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A Study On Dynamic Characteristicsof The Cut On The Laying Parts In Peripheral Milling

J. Mallesh[1] H.Sanghamesh[2]m.Narsimulu[3]
Professor, Department of Mechanical, Faculty of HITS ,Hyderabad ,India.

ABSTRACT**:** At a peripheral milling machining, positioning of the workpiece generally has deviations from its nominal position in the sense of small displacements and orientations. These differences generally depend on:Geometrical defects of the machining assembly;contact defects of the workpiece on the machining assembly;Deformation caused by dynamic cutting forces, for positioning and clamping. Indeed, the evolution cutting orces acting on the workpiece during machining causes a critical vibrational behavior of the part that generates small dynamic displacements interaction « workpiece-mounting » causing instabilities layring and a generation of geometric imperfections during machining. When the defect is too large by-the geometrical and dimensional specifications required, we must minimize vibration of the room, by acting on the optimal configuration of the locations of iso-static support clamps, but also cutting condition.

Key words: *Machining Dynamics, Cutting Forces, Equations of Motion, Prediction.*

I. INTRODUCTION

The machining by material removal is one of the most used methods in industry and especially in aeronautics where it sometimes take over 90% of the material milled to obtain a finished product as perfect as possible. However during this machining.Taking Into Account of The Dynamic Effects of The Cut on The Laying of The Parts In Peripheral Millingprocess, especially when roughing, the lining of parts undergoes more or less important accidental variations due to instability of the dynamic effects of cutting and cutting depths. This phenomenon of variation sometimes leaves a highly visible manner on the generated surface and thereby it is no longer perfect as desired, but rather rough. And even increases the random dispersions due to the deformations under the action of the cutting. To improve the quality of parts and maintain the reliability of the machines, it is necessary to look for ways to reduce these vibrations.Modeling in dynamic mode is a milling step to simulate the overall behavior of the part-tool-machine system. This modeling can be based on a theoretical or experimental study. To do this modeling in dynamic mode, encountered a number of practical difficulties:

- The general trend is to the realization of rigid structures for machine tools with significant own delicate frequencies up;
- The games present in the structure and contacts interfaces (part - machining assembly) make the nonlinear behavior;
- The wide variety of tools used (diameter and length) and the dimensions of the room change the dynamics of the whole (Tool / Piece / machining assembly).

Our approach is to study the influences of the dynamic effects of cutting on the lining of peripheral milling parts. It is therefore necessary to describe the phenomenon of vibration piece during machining, with the following assumptions:

- Flexible part and tool-mounting machining rigid.
- The movement of the piece is that of the displacement of surfaces of contact between
  the workpiece and the workpiece it is done in an arbitrary manner along the axes,
  with the axis of the cutter and heads up. The negative, , , , , , , ,
  The management of advances is in the positive direction, , , ,
  perpendicular to the advance direction that respects the right-hand rule., , , , ,
- Strawberry is discretized in number of sections along its axis.

In this work, we present the formulation of cutting effort model . Then we present the components of the cutting forces versus time for a device machining.In the next section, we present a model of a prismatic piece placed on a standard mountingIn this section we present the formulation of the equations of motion that govern the behavior of the workpiece during machining by milling device.

II. FORMALIZATION OF CUTTING EFFORT MODEL

The theoretical model presented in this work is based on the theory of predictive machining [9] The tool is a cutter diameter *Do*, length *Lo* and of *NT* teeth. It is discretized in elementary slices of constant thickness *dz*, perpendicular to its main axis, and powered by a cutting motion Mc whose N is the frequency of rotation around its axis (Fig. 1). The force exerted on a cutting edge is obtained by summation of the force components which are applied to each slice. A summation over all the edges engaged in the material allows to obtain the total force exerted on the tool at a given time.

