Introduction to STEP-NC

Cutting Tools for Milling

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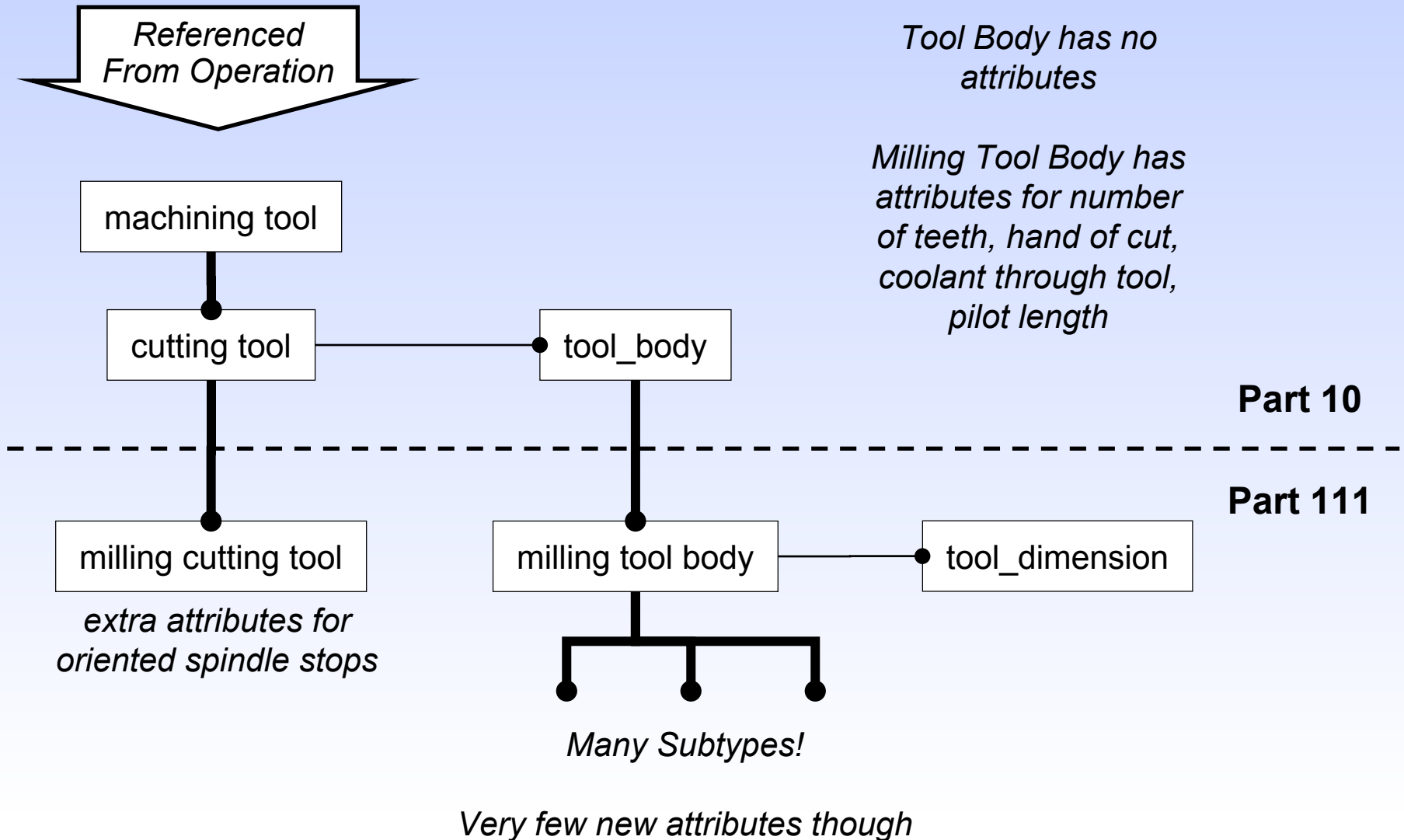
- ## Cutting tools
  - **Describe an ideal required tool for an operation.**
  - **An NC controller may select a different actual tool.**

  - **Only important parameters should be set.**
    - » **The more constrained the tool is, the less flexibility the controller will have**

