engineering laboratory

Webinar:
RAMP 2018: Submission Packet & Supporting Tools

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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 3

Solutions 0

Rules

Submit Solution

Challenge Followers 4

Manage Solutions 0

Edit this Challenge

Revisions:

10:55 a.m. ET, Apr 03, 2018
3:22 p.m. ET, Mar 26, 2018
4:40 p.m. ET, Mar 22, 2018
9:48 a.m. ET, Mar 01, 2018
2:36 p.m. ET, Feb 22, 2018
9:25 a.m. ET, Feb 02, 2018
12:09 p.m. ET, Feb 01, 2018
12:02 p.m. ET, Feb 01, 2018
1:24 p.m. ET, Jan 30, 2018
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

NIST will conduct a webinar on **Thursday, April 5th at 3:00pm EDT** to provide information about the ongoing Reusable Abstractions of Manufacturing Processes (RAMP) Competition. In addition to describing the competition, how to submit entries, and answering questions from viewers, the webinar will showcase the just-updated UMP Builder, an open tool that helps participants record Unit Manufacturing Process models–a main component of the competition. Click here to join the webinar!

A recording of the webinar will made available here in the near future.

On February 6, we held a live webinar to discuss the rules and logistics of RAMP 2018. You can find the webinar recording here and a copy of the slides here. The webinar also demonstrated a prototype tool to support RAMP 2018 called the UMP Builder, which can be accessed at https://umpbuilder.nist.gov/ Please use the discussion board if you have any questions.

In the future, manufacturing will be planned out in the virtual world. How can we do this if we don't even have models for the basic processes such as welding, drilling, and forging? Sewing, assembly, or distillation? Nope, we don't even have models for those either! At least, not the types of models really needed for our high-tech world.

Manufacturers need models to improve operations, to protect the environment, to share information, and to compose them into systems. Using your models will let manufacturers simulate, improve, and optimize all sorts of processes.

Showcase your manufacturing research by entering the RAMP 2018 Challenge! Finalists will be invited to present their entries in a workshop at the co-located ASME International Manufacturing Science and Engineering Conference (MSEC) 2018 and the 46th NAMRI/SME North American Manufacturing Research Conference (NAMRC) in College Station, TX, on June 18-22. **Click on the "Rules" link on the left of the page to check out the official rules for details on eligibility and submission criteria.**

Thank you for following us!

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 27 Tweet Pin it Share 8

Latest Discussion

wbernstein:
Question (received via e-mail): We are trying to address the follow example as listed on Slide 10: ...

wbernstein:
Thank you for letting us know. We updated the page to link to the correct page: https://umpbuilder.n ...

Ian Garretson:
I think it would be good to link to your UMP builder on this website: https://www.nist.gov/services ...

<u>Official challenge managers:</u>

Bill Bernstein

Mark Carlisle

KC Morris

If you have questions….

- Live participants
  - use the Q&A chat bar during presentation
  - open lines after presentation

- After the webinar, send any other questions to
  - Bill Bernstein, wzb@nist.gov
  - David Lechevalier, david.lechevalier@engisis.com

The “When” - Important Dates

Submission Deadline: **April 20, 2018**

@ 5pm ET

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

(by e-mail)

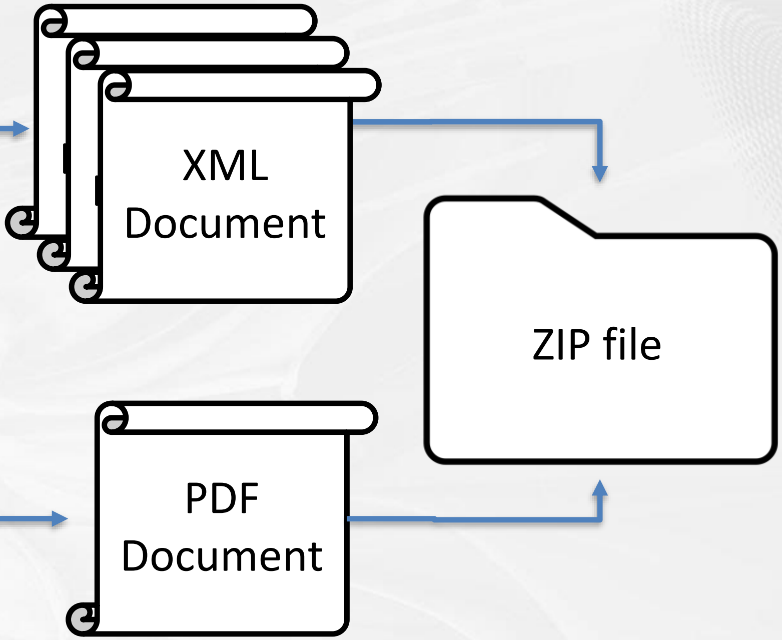
Announcement of Winners: **June 20, 2018**

ASME 2018 MSEC

College Station, TX

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

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

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

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 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