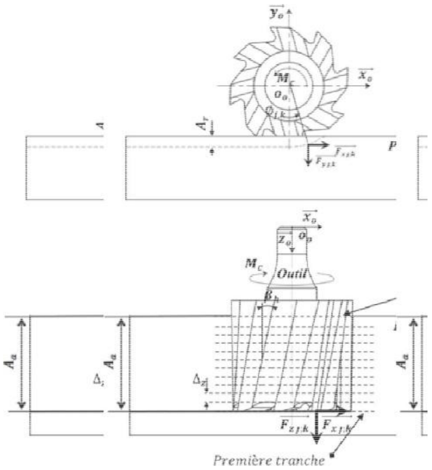

Figure 1 Modeling of cutting forces

The angular position o f a tooth in contact with the workpiece is determined by the, , , and radial , the number of teeth *NT*, the diameter of the tool *D* and, axial depth kness, coupeau at a certain place on the cuttiing edge can be, helix angle . Instant thic approximated as follows (Equ. 1

h, f sin ,, , , Ø, , , , , (1), , of the j, **f**, tooth at the, elementary

With, , is the feed per tooth and, , , is the angular position relative to the axis, disc k. Its, value changes throughout the axial, direction as follows (Equ. 2):, , , **+5607∅, !"# 2% " & !' & 1# +, & !. & 1**

, , , , , **)*,** , **)/0**, **12 34**, , (2), ,

Or *N* is the speed of rotation of the tool (tr/min), *t* is the time (min), D is the diameter of the cutter.Cutting actions can b e modeled as oblique cut, using the theory of predictive machining [9]. Where cutting forces can be calculated from data on t he properties of the material being machinned, the tool geometry and cutting parameterrs. The basis of this theory is the analysis of the stress distribution along ∅the shear plane and the tool-chip interface in terms off the angle of the shear plane **8** and the properties of the machined material.

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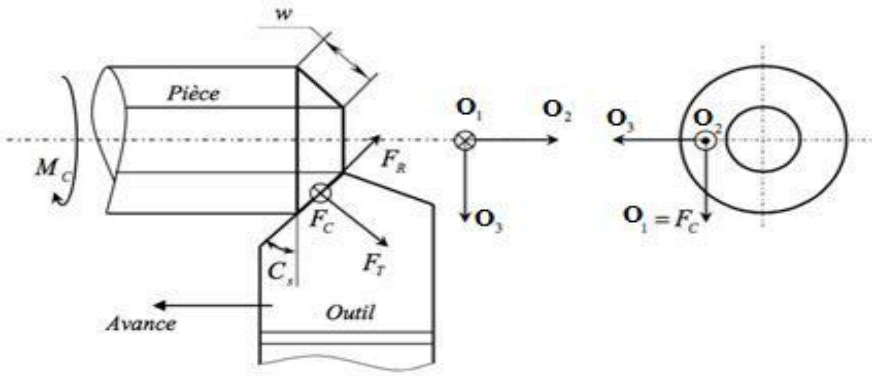

Figure 2 Modèle d’efforts de coupe pour la coupe oblique [1]

According to the theory[9], for an oblique cutting process, the actions of cutting forces in the cutting direction, feed and radial: (O_1), (O_2) et (O_3) respectively asshown in the figure (Figure 2), are given by the equations (Equ. 3):, , ,

9:, ;<, , # + ;A sin

9), **;= cos** (3),
9B, **;= sin!# & ;A cos**
the, Taking (, , , ; (F_C), (F_T) et (F_R), will be the components of the cutting force in, , cutting direction,, in advance and respectively, radial, and can, therefore be**0**determined using the equations (Equ. 4), (Equ. 5) et (Equ. 6)
E F cos!G & HI# (4),
(5), **LM!NO2!P#QRSN!P# NO2!TU# 12!VM##QL, RSN!TU# 12!VM#**, , , , , (6),
With λ is the average angle of friction at the tool-chip interface,, , is the cutting,
angle, ψ is the angle of inclination of the tool and, , is the angle of^{2}the chip flow.,
These components of the force obliquely cut are calculated^{E}, , □, ,
from the resulting *R*,,
strength in the shear plane and the tool-chip interface, it is given from the equation (Equ. 7)
Z[\,], , (7), With, **.**, is the, shear stress in the primary shear zone, *h* is the thickness of,
undeformed^{ab}section,, is the angle between the resultant of the cutting forces *R* and,
the shear plane and *w*^{c}cutting width is it determined from the following equation (Equ.,
8), □**f**
(8), Since the action of each segment cutting is regarded as an oblique section with an angle of cut equal to the helix angle, the resultant force is given by the equation (Equ.

