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SAVING ELECTRICAL ENERGY IN INDUSTRIES BY OPTIMIZING CUTTING PARAMETERS OF CNC MACHINE TOOLS

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ABSTRACT

"Save Energy", is the present interest of the world. Temperate usage of electrical force through viable use of it is an absolute necessity. Amid generation of parts utilizing Computerized Numerical Control machines, parcel of force is expended. Advancement is the demonstration of word scan be upgraded by least machining time in each machining forms. With the general utilization of modern and high cost CNC machines combined with higher work costs, ideal working parameters are alluring for delivering practical parts. This paper demonstrated that by diminishing the working time of high power expending generation utilizing CNC electrical vitality is monetarily used.

Three unique parts are considered for which different operations like turning, processing and confronting are performed in three distinct businesses. The optimizing so as to machine time is decreased the cutting rate, food and profundity of cut. Usage of ideal cutting parameters recommended by enhancement methods has lead to decrease in machining time, power utilization, work cost, item machining cost and enhance the use of the vigorously put CNC worked machines in assembling commercial enterprises. So this paper recommends the commercial enterprises with ideal cutting parameters for CNC machining procedures to have least machining time in businesses, which thus spares electrical vitality.

Key words: Optimisation, Machining, Electrical energy, CNC machines, Cutting parameters, Machining cost.

INTRODUCTION

Advancement of working parameters is a critical stride in machining streamlining, especially to operate CNC machine devices. With the general utilization of refined and high

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cost CNC machines combined with higher work costs, ideal working parameters are key for delivering the parts financially. In spite of the fact that handbooks give prescribed cutting conditions, there is a urgent requirement for dissecting the ideal parameters, resilience designations and process choice for machining, which will prompt a financial creation.

Machining parameter enhancement has an inescapable part in contemporary operation of CNC and non-customary machining forms. As there is a budgetary restriction included in every one of the machines, the powerful operation of these machines takes a middle stage to get required payback. The machining variables are negative for the brought about expense because of machining, which thusly requires discovering ideal qualities before a section is put into generation. The working parameters considered are cutting rate, profundity of cut and bolster rate that don't disregard any of the imperatives that might apply on the procedure and fulfill the target capacity of minimizing the machining time.

Literature survey

Al-Ansary et al. (1997) planned simultaneous advancement of configuration and machining resiliences utilizing the hereditary calculations system. Field M. et al. (1980) have done computerization of cost investigation of granulating operations. Franci Cus et al. (2003) enhanced the cutting procedure GA approach. Gopalakrishnan B. et al. (1991) chose parameter for turning process with requirements by scientific methodology in light of geometric programming. Jeffrey Horn et al. (1994) by Niched Pareto Genetic Algorithm, planned multi-target advancement method for machining process. Pei Wang and Ming Liang (2005) all the while comprehended procedure determination, machining parameter improvement and Tolerance plan. Shunmugam et al. (2000) ideally chose parameters in multi-instrument boring. Vijayakumar K. et al. (2003)' streamlined for multi-pass turning operations utilizing insect state system. Shunmugesh K. et al. (2014) advanced for CNC Turning process parameters with carbide apparatus for surface unpleasantness investigation utilizing Taguchi Analysis. Basil M. Eldhose et al. (2014) advanced the cutting parameters of SS 304 for CNC turning operation.

Mihir T. Patel et al. (2014) enhanced the machining parameters for turning diverse compound steel utilizing CNC. N.S. Pohokar and L. B. Bhuyar, (2014) evaluated instrument life and upgraded parameters for a CNC parallel shank end factory device utilizing hereditary calculation approach. S. K. Saini and S. K. Pradhan, (2014) connected delicate figuring systems for the streamlining of machining parameter in CNC turning operation.

