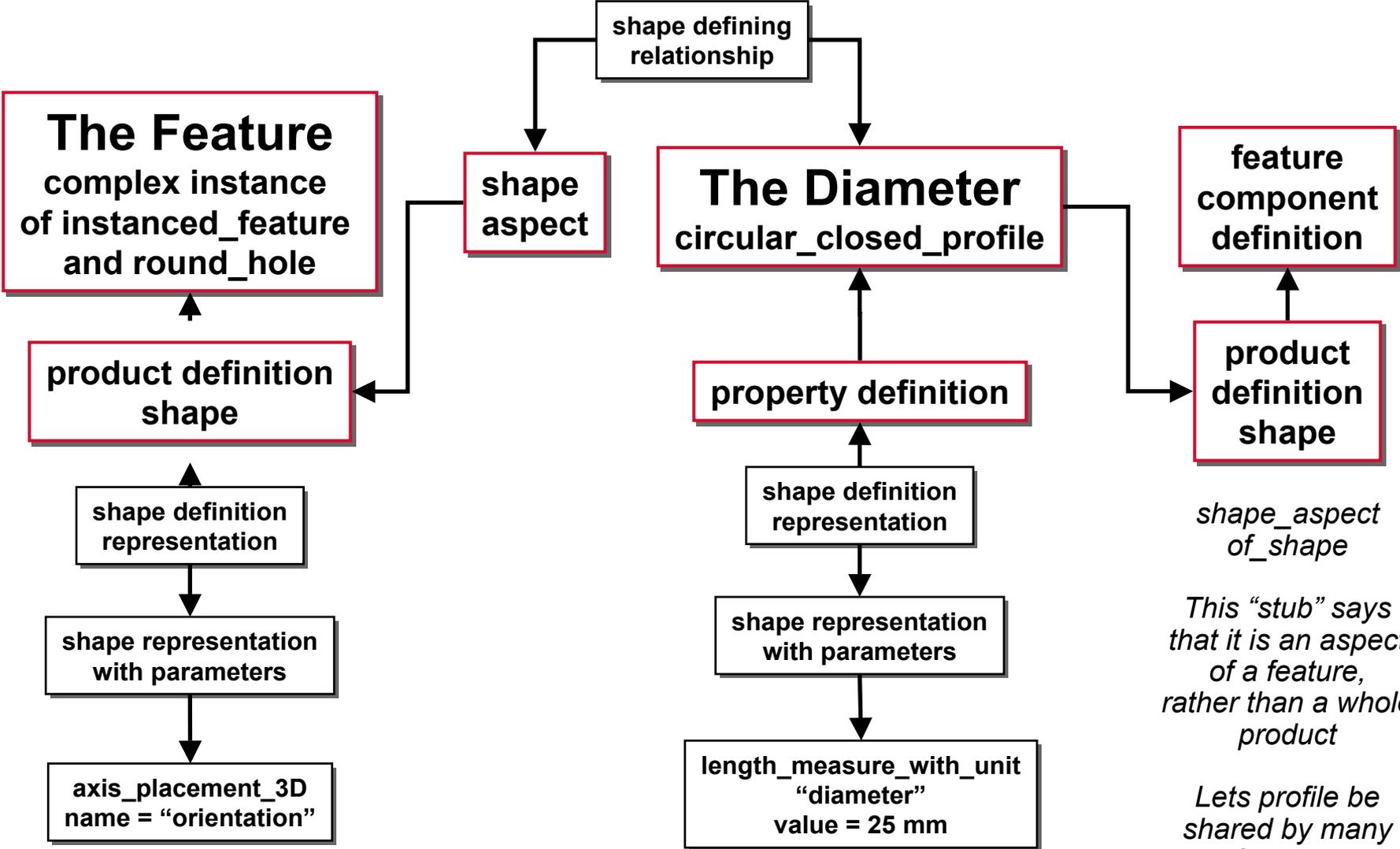






- **Define a round hole feature**
 - Implicitly described by sweeping a circular profile along a path.
- **Instance Diagram**
 - Will be represented by instanced feature and round_hole
 - Will other shape aspects will describe the circular profile and the swept path.