According to (Li XP, 1994, Zheng HQ, 1999), in milling, chip thickness varies with the time or position of the tool in the workpiece, and in the static mode the chip
thickness is given by the following relationship (Equ. 10):, , ,
h0j,k, **ft**, **sinØj,k**, **si: Øst < Ø j,k < Øex**, **t**, , (10),
^{l} **h0j,k**, **0**, , , , **si non**, , , ,
With, , , is the angle of entry into the material and, , is the exit angle, these,
angles are given^{8}, for the cut milling by the equation (Equ. ^{uv}11), and climb milling by,
, , **Ø**, , , , , **Ø**, ,
the equation (Equ. 12), with *D* is the diameter of the milling cutter and *Ar* is the radial depth of cut:
Ø8, **0**, , (11),
^{l}**Øuv arccos!!y & 2 #/y#**^{t}, , ,
Ø8, **% & arccos!!y & 2 #/y#**, **t**, (12),
l, **Øuv %**, , ,

To predict the cutting forces using a helical cutter, and to express the geometry of the cutter based on the work of (H.Z. Li, W.B. Zhang, X.P. Li, 2000). The prediction of cutting forces is determined from equations (Equ. 13) to cut milling and equations
(Equ. 14) to climb milling:, , , , , ,
}, **;v!"#** □$^{+}$**•:**^{560} □**•:**$^{+,}$**!9:,**, , , **cos!Ø,**, **# + 9),**, **sin!Ø, ##**, (13),
|**;** □**!"#** □$^{+}$**•:**^{560} □**•:**$^{+,}$**!&9:,**$_{+560}$**sin!Ø**$_{+,}$**,**, **# + 9),**, **cos!Ø, ##t**, ,
{, **;•!"#**, □, **•:**, □**•:**, **9B,**, , ,
}, **;v!"#** □$^{+}$**.:**^{560} □**.:**$^{+,}$, **!9:,**, , **cos!Ø,**, **# + 9),**, **sin!Ø, ##**, (14),
{, **;** □**!"#** □$^{+}$**•:**^{560} □**•:**$^{+,}$**!9:,**, , , **sin!Ø,**, **# & 9),**, **cos!Ø, ## t**, ,
, **;•!"#**, □, **•:**, □**•:**, **9B,**, , ,
|, , , **+560**, **+,**, , , ,

III. SIMULATION RESULTS FOR PERIPHERAL MILLING

In this section we present the simulation results for the case of the milling device for milling into opposition if the cutter is in the middle of the room

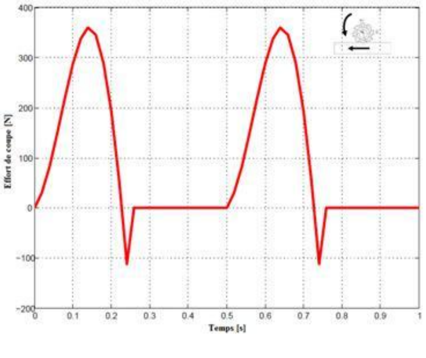

Figure 3 Fx Cutting effort to cut milling
Taking Into Account of The Dynamic Effects of The Cut on The Laying of The Parts In Peripheral Milling

