Introduction to STEP-NC

## *Advanced Control Flow for NC Workplans*

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- ## STEP-NC supports a rich set of control flow for machining workplans

  - **More types of programs than simple linear sequences of machining workingsteps**

  - **Branches, parallel segments, feedback from probing**

  - **Room for future intelligent controllers to optimize**

- ## Questions

  - **What other types of workingstep and functions are available?**

  - **What control flow options are available?**

  - **How are controlling expressions represented?**
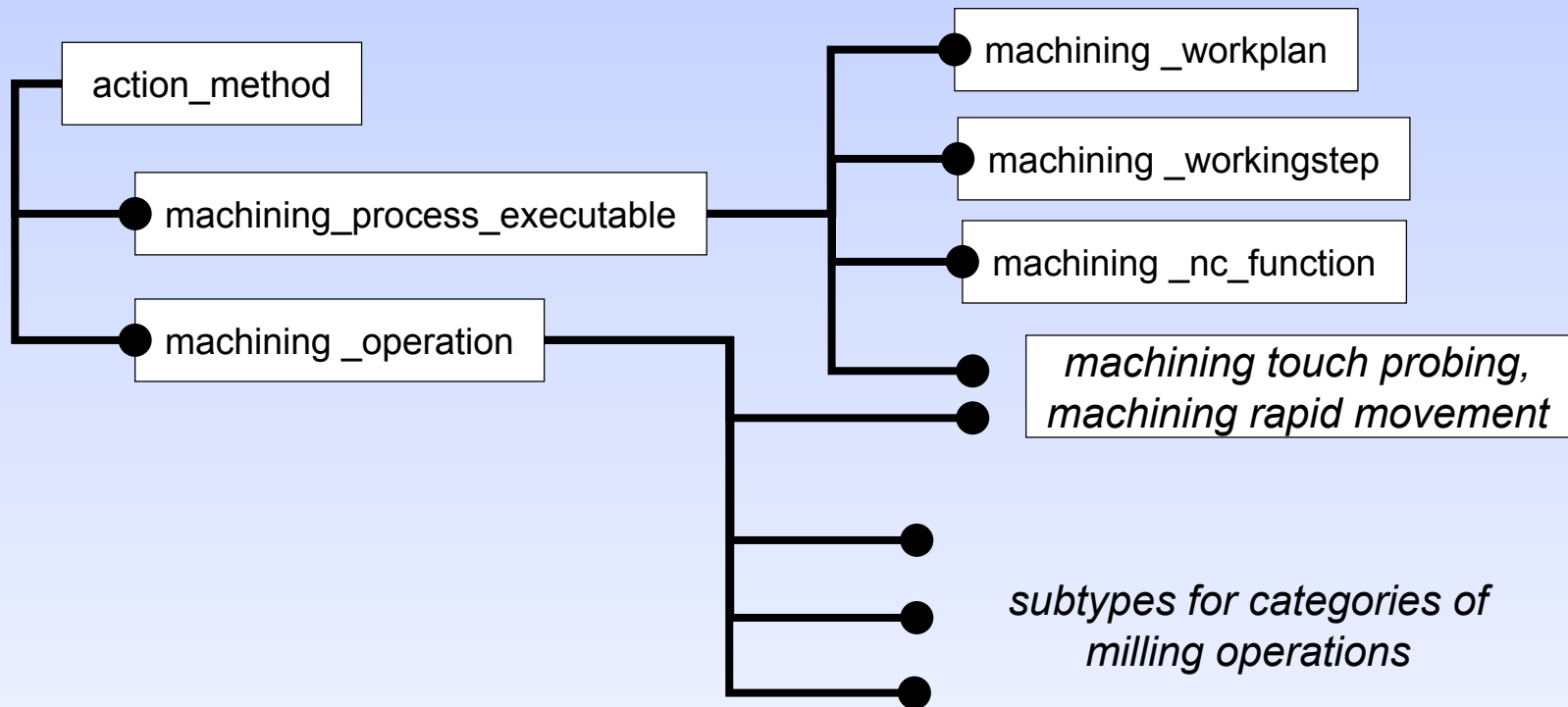
STEP-NC Executables
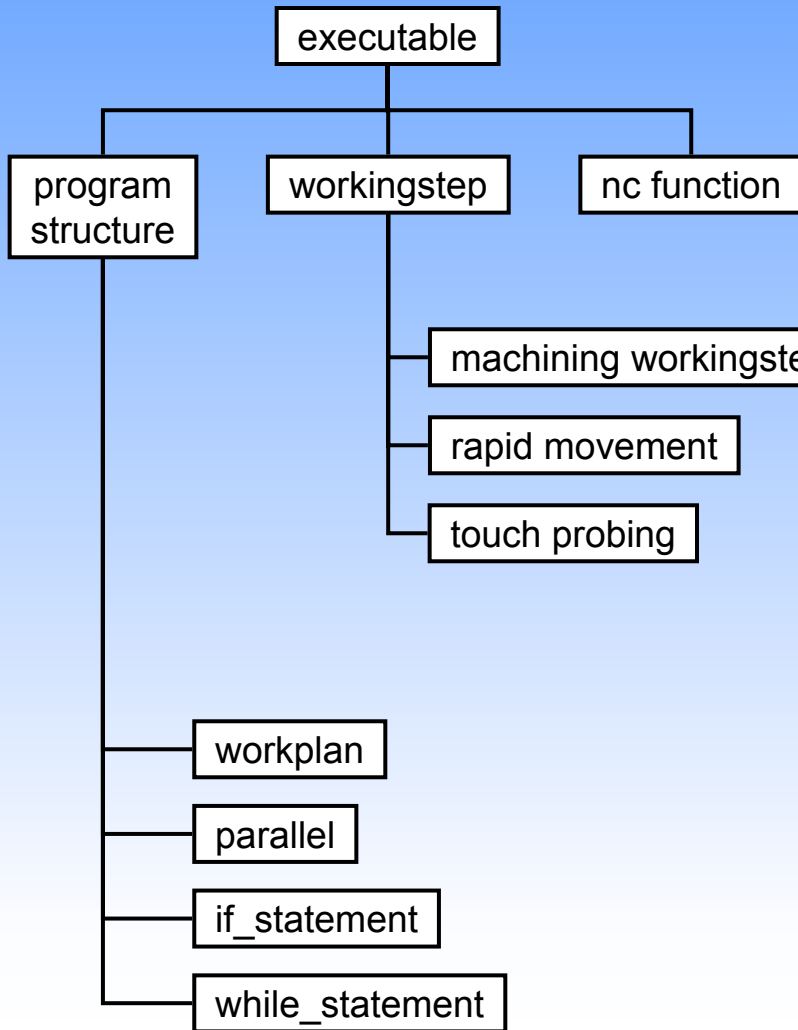
Program steps that do not move any machine axes (display message, etc.)

