UMP Schema Documentation

Version 1 | 11/16/2017

The root element of the schema is ***UnitManufacturingProcess***. This element contains different attributes as follows:

- **@id** (TYPE: xs:ID, required): identifies the Unit Manufacturing Process (UMP) model. The value must start with a letter or underscore, and can only contain letters, digits, underscores, hyphens, and periods.
- **@name**: (TYPE: xs:string, required): name of the represented UMP.
- **@timestamp** (TYPE: xs:date, required): specifies the date of the model creation. The date is specified in the following form "YYYY-MM-DD" where YYYY indicates the year, MM indicates the month, DD indicates the day.
- **@version** (TYPE: xs:int, optional): version number of the model.
- **@reviewed** (TYPE: xs:boolean, required): defines if the model has been reviewed. Value must be "true" or "false".
- **@typeOfProcess** (TYPE: xs:string, required): specifies the type of process that is represented in this model. Please refer to the taxonomy provided in the Manufacturing Processes Reference Guide by R. H. Todd, K. Allen and L. Alting, which is also freely available on the UPLCI website: http://cratel.wichita.edu/uplci/. If the process is not included in the taxonomy, suggest the lowest branch or node based on your expertise. Optional: Add your justification/reasoning in the description.
- **@description** (TYPE: xs:string, required): includes a general description of the UMP.

UnitManufacturingProcess contains different elements as follows:

- [1…*] ***Author***: includes the authors of the model.
- [1…*] ***Keyword***: includes the keywords for the model.
- [1…*] ***Input***: includes all inputs that enter the UMP such as material (for example, raw materials or work-in-progress), consumables (for example, lubrication or forced air), energy and external factors (such as temperature, humidity, particulates, vibration, and shocks) that occur during the manufacture of a product.
- [1…*] ***Output***: includes all outputs that exit the UMP model such as products, by-products, waste, and emissions.
- [0…1] ***Transformation***: includes transformation equations (or descriptions), data driven models, and feasibility constraints that describe the relations between the inputs in the process.
- [1] ***ProductAndProcessInformation***: includes relevant information to enable the transformation calculations of material, energy, and information. This includes items such as part geometry, material properties, control programs, and process plans.
- [1…*] ***Resource***: includes process resources such as equipment, fixtures, tooling, and inspection gauges.
- [0…1] ***UseBound***: includes formal or informal descriptions of the bounds of use for the model, providing guidance for the model's appropriateness or validity with respect to another situation
- [0…*] ***Review***: includes the reviews of this model.

Author contains 4 elements:

- [1] ***FirstName*** (TYPE: xs:string): the first name of the author.
- [1] ***LastName*** (TYPE: xs:string): the last name of the author.
- [1] ***Organization*** (TYPE: xs:string): the organization of the author.
- [0...1] ***Email*** (TYPE: xs:string): the email of the author.

Keyword is a xs:string type element. A **Keyword** must be unique.

Input and ***Output*** contain 2 elements and 1 attribute:

- [1] ***Name*** (TYPE: xs:string): the name of the input.
- [0…1] ***Description*** (TYPE: xs:string): the description of the input.
- ***@hyperlink*** (TYPE: xs:anyURI, optional): a hyperlink to provide supporting information about the input.

The **Name** of **Input** and **Output** must be unique.

Transformation contains 4 elements to represent the transformation occurring in the UMP:

- [0…*] ***Equation***
- [0…*] ***PMMLModel***
- [0…*] ***FeasibilityConstraint***
- [0…1] ***Description*** (TYPE: xs:string)*:* the general description of the transformation.

E*quation* contains 2 elements and 1 attribute:

- [1] ***MathMLEquation*** (TYPE: mml:math): the equation represented in a MathML format.
- [0…1] ***Description*** (TYPE: xs:string): the description of the equation.
- ***@name*** (TYPE: xs:string, mandatory): name given to the equation for facilitate the identification of the equation.
- ***@hyperlink*** (TYPE: xs:anyURI, optional): a hyperlink to provide supporting information about the equation.

