Sustainable Machining Process Calculator

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Universiti Malaysia PAHANG
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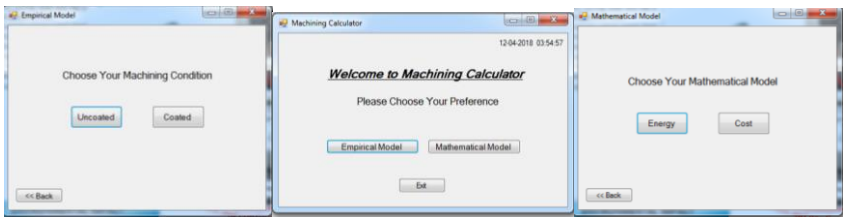
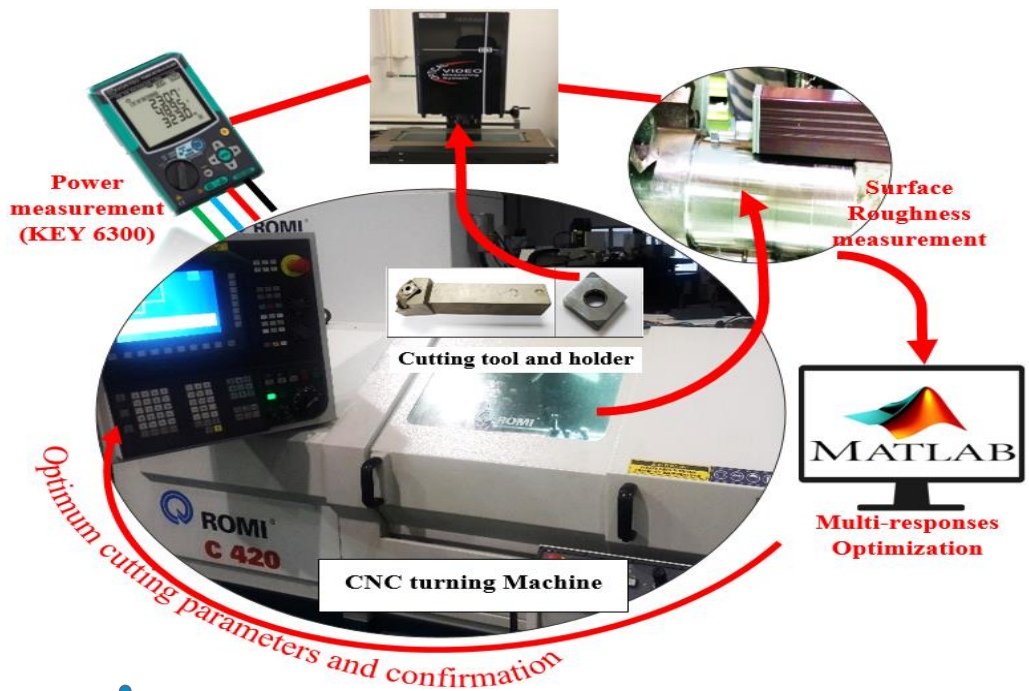
INVENTOR: ASSOC. PROF. IR. DR. AHMAD RAZLAN YUSOFF
FACULTY: FACULTY OF MANUFACTURING ENGINEERING,
UNIVERSITI MALAYSIA PAHANG, 26600 PEKAN, PAHANG, MALAYSIA
EMAIL: razlan@ump.edu.my
CO-INVENTORS: SALEM SALAH ABDULLAH BAGABER AND FAWZI ZAMRI ,

PRODUCT BACKGROUND

- Reducing energy consumption and machining cost under dry condition should considered for sustainable machining.
- Cutting parameters selection is an important task for dry turning steel and has a significant influence on both the energy consumption and operation cost.
- In this project, the influence of cutting parameters are namely cutting speed, feed rate and depth of cut on energy, cost and tool wear are firstly analyzed.
- Then a multi-responses parameter is optimized with the objective of minimizing energy and machining cost and solved based on NSGA II algorithm.
- Finally, a confirmation validation test is conducted to validate the proposed model.
- This method also effectively reduces the environment effects in terms of noncutting fluid use and less energy required which is effected in sustainable of machining.



