engineering laboratory

Webinar:
What, how, and where to enter the RAMP 2018 Challenge

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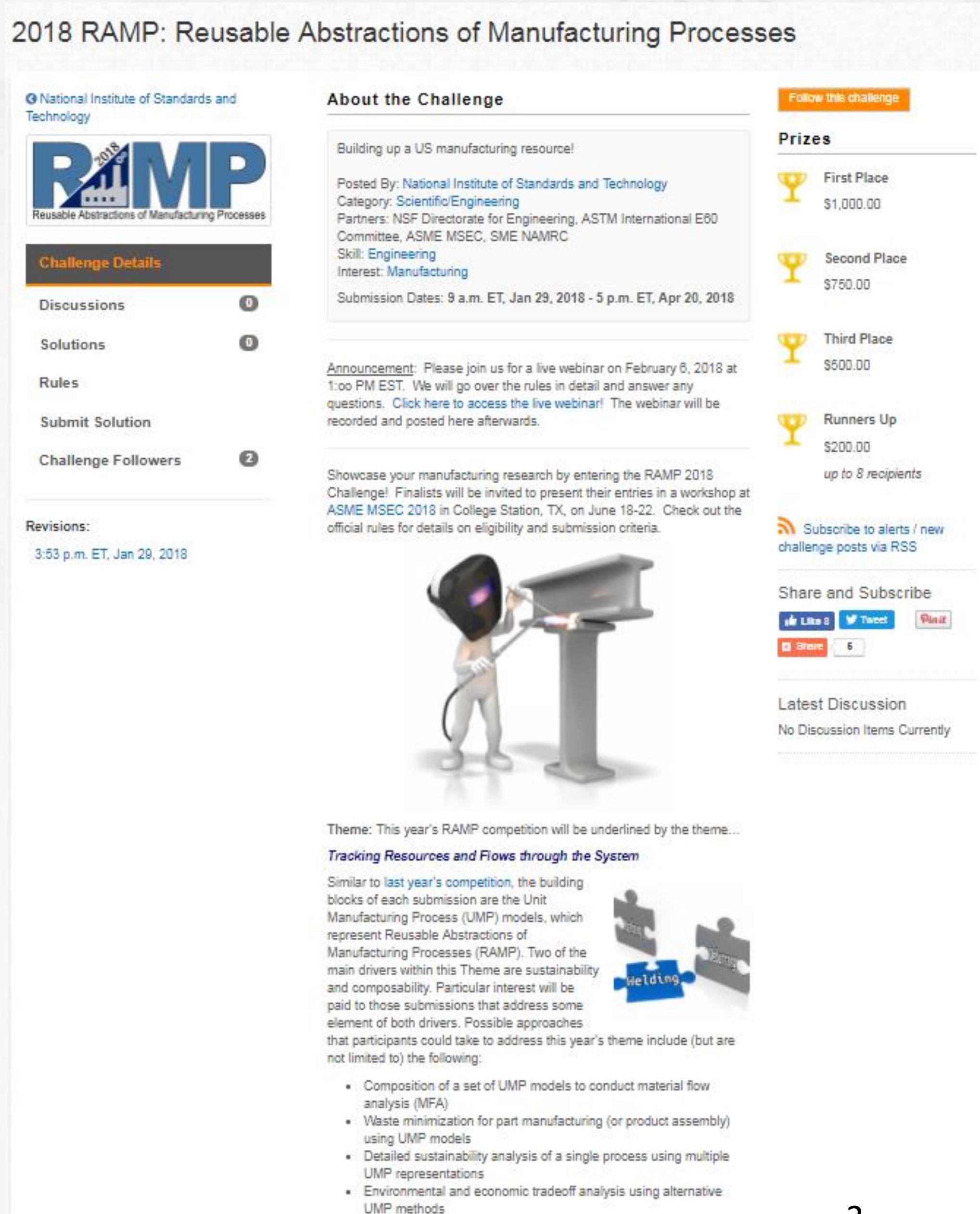
U.S. Department of Commerce

Visit us on-line!

https://www.challenge.gov/challenge/ramp-reusable-abstractions-of-manufacturing-processes/



2018 RAMP: Reusable Abstractions of Manufacturing Processes

National Institute of Standards and Technology

RAMP 2018 Reusable Abstractions of Manufacturing Processes

Challenge Details

Discussions 0

Solutions 0

Rules

Submit Solution

Challenge Followers 2

Revisions:

3:53 p.m. ET, Jan 29, 2018

About the Challenge

Building up a US manufacturing resource!