Table

S. No.	Industries case studies	Machining process	Job material
1	Case study 1: TVS Motor Company	Milling	Aluminium alloy
2	Case study 2: Kumar Industries	Turning & Facing	
3	Case study 3: GK & Sons	Turning	
Case study: 1			

Table: The results of optimization method Vs present method for milling

Method	Feed rate (mm/tooth)	Cutting speed (m/min)	Machining Time in secs
Present	0.05	400.00	37.68
Optimization	0.158	139.92	33.60
Saving/component/single operation			04.08

T_m = Machining time in min.

$$T_m = \frac{\pi \times D \times L}{1000 \times V \times f} \quad \ldots(2)$$

TL = Tool life in min.

$$TL = \left(\frac{C_v \times V_b^m \times K_{mv} \times K_j \times Z^x}{V_c \times a^q \times f^p \times B_r^y} \right)^{\frac{1}{n}} \quad \ldots(3)$$

C_{mt}	Material cost
C_d	Direct operation cost/min
C_w	Cost of tooling
T_h	Work handling time
T_c	Tool Changing time
V_b	Flank wear value
K_t	Coefficient of tool cutting edge angle
K_{mv}	Coefficient of work material hardness

a	Depth of cut
q	Exponent of depth of cut
x	Number of tool component
n	Tool life exponent
p	Exponent of feed effect
z	Number of cutting teeth
m	Exponent of the tool wear effect
B_t	Width of cut
K_s	Specific cutting force
L	Length of travel

Constraints

The constraints represent some functional relationship between the design variable and other design parameter satisfying certain physical phenomenon and certain resources limitations. So constraints states that the functional relationship among design variables is greater than, smaller than or equal to a resource value.

Velocity range : $\nu_{min} \leq \nu \leq \nu_{max}$

Feed range : $f_{min} \leq f \leq f_{max}$

Tool life : $TL \geq TL_{min}$

Cuttingforce : $F_c = \left(K_s \times a \times B_r \times f \times \frac{Z}{D}\right)$ …(4)

$F_c \leq F_{max}$

Surface Finish : $R_a = 318 \times \frac{f_z^2}{4 \times D}$ …(5)

$R_a \leq R_{min}$

where, V_{min} = Minimum cutting speed

V_{max} = Maximum cutting speed

f_{min} = Minimum feed rate

f_{max} = Maximum feed rate

TL = Tool life

TL_{min} = Minimum tool life desired

F_c = Actual cutting force

R_a = Actual surface finish

$R_{a\,min}$ = Min. req. surface finish

$F_{c\,max}$ = Maximum cutting force

Case study: 2

Problem description

The component of 26 mm diameter has been turned by 39 mm length. The tool materials are Carbide Insert – CNMG TT8020 and DNMG TT5100. The job material is Mild Steel EN3D. The machine selected is Mitsubishi. The cutting speed range is 108-245 m/min. and the feed range is 0.1- 0.4 mm/rev.

Objective function

The objective function used in this work is to minimize the machining time (T) for the operations turning, facing and undercutting performed on 30 mm diameter cylindrical component.

$$\text{Minimize (T)} = \left(\frac{L \times \text{No. of\_Pass}}{F \times N}\right) \text{(minutes)} \quad \ldots(1)$$

$$\text{Where, N} = \left(\frac{1000 \times V}{3.14 \times D}\right) \text{(rpm)} \quad \ldots(2)$$

$$\text{Tool Life (TL)} = \frac{(2.454 \times 10^9)}{V \times \left(\frac{1}{0.254}\right) \times F^{\left(\frac{1}{0.411}\right)}} \text{(minutes)} \quad \ldots(3)$$

where, T = Machining time for the work piece (min),

L = Length of the component (mm),

F = Feed given to the component (mm/rev),

N = Rotation per minute (rpm),

V = Cutting speed (mm/min),

D = Diameter of the component (mm).