- ## Questions
  - **What tools are available?**
  - **How do you associate a tool with an operation?**
  - **How do you specify the parameters of a tool?**
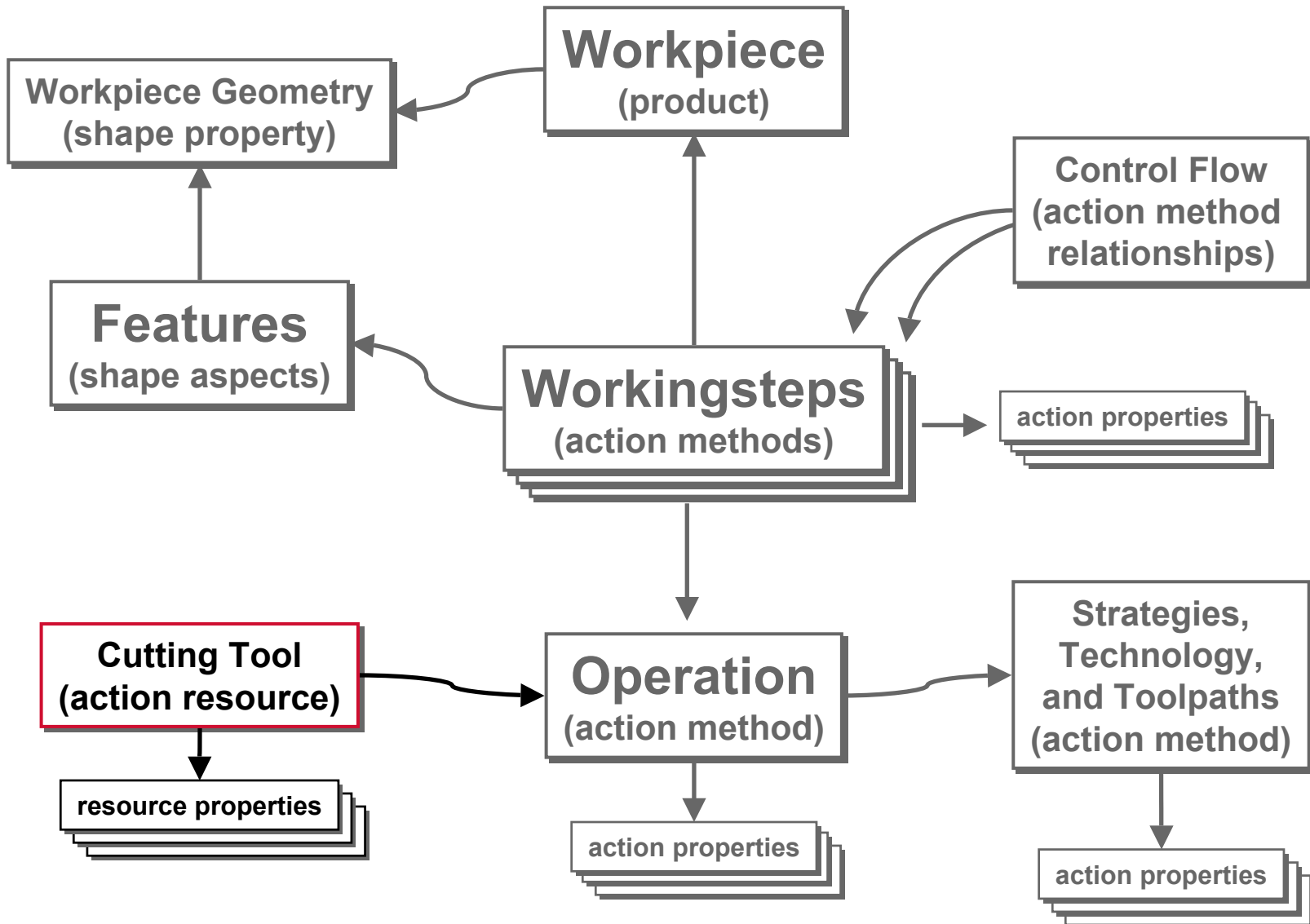
- **Every operation can have a tool associated.**
  - **Represents tool requirements, not a physical tool on a machine.**
  - **Potential for some best-fit optimization by the controller.**