*The value of **@name** must be unique.*

PMMLModel contains 2 elements and 1 attribute:

- [1] ***DataDrivenModel*** (TYPE: pmml:PMML): the data driven model represented in a PMML format.
- [0…1] ***Description*** (TYPE: xs:string): the description of the equation.
- ***@name*** (TYPE: xs:string, mandatory): name given to the equation for facilitate the identification of the PMML model.
- ***@hyperlink*** (TYPE: xs:anyURI, optional): a hyperlink to provide supporting information about the equation.

*The value of **@name** must be unique.*

FeasibilityConstraint contains 2 elements and 1 attribute:

- [1] ***MathMLFeasibilityConstraint*** (TYPE: mml:math): the feasibility constraint represented in a MathML format.

- [0…1] ***Description*** (TYPE: xs:string): the description of the feasibility constraint.
- ***@name*** (TYPE: xs:string, mandatory): name given to the equation for facilitate the identification of the feasibility constraint.
- ***@hyperlink*** (TYPE: xs:anyURI, optional): a hyperlink to provide supporting information about the feasibility constraint.

*The value of **@name** must be unique*

ProductProcessInformation contains 5 elements:

- [0…*] ***ControlParameters***: includes tunable model parameters that can be adjusted to evaluate different process settings. Example: In machining processes, depthOfCut, spindleSpeed, and feedRate are traditionally classified as ControlParameters.
- [0…*] ***FixedParameters*****:** includes model parameters that are fixed through the evaluation of the transformation equations. Example: In machining processes, specificCuttingEnergy and density of the workpiece material are traditionally classified as FixedParameters.
- [0…*] ***IntermediateVariable*****:** includes calculated variables required to complete the evaluation of the metrics of interest. Example: In a milling process, the millingTime of a given cross sectional area of width and depth of cut must be calculated before assessing the machining power.
- [0…*] ***MetricOfInterest***: includes performance metrics that the model evaluates regarding the process. Example: Cost per part or CO_2 emissions per part are classified as metrics of interest.
- [0…1] ***SupportingInformation***: includes all other relevant links to information needed to instantiate the model, including production plans, product and engineering specifications, and setup-operation-teardown instructions, to name a few.

ControlParameters contains 5 elements and 1 attribute

- [1] ***Name*** (TYPE: xs:string)*:* the name of the control parameter.
- [1] ***Symbol*** (TYPE: mml:math)*:* the symbol represented in a MathML format.
- [1…*] ***BoundEquation***: the equations to represent the bounds of the control parameter.
- [1] ***UOMCode*** ***OR*** [1] ***AlternativeUOMCode***: the unit of measurement code identifying the control parameter unit. ***UOMCode*** is used if a code is avalaible in the "Recommendation No. 20 - Units of Measure used in International Trade" from The United Nations Economic Commission for Europe (UNECE). (https://www.unece.org/fileadmin/DAM/cefact/recommendations/rec20/rec20_rev3_Annex1e.pdf). ***AlternativeUOMCode*** is used if no appropriate code is available in the "Recommendation No. 20 - Units of Measure used in International Trade" from UNECE.
- [0…1] ***Description*** (TYPE: xs:string)*:* the description of the control parameter.
- ***@hyperlink*** (TYPE: xs:anyURI, optional): a hyperlink to provide supporting information about the control parameter.

BoundEquation contains 2 elements:

- [1] ***MathMLEquation*** (TYPE: mml:math): the bound equation represented in a MathML format.
- [0…1] ***Description*** (TYPE: xs:string): the description of the bound equation.

UOMCode contains 1 element and 3 attributes that have fixed values:

- @***listID*** (TYPE: xs:string, required)*:* Value must be "UN/ECE Rec 20 Rev 3".
- @***listAgencyID*** (TYPE: xs:int, required)*:* Value must be 6.

- @***listVersionID*** (TYPE: xs:int, required)*:* Value must be 3.
- [1] ***UnitCodeContent*** (TYPE: xs:normalizedString)*:* the code representing the unit. Refer to https://www.unece.org/fileadmin/DAM/cefact/recommendations/rec20/rec20_rev3_Annex1e.pdf to choose the appropriate code.