Cutting force (F_c) = $1456.26 \times De^{1.06} \times F^{0.67}$ (Newton) …(4)

where, De = Depth of cut = 0.7 mm

Surface finish (R_a) = $\left(\dfrac{F^2 \times 0.256}{8 \times r_n}\right)$(microns) …(5)

where, r_n = Tool nose radius = 0.8 mm

Power (P_m) = $0.0242 \times De^{1.06} \times F^{0.67} \times V$ (kW) …(6)

Operating parameters

The operating parameters considered are cutting speed and feed rate that do not violate any of the constraints that may apply to the process and satisfy objective criteria of minimum machining time.

Constraints

In this study the following constraints are enforced.

(108 m/min)	$V_{min} \leq V \leq V_{max}$	(450 m/min)	(1st constraint)
(0.1 mm/rev)	$f_{min} \leq f \leq f_{max}$	(0.4 mm/rev)	(2nd constraint)
	$TL \geq TL_{min}$	(400 min)	(3rd constraint)
	$F_c \leq F_{cmax}$	(900 N)	(4th constraint)
	$R_a \leq R_{amin}$	(2 micron)	(5th constraint)
	$P_m \leq P_{max}$	(7.5 kW)	(6th constraint)

where, V_{min} = Minimum permissible cutting speed,

V_{max} = Maximum permissible cutting speed,

f_{min} = Minimum permissible feed rate,

F_{max} = Maximum permissible feed rate,

TL = Tool life (min),

TL_{min} = Minimum tool life desired,

F_c = Actual cutting force (Newton),

R_a = Actual surface finish (micron),

R_{amin} = Minimum required surface finish,

P_m = Actual power (KW),

F_{cmax} = Maximum cutting force (Newton),

P_{max} = Maximum power.

Results of case study 2

	Current practice			**Proposed by genetic algorithm**			
	Cutting speed (m/min)	**Feed rate (mm/rev)**	**Machining time (sec)**	**Cutting speed (m/min)**	**Feed rate (mm/rev)**	**Machining time (sec)**	
Rough turning	163.36	0.30	4.25	141	0.362	3.25	**1.00**
Finish turning	198.70	0.12	5.75	145.2	0.196	4.75	**1.00**
Rough facing	163.36	0.20	6.75	134.4	0.280	5.50	1.25
Finish facing	198.70	0.12	3.50	145.4	0.143	2.00	1.50
Under cutting	198.70	0.12	5.75	145.2	0.196	4.75	1.00
Total machining time reduced per component							5.75

Thus, after implementing the optimized values, the actual machining time is reduced by 5.75 sec.

For a shift total no of components = 300

Time taken for machining 300 components before optimization = 300 * 30/60
= 150 min

Time taken for machining 300 components after optimization = 300 * 24.25/60
= 121.25 min

Saving in time for machining for a shift = 150-121.25 = 28.75 min

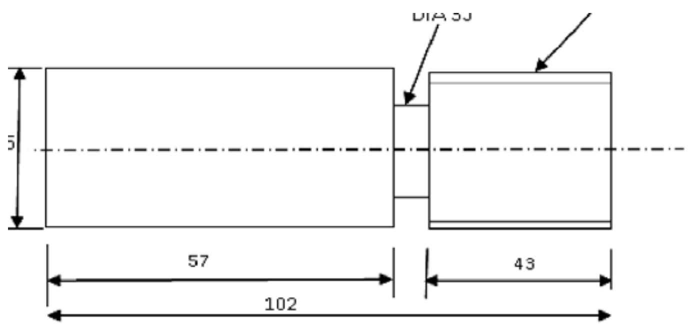
Additional no of components that can be machined in 28.75 min = 69

Total no of components that can be machined in a shift = 300 + 69 = 369

Hence % increase in productivity = (369-300)/300 = 23%

Case study: 3

Component sketch



Problem data

Length of turning	:	57 mm
Diameter of the job	:	50 mm
Tool material	:	Coated carbide - GC215
Job material	:	Carbon steel
Machine details	:	Mitsubishi
Cutting speed range	:	30-300 m/min
Feed Range	:	0.1-0.5 mm/rev

CONCLUSION

The electrical power demand in our country is increasing day by day. On the other hand we have limited power supply. So effective utilization electrical power is a must at present. Our project aims to achieve this by reducing the operating time of heavy current d by consuming production machines like Computer operated Numerical Control Machines. The machining time is reduced by optimizing the cutting speed, feed and depth of cut.

