

An Open Data Network for Manufacturing

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Blue Sky Competition

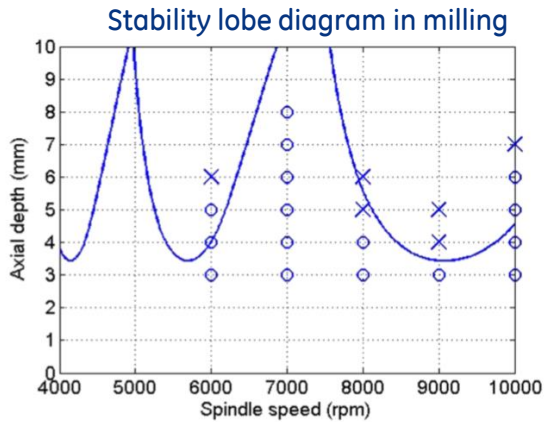
June 12, Erie PA



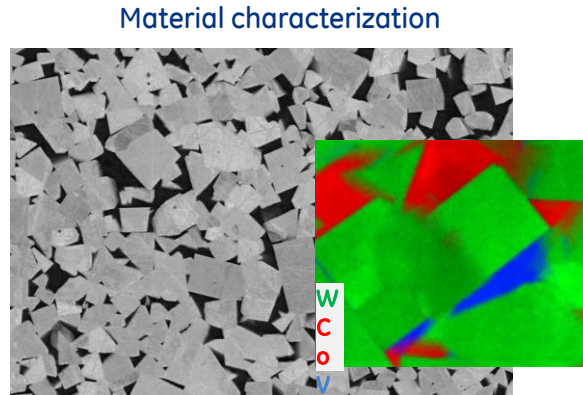
imagination at work

Blue Sky Vision

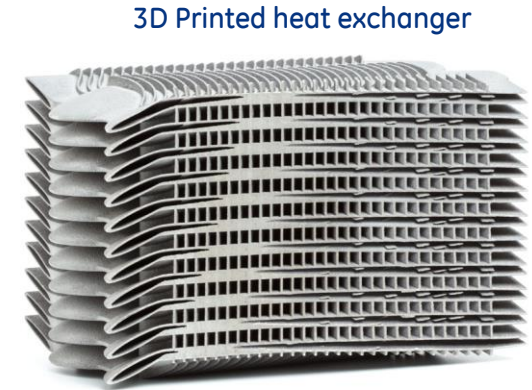
Experimental data: key requirement in advancing manufacturing process development and modeling!



Model calibration and validation



Fundamental analysis of a process



Process development

Current state for experimental data:

- cannot be shared and accessed easily
- available data not consolidated


Blue Sky Vision: community data sharing through an open data network for manufacturing!



Need

Consider a user interested in process parameters and tool life in turning Inconel 718:

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machining parameters tool life turning Inconel 718



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Scholarly articles for machining parameters tool life turning inconel 718

... integrity and tool life issues when turning Inconel 718 ... - Sharman - Cited by 134

... machinability characteristics of superalloy Inconel 718 ... - Thakur - Cited by 200

... tool life during high-speed machining of Inconel 718 - Thakur - Cited by 57

Machinability studies on INCONEL 718 - IOPscience

iopscience.iop.org/article/10.1088/1757-899X/149/1/012019/pdf

by MA Xavier - 2016 - Cited by 3 - Related articles

The best machining results with the help of carbide tool is observed at the speed of 60m/min. ... Therefore it can be concluded that best machining parameters of Inconel 718 is observed while machining with a cutting speed ($V_c = 120\text{m/min}$), depth of cut ($\text{DoC} = 0.6\text{mm}$) and feed rate ($f_d = 0.15\text{m/rev}$) using CBN tool.

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Tool wear/life evaluation when finish turning Inconel 718 using PCBN ...

<https://www.sciencedirect.com/science/article/pii/S2212827112000522>

by SA Khan - 2012 - Cited by 39 - Related articles

At the lowest cutting speed (150m/min), average tool life using the round insert was approximately 5 times longer in comparison to the C-type tool, with severe ...