AlternativeUOMCode contains 2 elements:

- [1] ***SuggestedUnitRepresentation*** (TYPE: xs:normalizedString)*:* a suggested unit representation that is needed for the unit (example: mol/(m^3.s)).
- [1] ***SuggestedUnitCodeContent*** (TYPE: xs:normalizedString)*:* a suggested code content that could be used for this unit. It can be a combination of existing codes from the "Recommendation No. 20 - Units of Measure used in International Trade" from UNECE.

FixedParameters contains 6 elements and 1 attribute

- [1] ***Name*** (TYPE: xs:string)*:* the name of the fixed parameter.
- [1] ***Symbol*** (TYPE: mml:math)*:* the symbol represented in a MathML format.
- [1] ***Value*** (TYPE: xs:decimal)*:* the value to represent the bounds of the fixed parameter.
- [0…*] ***BoundEquation***: the equations to represent the bounds of the fixed parameter.
- [1] ***UOMCode OR*** [1] ***AlternativeUOMCode***: the unit of measurement code to define the fixed parameter unit.
- [0…1] ***Description*** (TYPE: xs:string)*:* the description of the control parameter.
- ***@hyperlink*** (TYPE: xs:anyURI)*:* a hyperlink to provide supporting information about the control parameter.

IntermediateVariable and ***MetricOfInterest*** contains 5 elements and 1 attribute:

- [1] ***Name*** (TYPE: xs:string)*:* the name of the element.
- [1] ***Symbol*** (TYPE: mml:math)*:* the symbol represented in a MathML format.
- [0…*] ***BoundEquation***: the equations to represent the bounds of the element.
- [1] ***UOMCode OR*** [1] ***AlternativeUOMCode***: the unit of measurement code to define the element unit.
- [0…1] ***Description*** (TYPE: xs:string)*:* the description of the element.
- ***@hyperlink*** (TYPE: xs:anyURI)*:* a hyperlink to provide supporting information about the control parameter.

SupportingInformation contains 2 elements:

- [0…*] ***Hyperlink***
- [0…1] ***SupportingInformationDescription*** (TYPE: xs:string)*:* external information (such as safety documentation, production plans, etc.) about the product and the process.

Hyperlink contains 1 element and 2 attributes:

- [1] ***Uri*** (TYPE: xs:anyURI)*:* a hyperlink to provide supporting information about the product and process
- @***title*** (TYPE: xs:string, required)*:* the title of the supportive information link
- @***description*** (TYPE: xs:string, optional)*:* the description of the supportive information link

Each ***Name*** *of* ***ControlParameters, FixedParameters, IntermediateVariable,*** and ***MetricOfInterest*** must be unique.

Resource contains 2 elements and 1 attribute:

- [1] ***Name*** (TYPE: xs:string)*:* the name of the resource.
- [0…1] ***Description*** (TYPE: xs:string)*:* the description of the resource.
- ***@hyperlink*** (TYPE: xs:anyURI, optional): a hyperlink to provide supporting information about the resource.

The **Name** of **Resource** must be unique.

UseBound contains 2 elements:

- [0…1] **U*seBoundDescription*** (TYPE: xs:string): the description to describe the use bounds of the model.
- [0…*] ***UseBoundEquation***

UseBoundEquation contains 2 elements:

- [1] ***MathMLEquation*** (TYPE: mml:math): the use bound equation represented in a MathML format.
- [0…1] ***Description*** (TYPE: xs:string): the description of the bound equation.

Review contains 2 elements and 1 attribute:

- [1…*] ***Reviewer***
- [1] ***Feedback*** (TYPE: xs:string): the feedback of the model review.
- **@timestamp** (TYPE: xs:date, required): the date of the model review. The date is specified in the following form "YYYY-MM-DD" where YYYY indicates the year, MM indicates the month, DD indicates the day.

Reviewer has the same elements as ***Author:***

- [1] ***FirstName*** (TYPE: xs:string)*:* the first name of the reviewer.
- [1] ***LastName*** (TYPE: xs:string)*:* the last name of the reviewer.
- [1] ***Organization*** (TYPE: xs:string)*:* the organization of the reviewer.
- [0…1] ***Email*** (TYPE: xs:string)*:* the email of the reviewer.