Posted By: National Institute of Standards and Technology
Category: Scientific/Engineering
Partners: NSF Directorate for Engineering, ASTM International E60 Committee, ASME MSEC, SME NAMRC
Skill: Engineering
Interest: Manufacturing

Submission Dates: 9 a.m. ET, Jan 29, 2018 - 5 p.m. ET, Apr 20, 2018

Announcement: Please join us for a live webinar on February 6, 2018 at 1:00 PM EST. We will go over the rules in detail and answer any questions. Click here to access the live webinar! The webinar will be recorded and posted here afterwards.

Showcase your manufacturing research by entering the RAMP 2018 Challenge! Finalists will be invited to present their entries in a workshop at ASME MSEC 2018 in College Station, TX, on June 18-22. Check out the official rules for details on eligibility and submission criteria.

Theme: This year's RAMP competition will be underlined by the theme...

Tracking Resources and Flows through the System

Similar to last year's competition, the building blocks of each submission are the Unit Manufacturing Process (UMP) models, which represent Reusable Abstractions of Manufacturing Processes (RAMP). Two of the main drivers within this Theme are sustainability and composability. Particular interest will be paid to those submissions that address some element of both drivers. Possible approaches that participants could take to address this year's theme include (but are not limited to) the following:

- Composition of a set of UMP models to conduct material flow analysis (MFA)
- Waste minimization for part manufacturing (or product assembly) using UMP models
- Detailed sustainability analysis of a single process using multiple UMP representations
- Environmental and economic tradeoff analysis using alternative UMP methods

Follow this challenge

Prizes

First Place
$1,000.00

Second Place
$750.00

Third Place
$500.00

Runners Up
$200.00
up to 8 recipients

Subscribe to alerts / new challenge posts via RSS

Share and Subscribe

Like 8 Tweet Pin it Share 6

Latest Discussion

No Discussion Items Currently

Official challenge managers:

Bill Bernstein

Mark Carlisle

KC Morris

If you have questions….

- Live participants: use the Q&A chat bar
- After the webinar, send any other questions to
  - Bill Bernstein, wzb@nist.gov
  - David Lechevalier, david.lechevalier@engisis.com

Reusable Abstractions of Manufacturing Processes

ASTM International: Committee E60 on Sustainability

Scope:

The acquisition, promotion, and dissemination of knowledge, stimulation of research and the development of standards relating to sustainability and sustainable development.

http://www.astm.org/COMMITTEE/E60.htm

Subcommittee E60.13 on Sustainable Manufacturing

ASTM E3012-16:
Standard Guide for Characterizing Environmental Aspects of Manufacturing Processes

- Provides guidelines for the formal characterization and representation of unit manufacturing process (UMP) models

- Fundamental foundation for the idea of a repository of reusable UMP models

ASTM INTERNATIONAL

Access to ASTM E3012-16 for RAMP Participants:
https://www.astm.org/nist-ramp.htm

Goals of ASTM E3012-16

- Characterizing manufacturing process models in a consistent manner
- Sharing and re-using manufacturing process information
- Promoting integration of tools for manufacturing-related decision-making
- Aiding in environmental sustainability assessment

RAMP Reusable Abstractions of Manufacturing Processes

https://www.astm.org/nist-ramp.htm

More information about ASTM E3012-16

UMP Model

Product/Process Information

- Equipment and material specifications
- Process Specifications
  - Setup-operation-teardown instructions
  - Control Programs and process control
- Product and engineering specifications
- Production plans
- Quality plans
  - KPI's and quality plans
- PLM and sustainability plans
- Safety documentation