(PDF) High Speed Turning of Inconel 718 Using Ceramic and Carbide ...

https://www.researchgate.net/publication/260529409_High_Speed_Turning_of_Inconel_718_Using_Ceramic_and_Carbide

Aug 3, 2015 - High speed turning using carbide tool indicated that cutting speed and tool wear and tool life when machining Inconel 718 with ceramic.

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(PDF) Optimisation of turning parameters of Inconel 718 alloy using RSM

https://www.researchgate.net/publication/264837036_Optimisation_of_turning_parameters_of_Inconel_718_alloy_using_RSM

Sep 30, 2014 - Due to its peculiar characteristics, machining of Inconel 718 is a challenge to optimise tool wear, surface finish, and cutting force for finish turning operations.

[PDF] Aerospace — High-Temperature Machining Guide - Kennametal

https://www.kennametal.com/~/media/SuperAlloys_material_machining_guide_Aerospace.pdf

Alloys such as INCONEL® 718, however ... INCONEL® 718, γ' (gamma double prime) is the primary ... Tool Life Modeling • KC5010/KC5510 Machining Ti6Al4V. 30 ... Crater wear can, in turn, weaken the cutting edge, leading to catastrophic.

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[PDF]

Design Optimization of Cutting Parameters when Turning Inconel 718 ...

<https://waset.org/publications/108881757-899X/149/1/012019/pdf>

by M Aruna - Cited by 19 - Related articles

considering the cutting speed, feed rate and depth of cut as the cutting parameters, using ... wear, surface finish, and tool force for finished turning operations [4].

[PDF]

Optimization of CNC Turning Process Parameters on INCONEL 718 ...

<https://pdfs.semanticscholar.org/2319/e956968b8f13caa07775cd6cd52b9b89d984.pdf>

by K Saravanakumar - 2012 - Cited by 9 - Related articles

Inconel 718 and investigation the influence of machining process parameters ... not mention about the effect of grain size on tool life. [7] Real coded genetic ...

A Study on the Parameters in High-Speed Turning of Superalloy ...

<https://www.tandfonline.com/doi/abs/10.1080/10426910802714571>

by DG Thakur - 2009 - Cited by 40 - Related articles

A Study on the Parameters in High-Speed Turning of Superalloy Inconel 718 ... cutting factors which influence the machinability factors such as cutting force, ... of cutting parameters the cutting force, cutting temperature and tool life can be ...

[PDF]

High Speed Machining of Inconel 718: Tool Wear and ... - CyberLeninka

<https://cyberleninka.org/article/n/94058.pdf>

by DM D'Addona - Cited by 23 - Related articles

performance and tool life in machining Inconel 718 [7]. Altin et al. [8] found that ... different speeds two of them are conventional turning at 60 m/min and 90 m/min ...



Need

Consider a user interested in process parameters and tool life in turning Inconel 718:

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Scholarly articles for **machining parameters tool life turning inconel 718**

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... **machinability** characteristics of superalloy Inconel 718 ... - **Thakur** - Cited by 200
... **tool life** during high-speed machining of Inconel 718 - **Thakur** - Cited by 57

High Speed Turning of Inconel 718 Using Ceramic and Carbide

<https://link.springer.com/article/10.1007/s13369-013-0776-x>

by S Amini - 2014 - Cited by 22 - Related articles

Sep 22, 2013 - High speed turning using carbide tool indicated that cutting speed ... of cutting speed on tool wear and tool life when machining Inconel 718 ...

Journal paper

The study on force, surface integrity, tool life and chip on laser assisted ...

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5470554/>

by K Venkatesan - 2017 - Cited by 16 - Related articles

Laser assisted turning method has become a promising solution in recent years to lessen ... with the application of laser, the cutting speed of carbide tool has increased to a ... The tool life of uncoated carbide insert is noticed as half that of multi-layer ... Comparing the conventional machining (CM), during LAT of Inconel 718, ...

Journal paper

Investigation of Cutting Temperature during Turning Inconel 718 with ...

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6117700/>

by J Zhao - 2018 - Cited by 2 - Related articles

Cutting temperature has great influence on the tool life and the machined surface ... of Al concentration x for PVD Ti1-xAlxN coated tools in turning Inconel 718. B is the coefficient under specific cutting parameters in machining Inconel 718, ...