METHODOLOGY / STATE OF ARTS

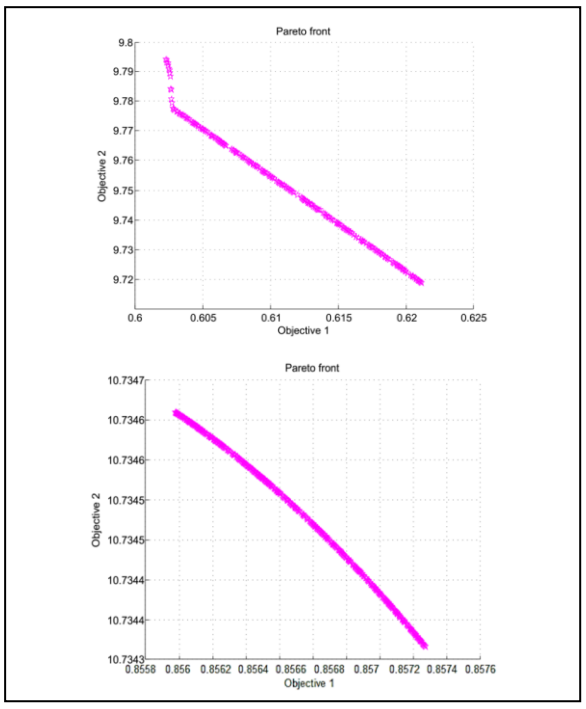


BENEFITS/USEFULLNESS

	Parameter (tool supplier)		Parameter (RSM)		Parameter (NSGA II)	
	dry	wet	dry	wet	dry	wet
Cutting speed (v)	150	90	127	147	112	145
feed rate (f)	0.15	0.2	0.191	0.169	0.183	0.179
depth of cut (a_p)	1.15	0.1	0.8	0.8	0.808	0.8
Total energy (kWh)	0.83	1.11	0.781	0.904	0.602	0.856
Total cost (RM)	12.809	14.60	12.701	13.056	9.775	10.734
% difference from parameter based on tool supplier	-	-	**5.9**	**18.5**	**27.5**	**22.8**
	-	-	**0.84**	**10.5**	**30.3**	**38.6**

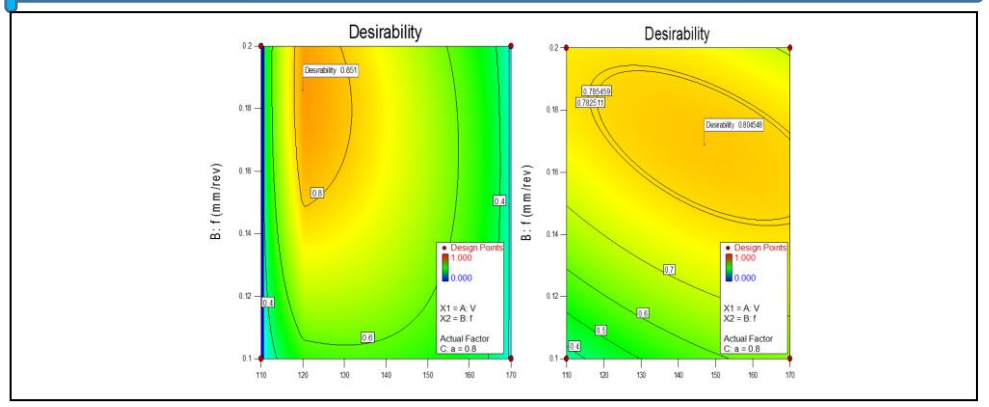
ENVIRONMENTAL IMPACT

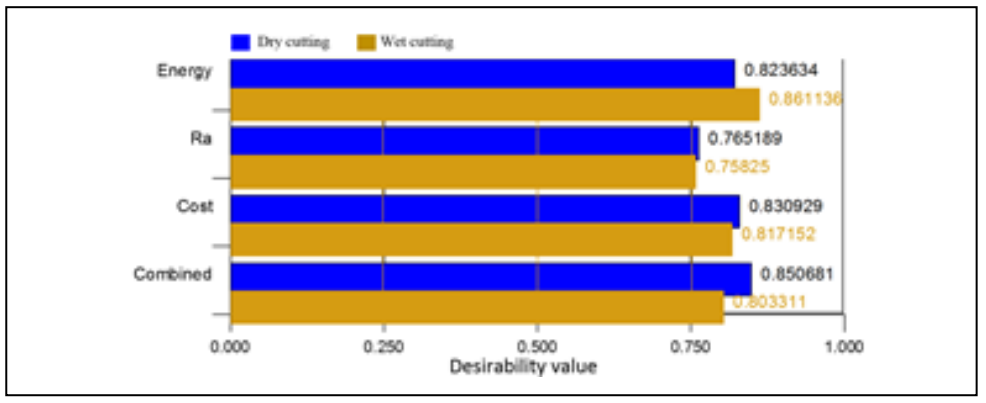
1. With simulation in Matlab R2013a, the multi-objective problem is solved by integrated NSGA II algorithm, and the simulation results indicate that cutting parameters optimization is beneficial for cost and energy saving during turning machining.
2. Dry cutting shows less energy consumption and machining cost with acceptable quality compare to the wet condition.
3. A two-confirmation method has been conducted to validation optimum point. This resulted in the energy saving of 9.2% and decreased machining cost by 4.6%.
4. The second-generation results of optimization using NSGA II shows improvement more than 70% compared to RSM optimization. The model proposed in this study effectively in machining energy, cost as well as environment which is overall enhancement of machining sustainable.