Input

- Energy
- Material & consumables
- Outside factors
- Disturbance

Transformation

- Energy
- Material
- Information

Resources

- Equipment
- Tooling
- Fixtures
- Human
- Software

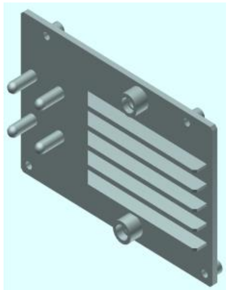
Output

- Product
- By-Product
- Waste
  - Solid, liquid, emission
  - Thermal, noise
- Feedback

Figure based on ASTM E3012-16. Standard available for competition participants.

Example: Machining UMP

Product/Process Information



Material Properties
Type: Aluminum 6061
Brinell hardness: 30-150
Specific cutting energy Up: 0.98 W/(s*mm^3)
Cutting speed: 120-140 m/min
Feed per tooth: 0.28-0.56 mm/tooth
Density: 2712 kg/m^3

Machine Instructions (G-code)
N1418 T3
N1419 G91 G28 Z0 M06
N1420 T1 M01
G90 G10 L2 P#501 X[#510]
N1421 M8
… …

Inputs

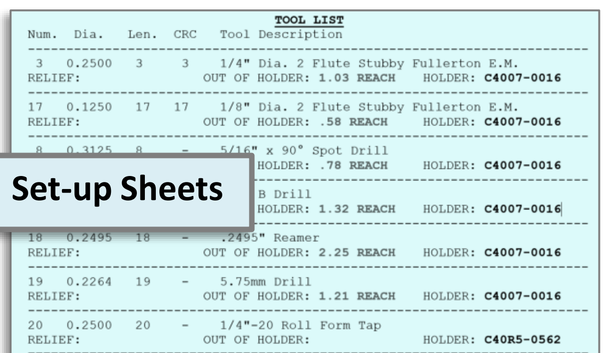
Transformations

http://cratel.wichita.edu/uplci/milling/

http://cratel.wichita.edu/uplci/drilling-2/

Outputs

Resources



```
                          TOOL LIST
Num.  Dia.    Len.  CRC   Tool Description
-----------------------------------------------------------------
 3   0.2500   3     3     1/4" Dia. 2 Flute Stubby Fullerton E.M.
RELIEF:                  OUT OF HOLDER: 1.03 REACH    HOLDER: C4007-0016
-----------------------------------------------------------------
17   0.1250   17    17    1/8" Dia. 2 Flute Stubby Fullerton E.M.
RELIEF:                  OUT OF HOLDER: .58 REACH     HOLDER: C4007-0016
-----------------------------------------------------------------
 8   0.3125   8     -     5/16" x 90° Spot Drill
                              HOLDER: .78 REACH       HOLDER: C4007-0016
-----------------------------------------------------------------
                              B Drill
                              HOLDER: 1.32 REACH      HOLDER: C4007-0016
-----------------------------------------------------------------
18   0.2495   18    -     .2495" Reamer
RELIEF:                  OUT OF HOLDER: 2.25 REACH    HOLDER: C4007-0016
-----------------------------------------------------------------
19   0.2264   19    -     5.75mm Drill
RELIEF:                  OUT OF HOLDER: 1.21 REACH    HOLDER: C4007-0016
-----------------------------------------------------------------
20   0.2500   20    -     1/4"-20 Roll Form Tap
RELIEF:                  OUT OF HOLDER:               HOLDER: C40R5-0562
=================================================================
```

Set-up Sheets

UPLCI Database
http://cratel.wichita.edu/uplci/

NIST SMS Testbed
http://smstestbed.nist.gov

Brodsky, A., et al. 2016. A system and architecture for reusable abstractions of manufacturing processes. In *Proc. of the 2016 IEEE Conference on Big Data.* DOI: 10.1109/BigData.2016.7840823