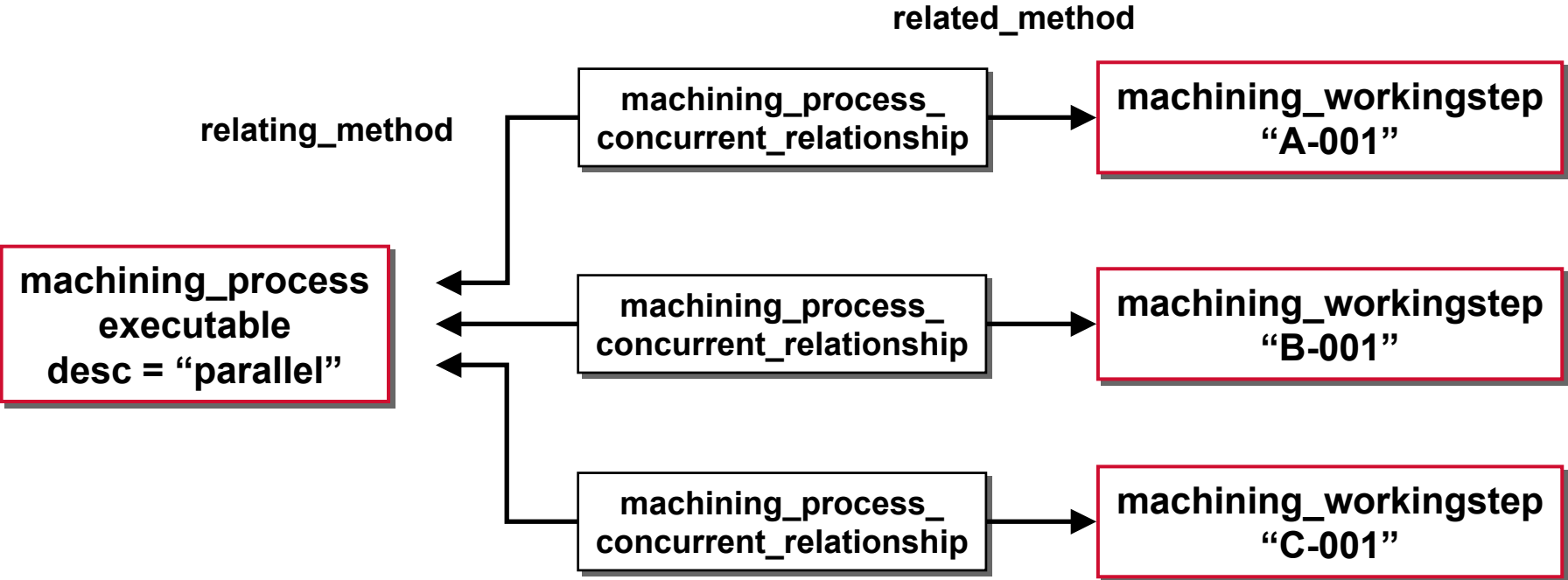**Program steps that move the machine axes**