Journal paper

Influence of spindle speed on tool wear in high-speed milling of

journals.sagepub.com/doi/abs/10.1177/0954405416668925

by J Ma - 2018 - Cited by 1 - Related articles

For high-speed milling of Inconel 718 curved surface parts, the spindle speed which determines cutting speed directly is regarded as an important cutting ...

Journal paper

comparison of machining inconel 718 with conventional - MM Science ...

www.mmscience.eu/content/file/archives/MM_Science_201415.pdf

by D FERNÁNDEZ - Cited by 6 - Related articles

turning of Inconel 718 is presented, which is the most commonly used nickel based alloy ... machining parameters are used the tool life can be improved further.

Conference paper

Effect of machining parameters on surface finish of Inconel 718 in end ...

https://www.matec-conferences.org/articles/.../pdf/.../mateconf_icmme2017_02009.pdf

by B Sarkar - 2017 - Cited by 3 - Related articles

In the present work effects of the machining parameters in end milling of Inconel 718 ... response model for tool life surface roughness and cutting force with ...

Journal paper

(PDF) Cutting forces and wear in dry machining of Inconel 718 with ...

https://www.academia.edu/.../Cutting_forces_and_wear_in_dry_machining_of_Inconel...

During machining Inconel 718, the cutting tool management of the ... Exploring higher cutting speed and adhesion of worked material onto the cutting tool Turning, milling and drilling are common operations maximum flank wear or nose ...

Journal paper

New tools and strategies take on ISO S materials | Secotools.com

<https://www.secotools.com/article/21491?language=en>

Machinability issues arise with regard to tool life, process time and reliability and Today's familiar HRSA Alloy 718 – known commercially as Inconel 718 – has ... Typical rough turning application parameters include cutting speeds of 150 ...

Report

[PDF]

A Study on the Optimal Machining Parameters of the Induction ... - MDPI

<https://www.mdpi.com/1996-1944/12/2/233/pdf>

by EJ Kim - 2019 - Cited by 2 - Related articles

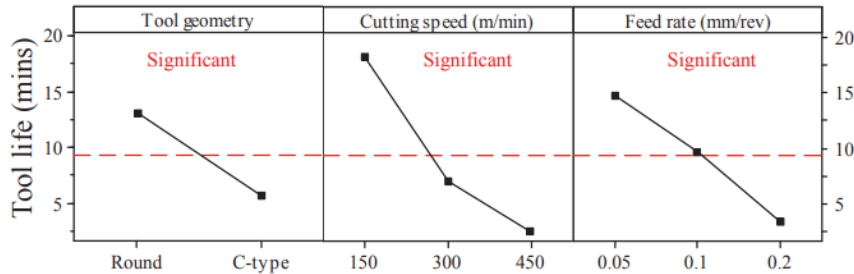
Jan 11, 2019 - the induction assisted milling of Inconel 718 using high heat coated ... et al. carried out a tool life and cutting force analysis with Inconel 718 ...

Journal paper



Need

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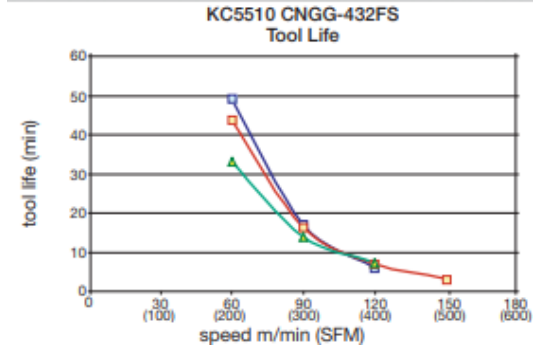
PCBN insert, depth of cut – 0.2 mm, max.
 flank wear – 300 μm , notch wear – 600 μm
 Raw data not published - 27 experiments

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Speed (m/min)	Flank Wear (micron)
60	90
90	105
190	160
255	320

CVD coated insert, feed – 0.1 mm/rev, depth – 0.5 mm
 90 mm cut length – need to calculate cut time