Goals of RAMP 2018 Challenge

- RAMP = Reusable Abstractions of Manufacturing Processes
- Capture and exchange research results in the field of sustainable manufacturing
- Demonstrate ASTM E3012-16 on a variety of unit manufacturing processes (UMPs)
- Demonstrate the use of the recorded models to perform analysis, e.g. through simulation or optimization.
- This year's theme:

Tracking Resources and Flows through the System

Example approaches to address the theme:

Tracking Resources and Flows through the System

- Composition of a set of UMP models to conduct material flow analysis (MFA)
- Waste minimization for part manufacturing (or product assembly) using UMP models
- Detailed sustainability analysis of a single process using multiple UMP representations

The “When” - Important Dates

Submission Deadline: **April 20, 2018**

@ 5pm ET

Announcement of Finalists: **May 7, 2018**

(by e-mail)

Announcement of Winners: **June 20, 2018**

ASME 2018 MSEC

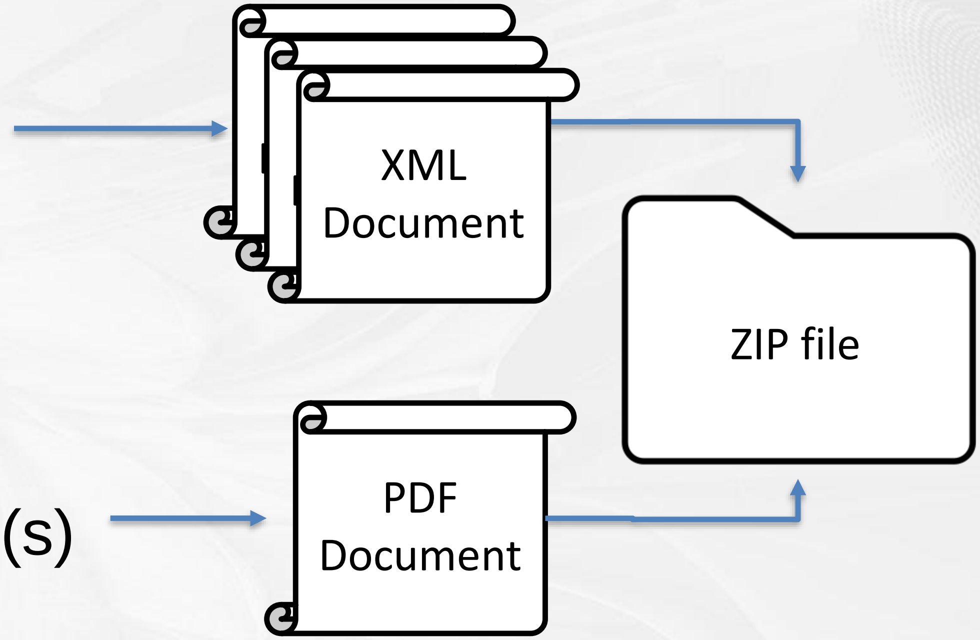
College Station, TX

The "Who"

- Can be individuals or teams
- Person accepting prize must be US citizen or permanent resident

What to submit?

1. Information Model(s)
2. Introductory Information
3. Graphical Representation(s)
4. Written Narrative



Note: submission should be a single ZIP file to challenge.gov

2. Introductory Information

- Description of your submission, including:
  - Names of participants
  - Team leader designation
  - Affiliations of participants
  - Submission title

Note: can serve as the title page of your submission.

3. Graphical Representation – Generic Milling Model

Product & Process Information

Job Information

Part Description: Heat Sink Test Part
Geometry: Complex, see CAD file (file.stp)
Material: Al6061
Operations: Mill thicknesses, bosses and counter bores, deburr, mill chamfers, radii, mill fins
Required Tools: End mills, chamfer mills, rounding mills

Variable definitions for transformation equations (short list)