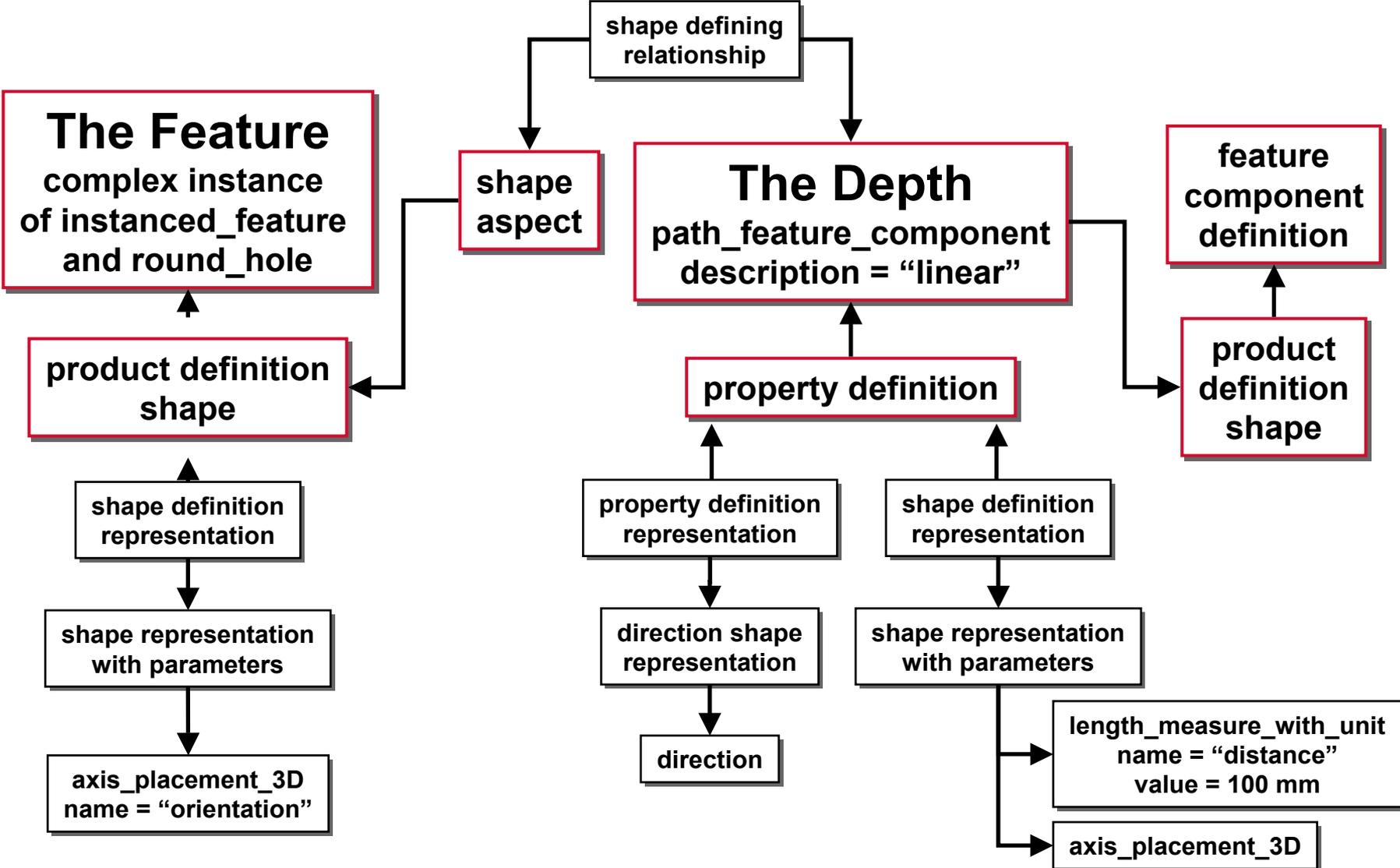


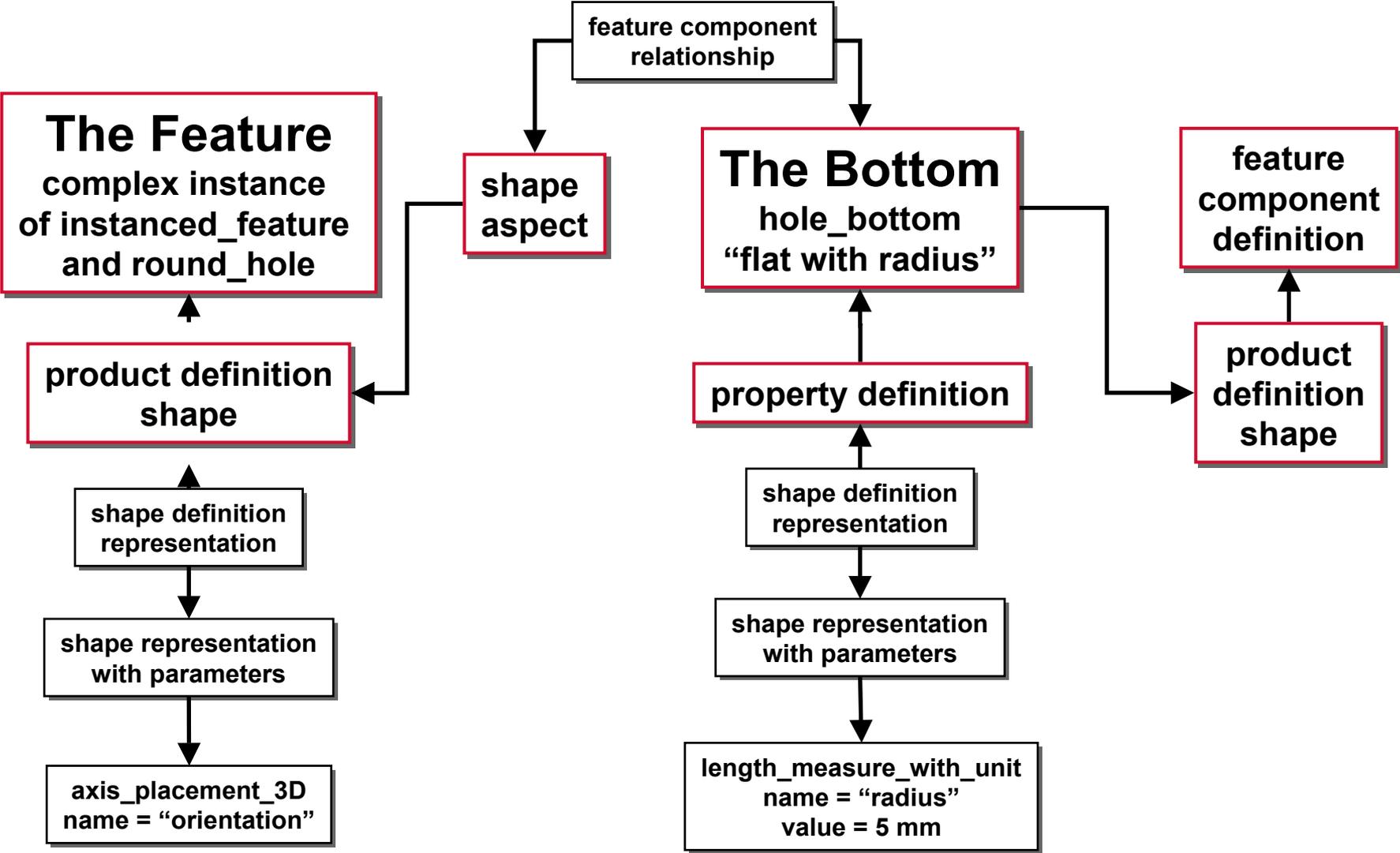


shape_aspect of_shape

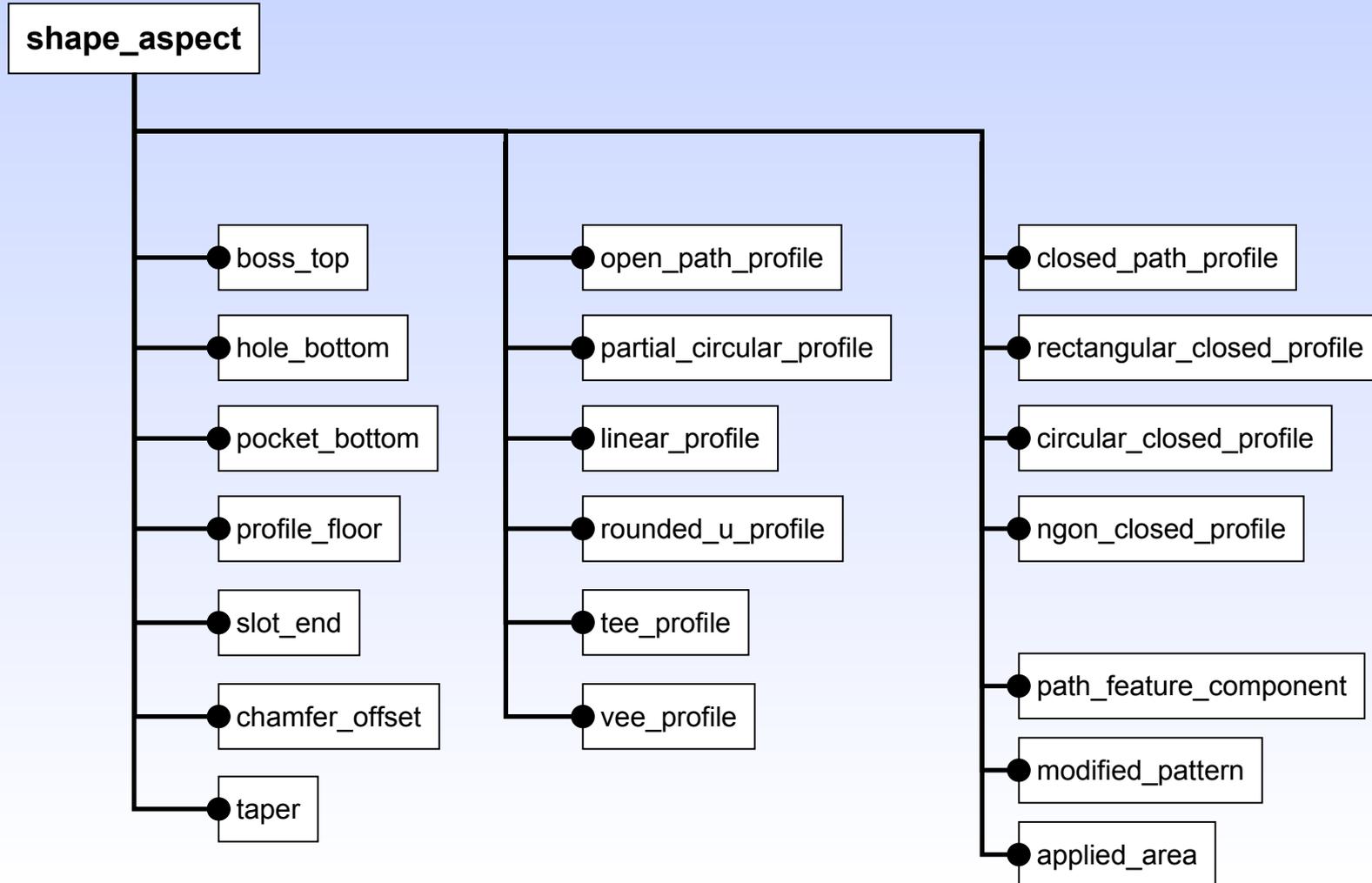
This "stub" says that it is an aspect of a feature, rather than a whole product

Lets profile be shared by many features





- **The relationship between the feature and it's parts tells you how the part is used.**
- **shape_defining_relationship**
 - paths and profiles that sweep out the feature shape.
- **feature_component_relationship**
 - bottom conditions, tapers, and other aspects.
- **Both are subtypes of shape_aspect_relationship**



- **Planar Face**
 - Sweeps a linear profile along a path

- **Slot**
 - Sweeps an open profile along a course of travel
 - Has slot end conditions on each side

- **Pocket**
 - Sweeps an open or closed profile down a depth
 - Has a pocket bottom condition

- **Workpiece describes the final output of a manufacturing process**
- **Workpiece is represented as a product**
 - The shape of the workpiece is a property of the product
- **Features describe material removal areas**
- **Features are represented as shape aspects on the workpiece shape**
 - Implicitly defined features are described by a profile moving along a path.
 - Explicitly defined features are described by surfaces from the workpiece shape.
 - Profiles, paths and other conditions are defined as shape aspects associated with the feature.