- **Previously, G&M codes just reference tool #1, #2, etc.**
  - **Human must make sure that #1 corresponds to the right thing.**
  - **Controller not able to add any value to the process.**

- **ISO 13399 : Cutting Tool Data Representation and Exchange**
  - **For tool maker to publish tool catalogs**
  - **Has more attributes than ISO 14649, but some are useless for machining**
  - **Considered too rigid and does not support new concepts in the tooling industry.**
    - » **Not useable in its present form, moving towards integration with STEP.**

- **Cutting Tool Data Representation in ISO 14649**
  - **For tool consumer to describe tool requirements**
  - **Currently, only data model for milling cutting tools are defined**
  - **Sufficient information for machining**
  - **Harmonized with the 13399 definitions that are available**

Referenced From Operation

Tool Body has no attributes

Milling Tool Body has attributes for number of teeth, hand of cut, coolant through tool, pilot length

machining tool

cutting tool ———— tool_body

Part 10

- -

Part 111

milling cutting tool

milling tool body ———— tool_dimension

extra attributes for oriented spindle stops

Many Subtypes!

Very few new attributes though

- **milling_cutter**
  - **facemill**
  - **t_slot_mill**
  - **dovetail_mill**
  - **woodruff_keyseat_mill**
  - **side_mill**
  - **thread_mill**
  - **endmill**
    - » **tapered_endmill**
    - » **ball_endmill**
    - » **bullnose_endmill**
- **boring_tool**
- **reamer**
  - **tapered_reamer**
  - **combined_drill_and_reamer**

- **centerdrill**
- **drill**
  - **spade_drill**
  - **twist_drill**
  - **tapered_drill**
- **counterbore**
  - **backside_counterbore**
- **countersink**
  - **backside_countersink**
- **tap**
  - **tapered_tap**
  - **combined_drill_and_tap**
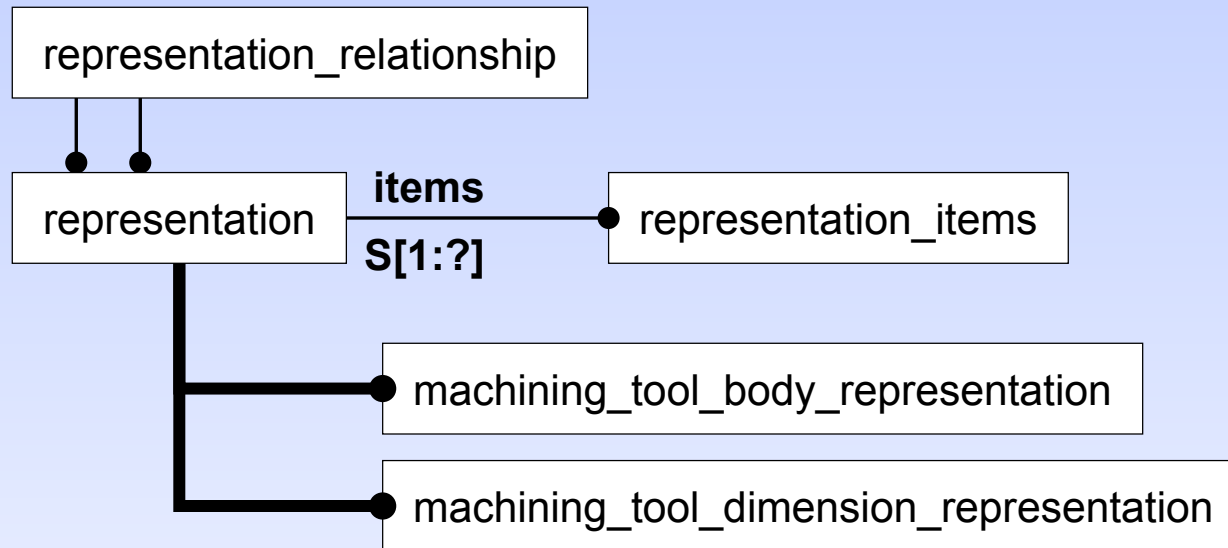- **threading_tool**
- **user_defined_tool**

- **Future parts will describe single point tools for turning**

  – **ARM hierarchy may end up changing a bit.**

  – **ARM hierarchy may also end up being reorganized if ISO 13399 work picks up again.**