- U_p – Specific Cutting Energy (W/mm^3)
- V_i – volume of input (mm^3)
- V – Cutting Speed (m/min)
- t_{a_o} – Approach and Overtravel time (sec)
- t_r – Retract time (sec)
- t_h – Handling Time (sec)
- t_i – Milling Idle time (sec)
- p_i – Milling Idle power (kW)
- e_i – Milling Idle Energy (kJ)
- e_c – Energy Consumed per cycle (kJ/cycle)
- t_c – Total time per cycle (sec)
- p_m – Milling Power (kW)
- e_m – Milling Energy (kJ)
- f_t – Feed per tooth (mm/tooth)
- VRR – Volume Material Removal Rate (mm^3/min)
- L_c – Extent of the first contact (mm)
- t_m – Milling Time (sec/cut)
- E – Total energy consumed (kWh/cycle)
- C – Total cost for energy ($)
- CO_2 – Total CO_2 for energy (kg)
- t_t – Total time for all cycles (sec)
- $Yield$ – Items produced in all cycles (qty)

Inputs

Electrical energy, kWh
Workpiece material (e.g. aluminum, steel)

Transformation Equations

$f_t = f_r/(N * n_t)$

$VRR = w_m * d * f_r$

For centered milling:

$L_c = D/2$

For peripheral milling:

$t_m = 60 * \frac{l_m + L_c}{f_r}$

$L_c = \sqrt{d * (D - d)}$

For face milling:

$t_m = 60 * \frac{l_m + 2 * L_c}{f_r}$

$L_c = \sqrt{w_m * (D - w_m)}$

$V = N * D * 1000\pi$

$p_i = p_s + p_c + p_a$

$t_c = t_l + t_c + t_u + t_i$

$V_i = l_m * w_m * h_m * n_c$

$t_{a\_o} = 60 * \frac{d_a + d_o}{f_r}$

$p_m = \frac{VRR * U_p}{1000}$

$t_h = t_{a\_o} + t_r$

$t_i = t_h + t_m$

$e_m = p_m * t_m$

$e_i = p_i + t_i$

$e_c = e_m + e_i + e_b$

$t_t = t_c * n_c$

$Yield = n_c$

$C = E * C_{kwh}$

$CO2 = E * CO2_{kwh}$

$E = e_c * n_c * 2.78e^{-4}$

Outputs

Finished part, qty
Waste
Heat, BTU
Material, kg

Resources

Operator: John Doe
Machine: GF Agile HP600U
Fixture Details: Mill Clearance, Drill, Ream and Tap Mounting Holes Orientation, Origin → (0.100,0.720,0.168)
Software: See MasterCam for fixture and tooling specifics

Tool List:
(1) 1/4" Dia. 2 Flute Stubby Fullerton E.M.
(2) 3/16" Dia. 2 Flute Stubby Fullerton E.M.
(3) 3" Face Mill
(4) 1/2" Dia. 2 Flute Stubby Fullerton E.M.
(5) 1/4" x 45° Chamfer Mill
(6) 1/4" 2 Flute E.M. With .020" x 45° Chamfers
(7) 1/4" x .093" Corner Rounding E.M.

3. Graphical Representation – Generic Milling Model

Product & Process Information

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Geometry: Complex, see CAD file (file.stp)
Material: Al6061
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- e_i – Milling Idle Energy (kJ)
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- f_t – Feed per tooth (mm/tooth)
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- E – Total energy consumed (kWh/cycle)
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(e.g. aluminum, steel)

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For peripheral milling:

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$L_c = \sqrt{d * (D-d)}$

For face milling:

$t_m = 60 * \frac{l_m+2*L_c}{f_r}$

$L_c = \sqrt{w_m * (D-w_m)}$

$V = N * D * 1000\pi$

$p_i = p_s + p_c + p_a$

$t_c = t_l + t_c + t_u + t_i$

$V_i = l_m * w_m * h_m * n_c$

$t_{a\_o} = 60 * \frac{d_a+d_o}{f_r}$

$p_m = \frac{VRR*U_p}{1000}$

$t_h = t_{a\_o} + t_r$

$t_i = t_h + t_m$

$e_m = p_m * t_m$

$e_i = p_i + t_i$

$e_c = e_m + e_i + e_b$

$t_t = t_c * n_c$

$Yield = n_c$

$C = E * C_{kwh}$

$CO2 = E * CO2_{kwh}$

$E = e_c * n_c * 2.78e^{-4}$

Outputs

Finished part, qty
Waste
Heat, BTU
Material, kg

Resources

Operator: John Doe
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(5) 1/4" x 45° Chamfer Mill
(6) 1/4" 2 Flute E.M. With .020" x 45° Chamfers
(7) 1/4" x .093" Corner Rounding E.M.