Page 1 - 9



IPR	DOC	
.005°	.005"	inch
.012°	.012"	metric
.005°	.010"	inch
.012°	.025"	metric
.008°	.010"	inch
.020°	.025"	metric

Figure 3: Tool life for INCONEL 718

Kennametal PVD coated grade, max. wear (flank, notch) – 300 μm , crater wear – 100 μm

- Rest of the papers:
 - focus on surface roughness – tool wear information not reported
 - raw data not reported



Need

Consider a user interested in surface potential and surface finish relation for ECM of Inconel 718:

About 57,700 results (0.67 seconds)

Did you mean: inconel 718 **ECU** potential for good surface finish

Dissolution Effects with Different Microstructures of Inconel 718 ...
[jes.ecsdl.org/content/165/16/E872.full](https://www.ecsdl.org/content/165/16/E872.full)

by D Zhu - 2018 - **Related articles**

Dec 19, 2018 - **Inconel 718**, a high-strength, thermal-resistant, **nickel**-based **alloy**, is widely used in the aviation field. ... **ECM** offers a **better** and more economical alternative for generating complex-shaped components from **Inconel 718**.^{7,8}. A large amount of research on dissolution characteristics has been carried out in **ECM**.

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(PDF) Dissolution Effects with Different Microstructures of Inconel 718 ...
https://www.researchgate.net/.../329789430_Dissolution_Effects_with_Different_Micros...

Jan 2, 2019 - the anodic dissolution behavior and **surface texture** development of cobalt under **ECM** ...
ied the **ECM** property of two laser rapid formed **Inconel 718** alloys electrode **potential** are the first to undergo a chemical reaction in **ECM**. ... the surface quality is **better** when the content of Nb in **Inconel 718** is.

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Applied Sciences | Free Full-Text | Enhancement of the Localization ...
<https://www.mdpi.com/2076-3417/9/4/690/htm>

by D Wang - 2019 - **Cited by 1** - **Related articles**

Feb 18, 2019 - The **surface roughness** of the non-machined area can be noticeably improved.

Keywords: electrochemical machining; **Inconel 718**; alkaline solution; stray corrosion ...

Electrochemical machining (**ECM**) is an anodic dissolution process, The **potential** ranges from -2 V to 2 V with a scan rate of 1 mV/s.

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Multiple performance optimization of electrochemical drilling of Inconel ...
<https://www.sciencedirect.com/science/article/pii/S221509861630564X>

by N Manikandan - 2017 - **Cited by 13** - **Related articles**

Besides the material removal rate and **surface roughness**, the geometric measures such as ...
Superalloys **Inconel 625** are extensively utilized in numerous engineering ... Electrochemical Machining (**ECM**) is one of the contemporary machining ... voltage applied, discharge rate of electrolyte in determining the **best possible** ...

Surface micro treatment of INCONEL 718 alloys with a picoseconds ...
<https://www.spiedigitallibrary.org/.../Surface...treatment...INCONEL-718-all.../12.25...>

by G Witkowski - 2018 - **Cited by 1** - **Related articles**

Dec 4, 2018 - **Surface micro treatment** of **INCONEL 718** alloys with a picoseconds laser to The treated **ECM surface** is very smooth and the machining does not ... It is **possible** to use electrolyte as a micro-tool instead of a metal electrode. speed about 500 independent points per second with **good** marking quality.

[PDF]

Optimization of Micro Electrochemical Machining of Inconel 718 using ...
https://www.ripublication.com/ijaer18/ijaerv13n9_37.pdf

and feed rate. Besides the MRR, the **surface roughness** and ... ascertain the **best possible** machining performance is yet a ... during micro **ECM** of **Inconel 625**.

[PDF]

156. optimization of process parameter in electrochemical machining ...
<pnrnsolution.org/Datacenter/Vol3/Issue1/156.pdf>

The material used in the Study was **Inconel 718**. ... Electrochemical Machining (**ECM**) has tremendous **potential** because of versatility of its applications, and it is ... wear, absence of stress/burr, high material removal, smooth **surface finish** and the ... desirable properties like easily machinable, low wear rate, **good** conductor.

You visited this page on 5/20/19.