Control flow for the machining program

- **Rapid Movement**
  - **return_home**
- **Touch Probing**
  - **workpiece_probing (offset in one direction**
  - **workpiece_complete_probing (x, y, z offsets)**
  - **tool_probing**
    - » **tool_length_probing**
    - » **tool_radius_probing**

- **NC Functions**
  - **display_message**
  - **exchange_pallet**
  - **index_pallet**
  - **index_table**
  - **optional_stop**
  - **program_stop**
  - **set_mark**
  - **unload_tool**
  - **wait_for_mark**

- **STEP-NC supports seven kinds of control flow**
  - **Workplan (Sequential) : execution by a sequence**
  - **Unordered Serial : all executables have to be executed but the order of execution does not matter**

  - **Concurrent : all executables are started at the same time**
  - **Parallel : all executables don't need to be started at the same time**

  - **If Statement : binary choice according to the given condition**
  - **Selective : execute only one among several executables**

  - **While Statement : repetitive execution**

action_method

machining_process_executable

machining _operation

machining _workplan

machining _workingstep

machining _nc_function

machining touch probing, machining rapid movement

subtypes for categories of milling operations

- **Advanced control flow things represented by machining process executable**
  - **Use other action method relationship subtypes**
  - **Not just sequential method**

related_method

relating_method

machining_process_ concurrent_relationship	machining_workingstep "A-001"

machining_process executable desc = "parallel"

machining_process_ concurrent_relationship	machining_workingstep "B-001"

machining_process_ concurrent_relationship	machining_workingstep "C-001"

- **Use machining_process_concurrent_relationship, a concurrent action method subtype of AMR**

relating_method

related_method

machining_process_
branch_relationship
"true branch"

machining_workingstep
"A-001"

machining_process
executable
desc = "if statement"

machining_process_
branch_relationship
"false branch"

machining_workingstep
"B-001"

action_property
name = "condition"

property definition
representation

representation

???

- **Use the branch subtype of AMR**
- **How do we represent the condition?**

- **STEP-NC ARM defines machining control flow (if/then, while, etc) controlled by expressions.**
  - **Expressions use literal values and variables that are associated with the result of a measurement operation.**