4. Written Narrative (1500 words max)

- Validation: explain how the model is validated.
  - Examples include: case study, literature review, traditional cross-validation techniques, or others
- Novelty of UMP analysis: show off your ideas!
  - Knowledge/understanding of UMP modeling
  - Standards supporting reusable models
  - Techniques for development & validation of UMP models
- Other important topics:
  - How does your submission contribute to manufacturing science?
  - How does your submission address the theme?

1. Information Model

- Your UMP model must abide by the schema (XSD) provided on the RAMP 2018 website
- Description of each element and attribute included in the schema are documented on the challenge site:

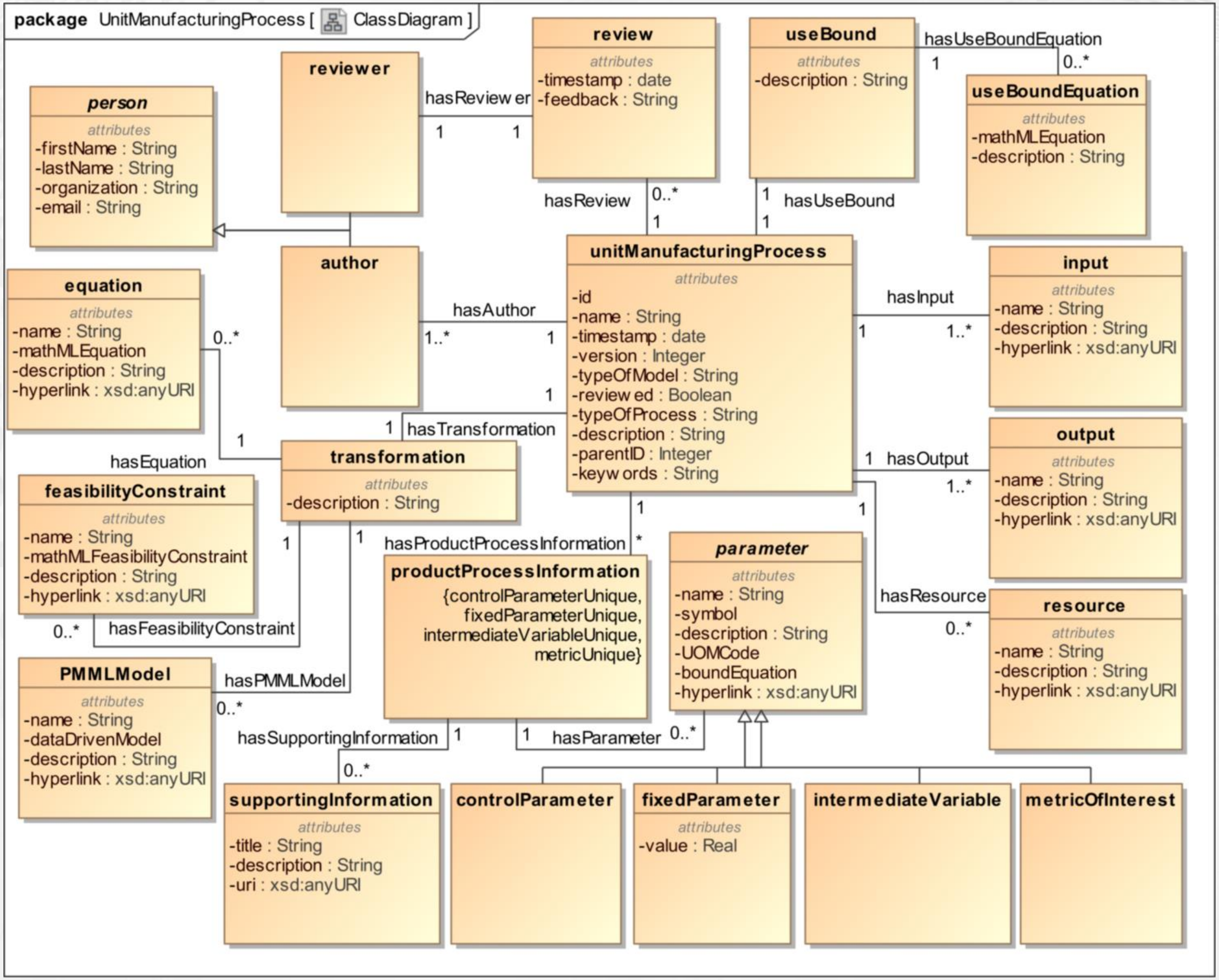
https://www.challenge.gov/wp-content/uploads/2018/01/UMP_Schema_Documentation.pdf