[PDF] evaluation of electrochemical machining technology for surface ...

https://web.ornl.gov/.../web_ECMTechologies_MDF-TC-2014-039_Final%20Report...

by RR Dehoff - 2015

Sep 23, 2015 - Surface appearance of electron beam melted Inc718 after **ECM** treatment with ...

Opportunities for MDF technical collaborations are listed in the announcement ... Prior to machining, the **surface roughness** of the Arcam Electron Beam Melting **Inconel 718** test ... This design could be improved to deliver **better**.

Comparison of Flank Super Abrasive Machining vs. Flank Milling on ...
<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6164976/>

by H González - 2018 - **Cited by 2** - **Related articles**

Sep 6, 2018 - Flank Milling on **Inconel**® **718 Surfaces** ... such as electrochemical machining (**ECM**), linear friction welding (LFW), ... This technique is becoming a **good** alternative for **finishing**, however



Need

Page 1 - 1

Table II. Experimental conditions.

Parameters	Conditions
Cathode feeding rate v_c (mm/min)	0.5
Electrolyte	NaNO ₃
Inlet pressure P_I (Mpa)	0.8
Outlet Pressure P_O (Mpa)	0.15
Electrolyte temperature T (°C)	30±0.5
Electrolyte conductivity κ ($\Omega^{-1}\text{m}^{-1}$)	15.2
Electrolyte concentration	20%
Voltage U (V)	20
Pulse duty	70%
Pulse frequency f (Hz)	1000
Initial inter-electrode gap (mm)	0.3

Solid-solution material : Ra 1.378 μm

Solution and aging material: Ra 0.188 μm

One test condition given

- Rest of the papers:
 - don't report surface roughness
 - raw data not reported
 - focus on various surface artifacts without providing adequate experimental details

Page 1 - 5

Table 3. Experimental results showing MRR, SR and overcut

S.No	Electrolyte Conc (mole/lit)	Voltage (volts)	Feed rate (mm/min)	MRR (mm^3/min)	SR (μm)	Overcut (mm)
1	0.23	9	0.02	0.0366	0.5583	0.13443
2	0.23	12	0.04	0.0395	0.4933	0.09962
3	0.23	15	0.06	0.0884	0.3853	0.02161
4	0.32	9	0.04	0.0396	0.6150	0.15123
5	0.32	12	0.06	0.0787	0.5300	0.07562
6	0.32	15	0.02	0.0795	0.4960	0.11163
7	0.41	9	0.06	0.0735	0.6450	0.06842
8	0.41	12	0.02	0.0565	0.6433	0.04082
9	0.41	15	0.04	0.0908	0.5447	0.03241



Need

- Available experimental data mostly from journal and conference papers -
 - raw data not published
 - data only relevant to study in question reported
 - experimental data that does not validate the proposed model does not get published – underlying data may be valid
 - experimental validation with small datasets cannot be extrapolated

How can we improve experimental data reporting and consolidate results?



Vision

An open data network for manufacturing processes to compile all manufacturing process experimental data!



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Home Process Data Contribute Collaborate Education Help

Introduction:

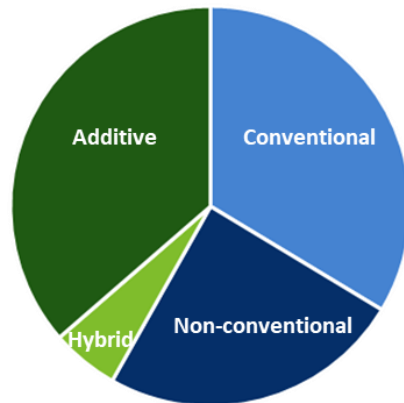
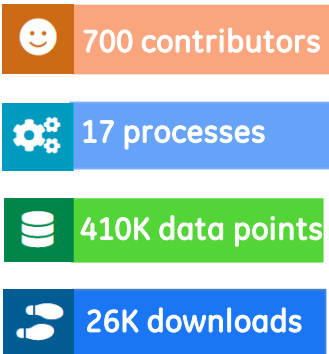
The manufacturing data network is a collaborative effort between academia, government labs, and industry to serve as a data source for all manufacturing process data.