- **Map expressions using PLIB Part 20**

- **Property with expression representation.**
  - **Expression only references PLIB things.**
  - **What AP-238 needs to define.**
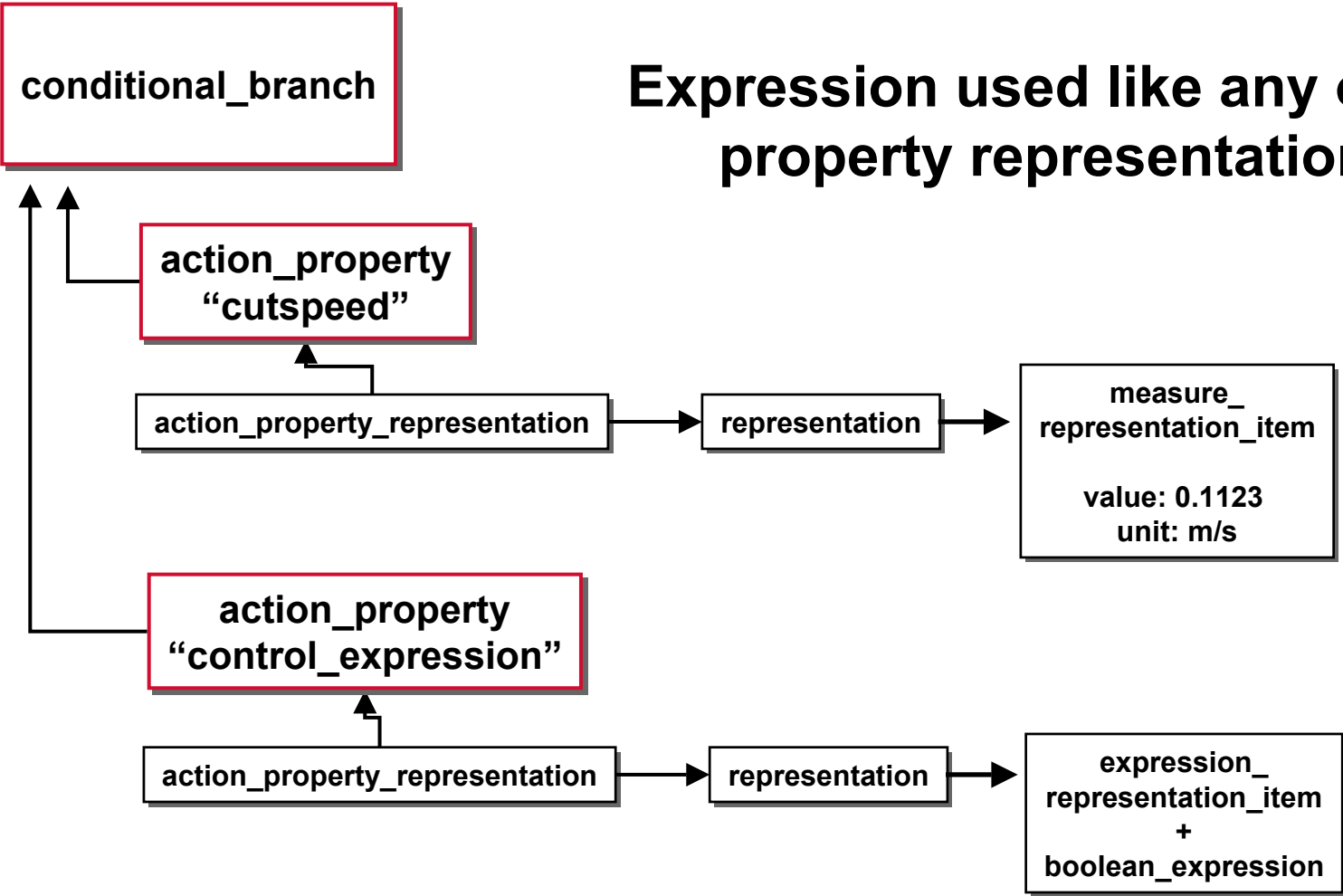
control flow workingstep

(if/then, while, etc)

expression rep item can be combined in a complex instance with more specific PLIB expression types
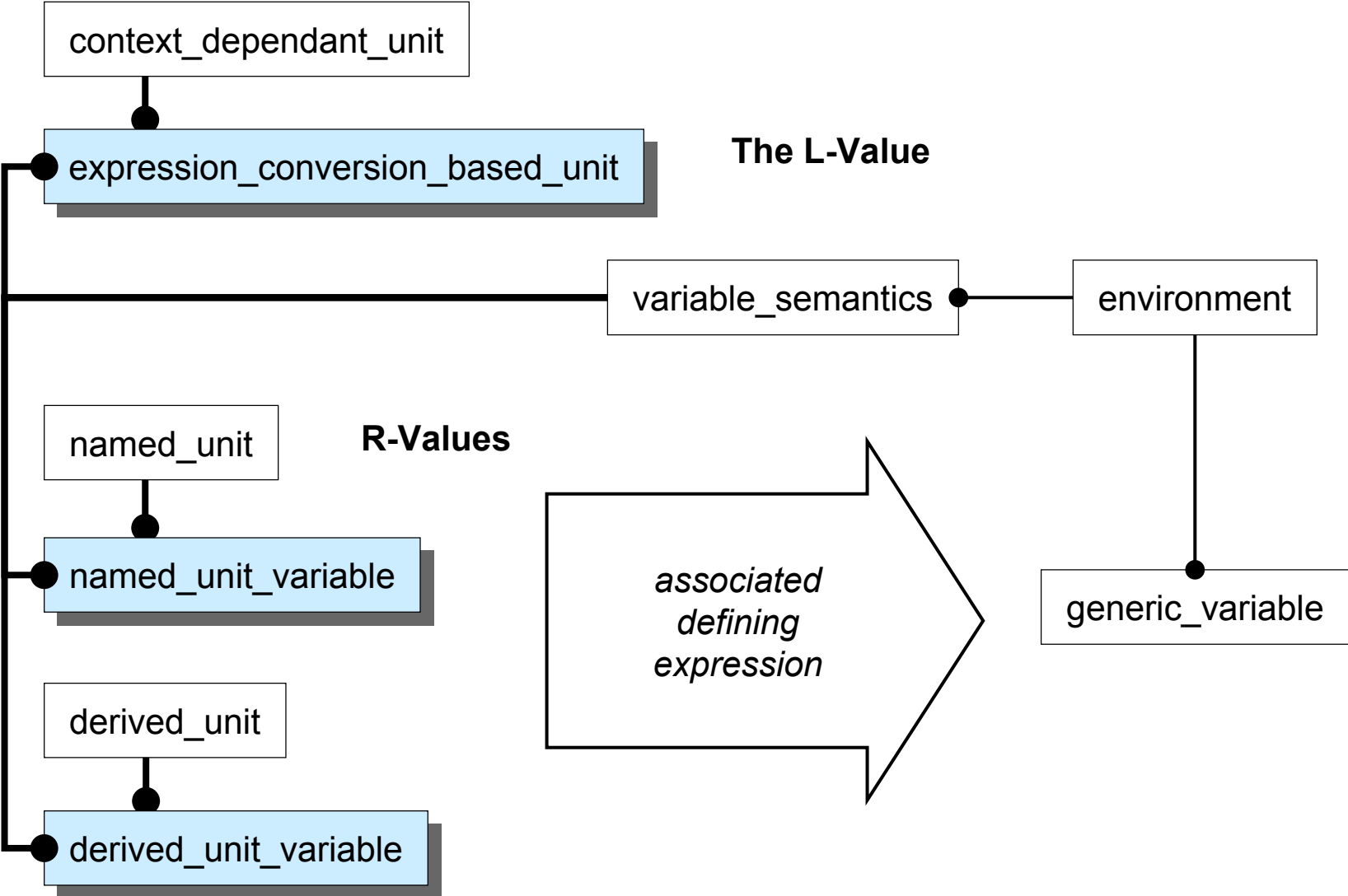
Just like measure rep item