- Example: For recording transformations, you must use MathML or PMML

Note: This schema is not part of the published standard.

Info about MathML: https://www.w3.org/Math/
Info about PMML: http://dmg.org/pmml/v4-3/GeneralStructure.html

UMP Schema for RAMP 2018



https://www.challenge.gov/wp-content/uploads/2018/01/UMP_Schema_Documentation.pdf

Dealing with variables in your model

ProductProcessInformation contains 5 elements:

- [0…*] ***ControlParameter***: includes tunable model parameters that can be adjusted to evaluate different process settings.
- [0…*] ***FixedParameter*****:** includes model parameters that are fixed through the evaluation of the transformation equations.
- [0…*] ***IntermediateVariable*****:** includes calculated variables required to complete the evaluation of the metrics of interest.
- [0…*] ***MetricOfInterest***: includes performance metrics that the model evaluates regarding the process.
- [0…1] ***SupportingInformation***: includes all other relevant links to information needed to instantiate the model

Dealing with units in your model

Use “Common Code” from United Nations Economic Commission for Europe (UNECE)

Quantity	ST	Level/ Category	Name Description	Representation symbol	Conversion factor to SI	Common Code
Space and Time						
angle (plane)	I	1	radian	rad	m x m^{-1} = 1	C81
	I	1S	milliradian	mrad	10^{-3} rad	C25
	I	1S	microradian	µrad	10^{-6} rad	B97
	#I	1	degree [unit of angle]		1,745 329 x 10^{-2} rad	DD
	#I	1	minute [unit of angle]	'	2,908 882 x 10^{-4} rad	D61
	#I	1	second [unit of angle]	"	4,848 137 x 10^{-6} rad	D62
	D	2	grade		= gon	A91
	I	2	gon	gon	1,570 796 x 10^{-2} rad	A91
solid angle	I	1	steradian	sr	m^2 x m^{-2} = 1	D27
length,	I	1	metre	m	m	MTR
breadth	I	1M	decimetre	dm	10^{-1} m	DMT
height	I	1S	centimetre	cm	10^{-2} m	CMT
thickness,	I	1S	micrometre (micron)	µm	10^{-6} m	4H
radius,	I	1S	millimetre	mm	10^{-3} m	MMT

https://www.unece.org/fileadmin/DAM/cefact/recommendations/rec20/rec20_rev3_Annex1e.pdf