  – **Should not change existing information requirements only the way they are documented.**

How to reach goal   *Required equipment*

```
 ┌──────────────────┐   usage   ┌──────────────────┐  kind
 │  action_method   │●──────────│ action_resource  │──────────┐
 └──────────────────┘   S[1:?]  └──────────────────┘          │
          │                              │           ┌──────────────────────┐
          │                              │           │  action_resource_type │
 ┌──────────────────────┐       ┌──────────────────┐ └──────────────────────┘
 │ machining_operation  │       │  machining_tool  │
 └──────────────────────┘       └──────────────────┘
```
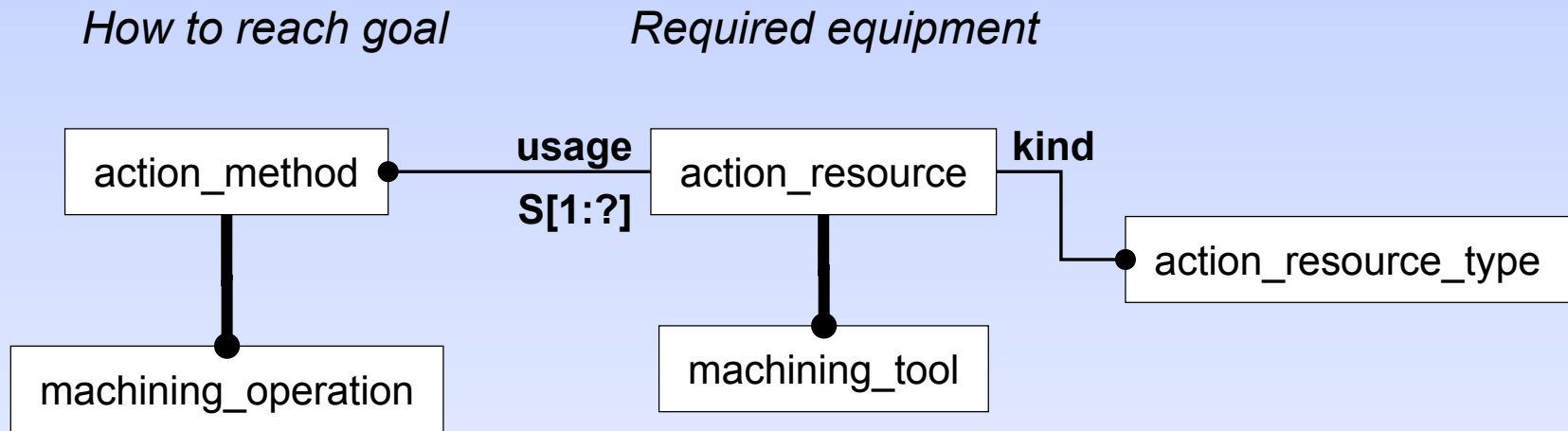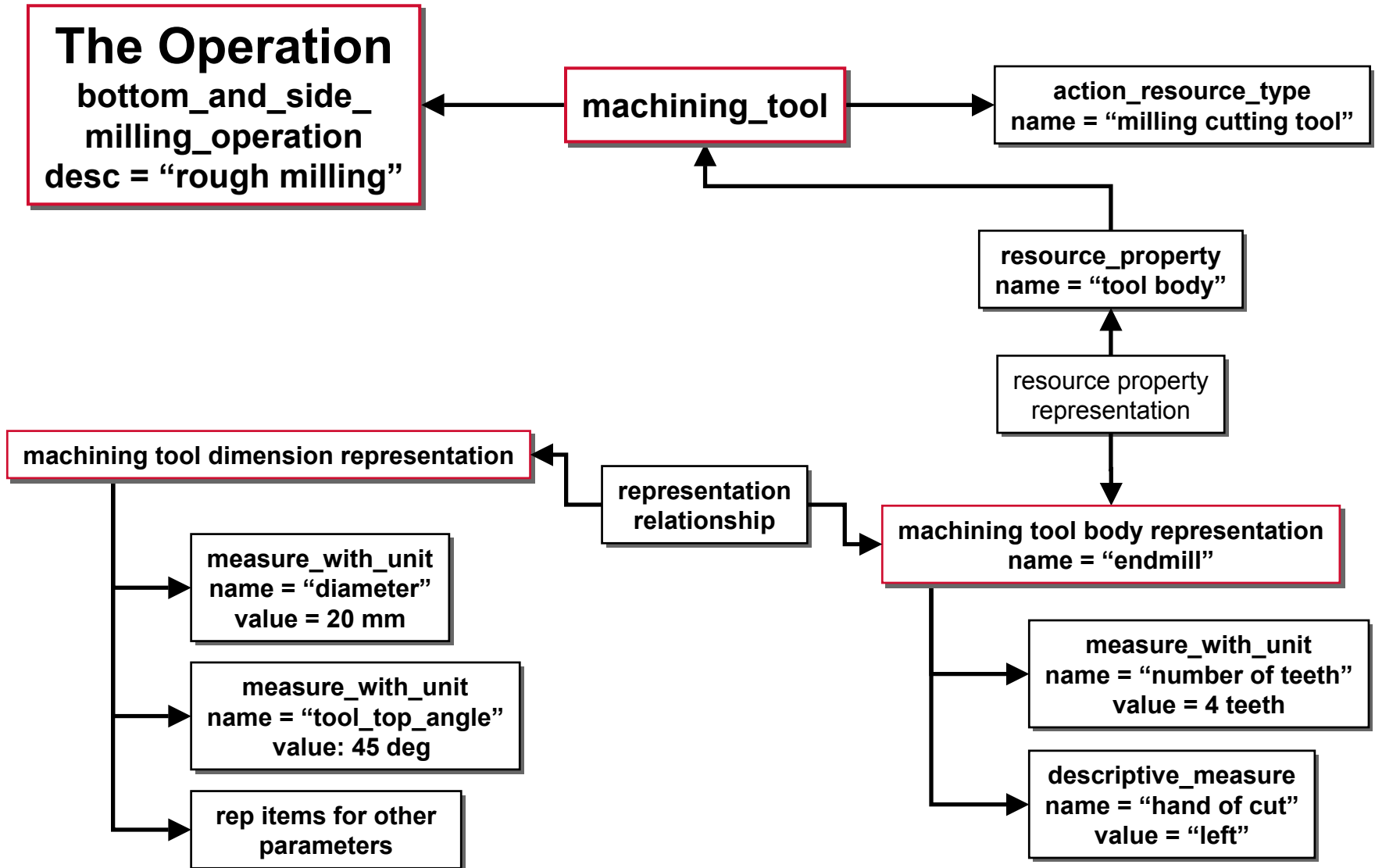
- ## Tool is equipment required by the operation