usual property to representation relationship "controlling expression"

representation_item

generic_expression

expression_representation_item

Expression Property Representation
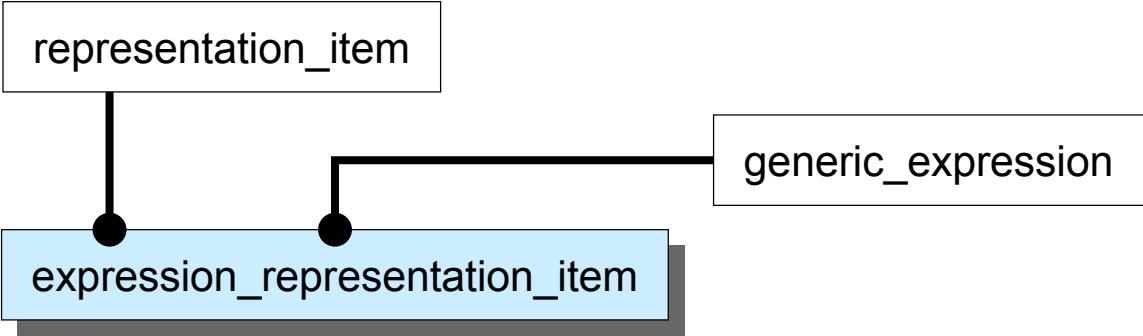
Expression used like any other property representation.

```
conditional_branch
```

```
action_property
"cutspeed"
```

```
action_property_representation  →  representation  →  measure_
                                                        representation_item

                                                        value: 0.1123
                                                        unit: m/s
```

```
action_property
"control_expression"
```

```
action_property_representation  →  representation  →  expression_
                                                        representation_item
                                                        +
                                                        boolean_expression
```

- **STEP-NC AIM must describe the controlling expression, as well as other properties**
    - **control expression is a property that has expression representation.**
    - **We will create expression_representation_item**

- **STEP-NC also associates names with variables**
    - **PLIB has no name, use rep_item_name??**
    - **AP-214 describes how STEP units can be defined for PLIB variables**

- **In Frankfurt (May 2001), the STEP-NC boolean expression was harmonized with the PLIB model to simplify mapping.**

- **STEP-NC supports a rich set of control flow for machining workplans**
  - **More types of programs than simple linear sequences of machining workingsteps**
  - **Branches, parallel segments, feedback from probing**
  - **Room for future intelligent controllers to optimize**

- **Probing operations to collect information, then conditionals to change the plan based on that.**

- **Expressions represented as another type of property.**

- **Plenty of room for controller intelligence.**