Example of a well-formed XML document


```
▼<UnitManufacturingProcess xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xmlns="http://www.nist.gov/umpCore"
name="Atomic Layer Deposition" timestamp="2017-04-17" reviewed="true" typeOfProcess="Atomic Layer Deposition"
description="This process does not belong to the Todd Allen taxonomy, since it is a fairly new process geared for
industrial-scale semiconductor manufacturing.">
 ▶<Author>...</Author>
  <Keyword>nano-thin-film manufacturing</Keyword>
  <Keyword>semiconductor manufacturing</Keyword>
 ▶<Input>...</Input>
 ▶<Input>...</Input>
 ▶<Input>...</Input>
 ▶<Output>...</Output>
 ▶<Output>...</Output>
 ▶<Output>...</Output>
 ▶<Output>...</Output>
 ▶<ProductProcessInformation>...</ProductProcessInformation>
 ▶<Resource>...</Resource>
 ▶<Resource hyperlink="http://www.ni.com/en-us/shop/labview.html">...</Resource>
 ▶<Resource hyperlink="https://www.comsol.com/">...</Resource>
 ▶<Resource hyperlink="https://www.nrel.gov/lci/">...</Resource>
 ▶<Resource hyperlink="http://www.gabi-software.com/america/index/">...</Resource>
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 ▶<Resource hyperlink="https://shop.edwardsvacuum.com/products/r2/list.aspx">...</Resource>
 ▶<Resource hyperlink="https://www.mksinst.com/product/Category.aspx?CategoryID=91">...</Resource>
 ▶<Resource hyperlink="http://tsi.com/ultrafine-condensation-particle-counter-3776/">...</Resource>
 ▶<Resource hyperlink="http://www.tsi.com/scanning-mobility-particle-sizer-spectrometer-3936/">...</Resource>
 ▶<Resource hyperlink="https://engineering.case.edu/centers/scsam/microscopes/scanning-electron">...</Resource>
 ▶<Resource hyperlink="http://engineering.case.edu/centers/scsam/microscopes/transmission-electron/technai">...</Resource>
 ▶<Resource hyperlink="https://research.case.edu/corefacilities/CoreFacilityDetail.cfm?n=64">...</Resource>
 ▶<Transformation>...</Transformation>
 ▶<UseBound>...</UseBound>
</UnitManufacturingProcess>
```

Review Criteria for Selecting Finalists

- **Completeness:** Submission follows the guidelines and includes all necessary components.
- **Complexity:** Model reflects the complexities of the manufacturing process, especially those which influence sustainability indicators such as energy and material consumption.
- **Clarity and adherence to theme:** Model is clear in describing the process-related information.
- **Accuracy:** Submission accurately models the process as shown through validation.
- **Novelty:** Approach taken develops new techniques to advance model reusability or reliability.

Live Judging at MSEC 2018 + Awards

Live Judging will be based off the same review criteria (75%) along with presentation clarity, content, and quality of in-person presentation (25%)

Awards

- First Place Prize: $1,000
- Second Place Prize: $750
- Third Place Prize: $500
- Runners Up Prizes (up to five): $200 each

RAMP 2018 support

- Communication through the RAMP 2018 challenge.gov discussion board

- UMP Builder: to help conform to the schema and automatically generate graphical representation
  - Note: optional for the competition

UMP Builder affordances

UMP Builder is a publicly available toolkit, developed at NIST, provides 5 key features:

- **Build UMP:** UMP Builder provides a form generated by the updated UMP schema. Facilitates the creation of MathML expressions.
- **Validate UMP:** UMP Builder offers model validation against the XML schema definition (XSD) for UMP models.
- **Visualize UMP:** UMP Builder automatically generates an interactive visualization of the build model, resembling the graphical representation in ASTM E3012-16.
- **Record UMP:** UMP Builder also can serve as a repository of your models. You can save either validated models or models that are a work-in-progress. Your models are kept private and are not viewable for other users of the system.
- **Explore UMP repository:** Once you record a set of models, UMP Builder offers various querying capabilities to explore the repository. You will be able to see only your own models.

https://umpbuilder.nist.gov

For best performance, use Mozilla Firefox.

Pause to check Q&A board...

https://www.challenge.gov/challenge/ramp-reusable-abstractions-of-manufacturing-processes/

Demo: UMP Builder

https://umpbuilder.nist.gov

Available for your use!

Thank you for your attention!

Best of luck in RAMP 2018!

https://www.challenge.gov/challenge/ramp-reusable-abstractions-of-manufacturing-processes/