Download:

Standard data templates for processes:

Turning	ECM	Additive – Powder Bed Fusion
Milling	EDM	Additive – Binder Jet
Drilling	Laser	Additive - DED
Grinding	Welding	

Data summary:



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Home Process Data Contribute Collaborate Education Help

Select Process

Material

Process Variable

Turning ▼

Inconel 718 ▼

Tool Wear ▼

Enter

Search:

#	Machine	Tool	Type of cut	Cut speed (s/mm)	Coolant	Cut time (min)	Tool wear (mm)	Type of wear	Surface roughness	Tool Images	Source	Affiliation
1	M1	DNMG 432	OD Turning	50	Flood	4.5	0.11	Flank	-		XYZ	State University
2	M1	DNMG 432	OD Turning	50	Flood	9	0.18	Flank	-		XYZ	State University
3	M1	DNMG 432	OD Turning	50	Flood	13.5	0.27	Flank	-		XYZ	State University
4	M1	DNMG 432	OD Turning	70	Flood	3.2	0.12	Flank	-		XYZ	State University
5	M1	DNMG 432	OD Turning	70	Flood	6.4	0.24	Flank	-		XYZ	State University
6	M1	CNMG 432	OD Turning	50	Flood	4.5	0.1	Flank	-		XYZ	State University
7	M1	CNMG 432	OD Turning	50	Flood	9	0.17	Flank	-		XYZ	State University
8	M1	CNMG 432	OD Turning	50	Flood	13.5	0.29	Flank	-		XYZ	State University
9	M1	CNMG 432	OD Turning	70	Flood	3.2	0.13	Flank	-		XYZ	State University



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Select Process

Material

Process Variable



Turning ▼

Inconel 718 ▼

Tool Wear ▼

Enter

Search:

#	Machine	Tool	Type of cut	Cut speed (s/mm)	Coolant	Cut time (min)	Tool wear (mm)	Type of wear	Surface roughness	Tool Images	Source	Affiliation
1	M1	DNMG 432	OD Turning	50	Flood	4.5	0.11	Flank	-		XYZ	State University
2	M1	DNMG 432	OD Turning	50	Flood	9	0.18	Flank	-		XYZ	State University

Blue Sky questions:

- Can a standardized data template be created for each process?
 - 'must have' and 'nice to have' inputs?
- How can the data be curated effectively?
- How do we ensure data quality?



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Home Process Data **Contribute** Collaborate Education Help

Contribute data to the network:

Select Process **Upload Data File**

ECM ▼ Browse.. No file selected Upload

Data analytics:

1. Run analytics
2. Compare with community data
3. Outlier detection

Blue Sky questions:

- What are the right incentives to contribute to the network?
 - data analytics and visualization toolkit
 - requirement for journal submission



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Search participants:

Select Process Additive – Powder Based Fusion ▼

Process Variable Distortion ▼

Enter

Collaboration:

- Sample measurement
- Data science (ML/AI)
- Industry validation

Blue sky questions:

- How do we facilitate and encourage collaboration between researchers?
 - manufacturing & data science
- What role does industry participants play in the network?
 - validate data with shop experience
- How do we create a user community to fill-in experimental data gaps?



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Home Process Data Contribute Collaborate **Education** Help

Teaching datasets:

Select Process Process Variable

Turning ▼ Tool Wear ▼ Download dataset

Demonstration videos:

- Conventional machining
- Non-conventional machining
- Additive

Blue sky questions:

- How do we share learnings from the data widely with the community?
- How can teachers use the data to enhance manufacturing learning and outreach?
 - sample datasets for variables
 - demonstration videos



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Home Process Data Contribute Collaborate Education **Help**

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Uploading data: upload@mfgdatanetwork.com
Bug report: bug@mfgnetwork.com

Click here for a list of [FAQs](#)

Blue sky questions:

- How to ensure effective management and support of the data network?
 - process and data owners
 - data storage and site maintenance



Vision

Research + Education:

- Intersection of multiple disciplines - manufacturing science, computer science, and data science
- Accelerate advances in manufacturing process development and modeling through collaboration and community learning
- Facilitate innovation in machines and tools by benchmarking best-in-class
- Enhance manufacturing education and outreach;
 - real world data
 - up-to-date with current state of the art



Thank you!