"Small drops of water forms Ocean". Even 1% of saving in operating time of each and every CNC machines in industries, a considerable amount of electrical power saving.

Implementation of optimal cutting parameters suggested by optimization technique will lead to reduce the machining time, power consumption, labour cost, unit cost of product machining cost and improve the utilisation of the heavily invested CNC machines in manufacturing industries.

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REFERENCES

1. Al-Ansary and I. M. Deiab, Concurrent Optimization of Design and Machining Tolerances using the Genetic Algorithms Method, Int. J. Machine Tools Manufacture, **37(12)**, 1721-1731 (1997).
2. K. Deb, Optimization for Engineering Design, Prentice Hall of India, New Delhi (2002).
3. M. Field, R. Kegg and S. Buescher, Computerized Cost Analysis of Grinding Operations, Ann. CIRP, **29(1)**, 233-237 (1980).
4. Franci Cus and Joze Balic, Optimization of Cutting Process by GA Approach, Robotics and Computer Integrated Manufacturing, **19**, 113-121 (2003).
5. B. Gopalakrishnan and Faiz Al-Khayyal, Machine Parameter Selection for Turning with Constraints: An Analytical Approach Based on Geometric Programming, Int. J. Production Res., **29(9)**, 1897-1908 (1991).
6. Jeffrey Horn, Nicholas Nafpliotis and David E. Goldberg, A Niched Pareto Genetic Algorithm for Multiobjective Optimization, Ist IEEE Conf. on Evolutionary Computation, Orlando, FL, USA, 82-87 (1994).
7. Pei Wang and Ming Liang, Simultaneously Solving Process Selection, Machining parameter optimization, and Tolerance Design problems: A Bi-Criterion Approach, J. Manufacturing Sci. Engg., **127**, 533-544 (2005).

8. R. Saravanan, Manufacturing Optimization through Intelligent Techniques, CRC Press (2006).

9. M. S. Shunmugam, S. V. Reddy and T. T. Narendran, Optimal Selection of Parameters in Multi-Tool Drilling, J. Mater. Process. Technol., **1032**, 318-323 (2000b).

10. K. Vijayakumar, G. Prabhaharan, P. Asokan and R. Saravanan, Optimization of Multi-Pass Turning Operations using Ant Colony System, Int. J. Machine Tool and Manufacture, **43**, 1633-1639 (2003).

11. K. Shunmugesh, K. Panneerselvam, M. Pramod and Amal George, Optimization of CNC Turning Parameters with Carbide Tool for Surface Roughness Analysis Using Taguchi Analysis, Res. J. Engg. Sci. ISSN 2278-9472, **3(6)**, 1-7 (2014).

12. Basil M. Eldhose, Cijo Mathew and Binu Markose, "Optimization of the Cutting Parameters of SS 304 for CNC Turning Operation, Int. J. Innovative Res. Adv. Engg. (IJIRAE), ISSN: 2349-2163, **1(8)** (2014).

13. Mihir T. Patel and Vivek A. Deshpande, Optimization of Machining Parameters for Turning Different Alloy Steel Using CNC, Int. J. Innovative Res. Sci. Engg. Technol., ISSN: 2319-8753, **3(2)** (2014).

14. N. S. Pohokar and L. B. Bhuyar, Estimation of Tool life and Optimization of Parameters for a CNC Parallel shank End Mill Tool Using Genetic Algorithm Approach, Int. J. Emerging Technol. Adv. Engg., ISSN 2250-2459, **4(2)**, (2014).

15. S. K. Saini and S. K. Pradhan, Soft Computing Techniques for the Optimization of Machining Parameter in CNC Turning Operation, Int. J. Emerging Technol. Adv. Engg., ISSN 2250-2459, **4(3)** (2014).

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