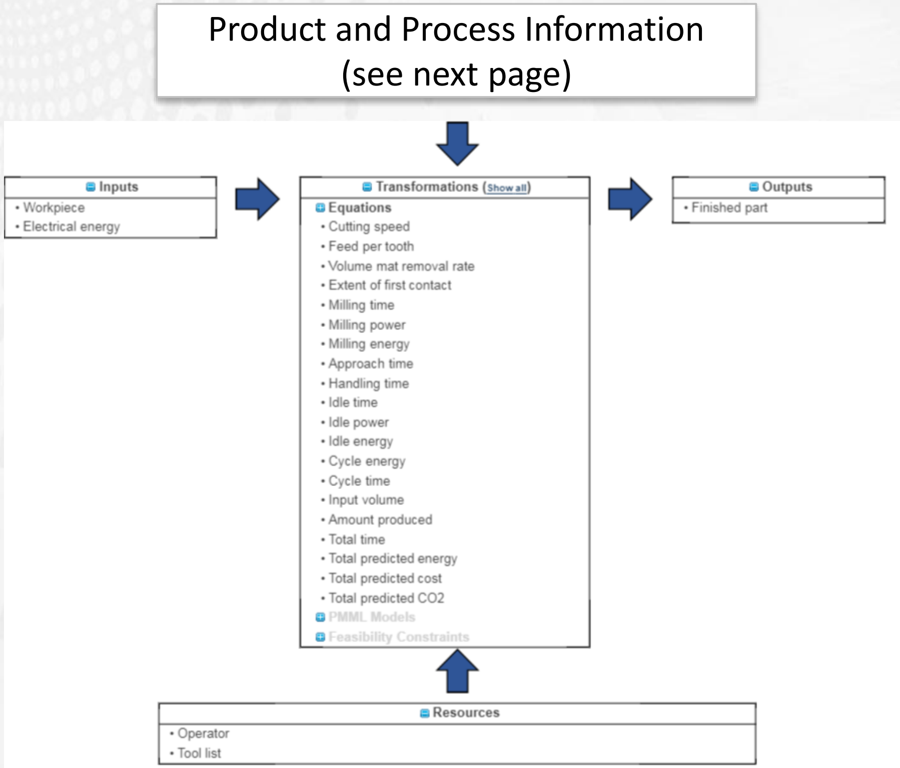
Finished part, qty
Waste
Heat, BTU
Material, kg

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
(generated by the UMP Builder)



Product And Process Information

Control Parameters
- Spindle speed
- Feed rate
- Depth of cut

Fixed Parameters
- Work piece length
- Work piece width
- Work piece height
- Diameter of the cutter
- Number of teeth
- Offset distance of tool
- Approach distance of tool
- Rapid traverse speed (horizontal)
- rapid traverse speed (vertical)
- Retract time
- Spindle power
- Axis power
- Loading time
- Cleaning time
- Unloading time
- Basic power
- Cost per kWh of energy
- CO2 per kWh of energy
- Number of cycles

Intermediate Variables
- Cutting speed
- Feed per tooth
- Volume material removal rate
- Extent of the first contact
- Milling time
- Specific cutting energy
- Milling power
- Milling energy
- Approach and overtravel time
- Handling time
- Milling idle time
- Milling idle power
- Milling idle energy
- Milling energy per cycle
- Total time per cycle
- Yield
- Volume of input

Metric of Interest
- Total time
- Total energy
- Total cost
- Total CO2

Supporting Information
- Heat sink part
- CAM files of the run

3. Graphical Representation (cont.)
(generated by the UMP Builder)

Metadata

UnitManufacturingProcess

- **id** *5ab9101d4da60a002efb046f*
- **name** *Milling Example*
- **timestamp** *2018-03-26*
- **reviewed** *false*
- **typeOfProcess** *Milling*
- **description**

This model predicts the energy consumed of a milling process by

Authors

- **Name:** *Bill Bernstein* **Organization:** *NIST* **Email:** *wzb@nist.gov*

Keywords

- *energy consumption*
- *milling*
- *SMS testbed*

Use Bounds

Reviews

Transformation Equations

Full list of transformations

Cutting speed: $V = N \times (D \times \pi) \times 1000$

Feed per tooth: $f_t = {}^{f_r}/_{(N \times n_t)}$

Volume mat removal rate: $VRR = w_w \times d_c \times f_r$

Extent of first contact: $L_c = \sqrt{w_w \times (D - w_w)}$

Milling time: $t_m = {}^{60(l_w + 2L_c)}/_{f_r}$

Milling power: $p_m = {}^{VRR \times U_p}/_{1000}$

Milling energy: $e_m = p_m \times t_m$

Approach time: $t_{a_o} = 60 \times {}^{2d_a}/_{f_r}$

Handling time: $t_h = t_{a_o} + t_m$

Idle time: $t_i = t_h + t_m$

Idle power: $p_i = p_s + p_c + p_a$

Idle energy: $e_i = p_i \times t_i$

Cycle energy: $e_c = e_m + e_i + e_b$

Cycle time: $t_c = t_l + t_c + t_u + t_i$

Input volume: $V_i = l_w \times w_w \times h_w \times n_c$

Amount produced: $n_T = n_c \times n_i$

Total time: $t_T = t_c \times n_c$

Total predicted energy: $E_T = e_c \times n_c \times 0.0002777777777777777$

Total predicted cost: $C_T = E_T \times C_{energy}$

Total predicted CO2: $CO2_T = E_T \times CO2_{energy}$

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?

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

RAMP 2018 Reusable Abstractions of Manufacturing Processes

Example of a well-formed XML document


```xml
▼<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>
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 ▶<Resource hyperlink="https://www.comsol.com/">...</Resource>
 ▶<Resource hyperlink="https://www.nrel.gov/lci/">...</Resource>
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 ▶<Resource hyperlink="https://shop.edwardsvacuum.com/products/r2/list.aspx">...</Resource>
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 ▶<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>
```

Pause to check Q&A board...

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

Demo: UMP Builder with example submission

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/