  - **Use action resource subtype machining_tool.**

  - **action resource refers to all of the action methods that use it through the "usage" attribute.**

  - **Also has a "kind" attribute that categorizes the resource**

    » **A/R Type has value "milling cutting tool"**

```
┌─────────────────────────────────┐
│  representation_relationship     │
└─────────────────────────────────┘
       │   │
       ●   ●
┌──────────────────┐   items      ┌──────────────────────────┐
│  representation   │──────────●──│  representation_items     │
└──────────────────┘   S[1:?]     └──────────────────────────┘
       │
       ├────────────●  machining_tool_body_representation
       │
       └────────────●  machining_tool_dimension_representation
```

- **Tool Body and Dimension are complex properties**
  - **Mapped as subtypes of representation**
    - » **Different tool bodies distinguished using the representation.name attribute**
  - **Will contain multiple representation items**
  - **Tool Dimension related to Tool Body using a representation relationship**

The Operation
bottom_and_side_
milling_operation
desc = "rough milling"

machining_tool

action_resource_type
name = "milling cutting tool"

resource_property
name = "tool body"

resource property
representation

machining tool dimension representation

representation relationship

machining tool body representation
name = "endmill"

measure_with_unit
name = "diameter"
value = 20 mm

measure_with_unit
name = "tool_top_angle"
value: 45 deg

rep items for other parameters

measure_with_unit
name = "number of teeth"
value = 4 teeth

descriptive_measure
name = "hand of cut"
value = "left"

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- **Tool associated with operation**
  - **Through action resource usage field.**

- **Parameters specified using representation subtypes for tool body and dimension**
  - **Type of tool body identified using representation name**