$$\text{Power consumption} = 5.36989 + 0.017461 \times v_c - 22.70315 \times fr - 1.15085 \times a_p + 0.012301 \times v_c \times a_p + 60.30027 \times fr^2, \quad (5)$$

PRODUCT CHARACTERISTICS



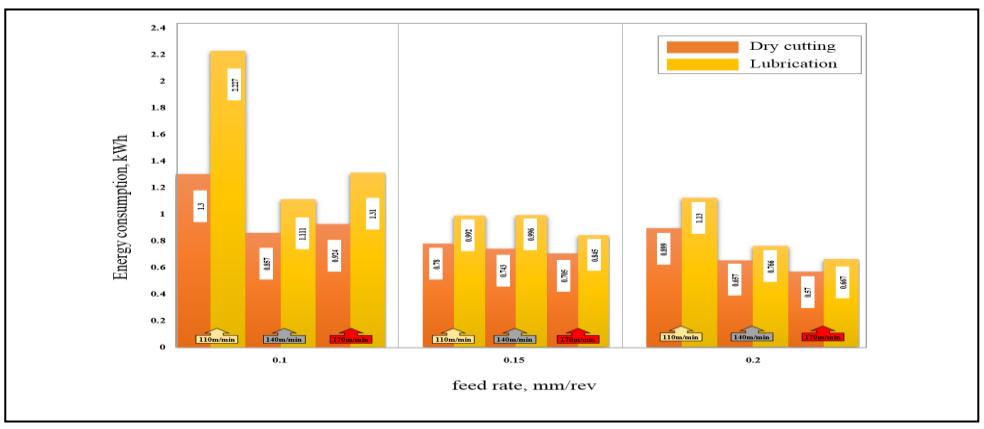


PUBLICATIONS

1. Salem Abdullah Bagaber and Ahmad Razlan Yusoff (2017) Multi-objective optimization of cutting parameters to minimize power consumption in dry turning of stainless steel 316 Journal of Cleaner Production, 20, 30–46 IF=5.715, Q1, ISI journal.
2. S A Bagaber and A R Yusoff (2018) Multi-response optimization in dry turning of stainless steel as a key factor in minimum energy, The International Journal of Advanced Manufacturing Technology, 1-14, IF=2.015, Q2, ISI journal.
3. Salem Abdullah Bagaber and Ahmad Razlan Yusoff (2017) A comparative studey on performance of CBN inserts when turning steel under dry and wet conditions, IOP Conference Series: Materials Science and Engineering 257 (1), 012041 Scopus journal.
4. Salem A. Bagaber, and Ahmed Razlan Yusoff (2017) Effect of cutting parameters on sustainable machining performance of coated carbide tool in dry turning process of stainless steel 316, AIP Conference Proceedings 1828,020013 Scopus journal.

ANALYSIS

1. It is deals with multi-responses optimization of cutting parameters for three objectives including energy, cost, and quality, which are affected by three variables, namely cutting speed, feed rate, and cutting depth.
2. In the model, direct energy and indirect embodied energy are considered in energy consumption calculation; machining cost model contains all machining tool including energy cost, production operation cost, cutting tool cost, and cutting fluid cost; and quality is represented by surface roughness.



COLLABORATORS

Sapura

TMEH

MARKET SURVEY
"ALL MACHINING PLAYER"

MARKETABILITY

- The optimum machining parameters are obtained by RSM, which are v=110 m/min, f=0.191 mm/rev, ap = 0.8 mm for dry cutting and for wet lubrication v=147 m/min, f=0.169 mm/rev, ap = 0.8 mm, and the optimal objective values are 0.57-3.84 kWh and RM 8.94-9.78 for dry and wet, respectively.
- Consequently, the energy saving is 33.46%, and the machining cost is decreased by 17.81%. The proposed model effectively minimises the machining cost and energy, which result in overall enhancement of sustainable machining

ACHIEVEMENTS

- **GOLD MEDAL,** CREATION, INNOVATION, TECHNOLOGY & RESEARCH EXPOSITION, 2018, UMP