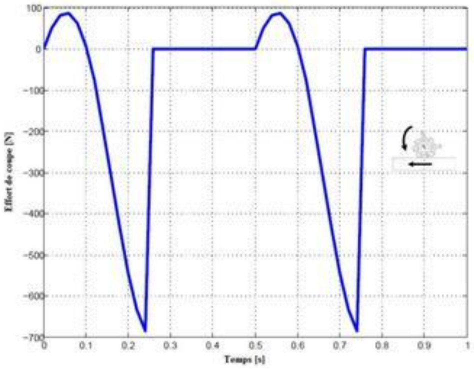

Figure 3 Fy Cutting effort to cut milling

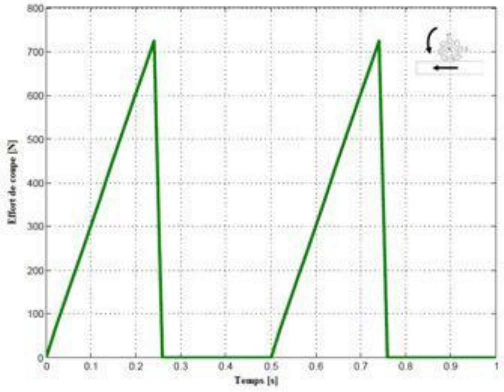

Figure 4 Fz Cutting effort to cut milling.Cutting forces F_x, F_y et F_z are simulated for the device with milling:

Table 1 simulation data

N [trs/s]	D[mm]	NT [dent]	f_t[mm/dent]	A_a [mm]	A_r [mm]		**,ab**[N/m^2]
2	10	1	0,1	8	10	0 °	460 x 10^6

The figures 3, 4 et 5 show that for the case of cut milling, cutting efforts begin with zero values then they evolve in a progressive way, this increase explains the increase in the cutting section, the cutting force deponds, then they cancel a brusque manner especially for efforts F_y et F_z, and it periodically, which explains the entrance of the tooth of the cutter into the material with a zero thickness

IV. PERIPHERAL MILLING LAYING DYNAMIC

This model was developed in view of processing the results of the simulation of the dynamic response of the peripheral section which causes the part of the movement. The difficulty of the task was to effectively bring needed. Indeed, the importance of geometric modeling is attached to the choice of model, which allows us, among other calculate all geometric parameters required for the temporal integration.

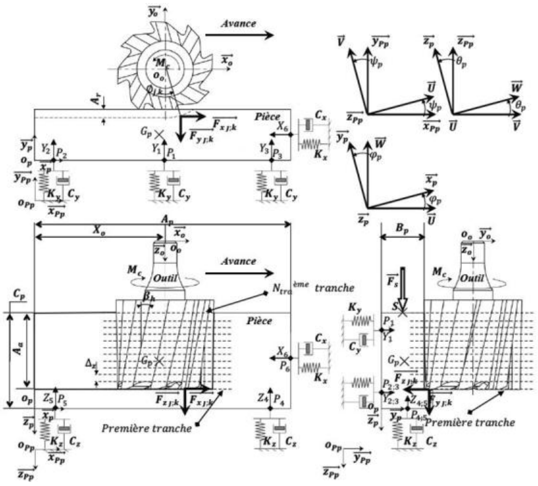

Figure 5 Modelling of peripheral milling in dynamic mode.The position of each support are identified by:, , , , ,
A tool we bind the marker**F: ‡9„,ˆ,, Š**
Iin the part it is related marker **F : ‰9**,
The workpiece it is related marker**F : ‰9,,,Š**
It locates the clamping stress application point S by:, , , , , , , , , , ,
Our model aims to study the dynamic behavior of the system piece - machining assembly, it is modeled by a spring mass system applied at the mounting sills, scalar equations of motion are:

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These equations represent the equations of motion of the workpiece to an isostatic, clamping; 3 rotations (Euler angles) and three translations of direction parallel to the, xes, , , et **Mœ**, **M:** et **M)** are the mass of the piece and the inertia operators:, , , ,
M:, , **1¤ M¥, B¥$^{)}$ + C¥$^{)}$**
M), , 1¤^{12} M$_{¥}$, **A¥$^{)}$ + B¥$^{)}$**
, , **12**

Modeling mass spring
To optimize the machining process, we have properly selected the cutting parameters. To see the influence of these parameters, we compare the results obtained by varying the values of the cutting feed.

The set of simulations was carried out with a frequency N = 21 [trs/s], number of teeth of the tool NT = 1 teeth, axial depth Aa = 8 mm, radial depth Ar = 10, The only variable parameter is the feed per tooth which is selected from [0, 1 -- 0, 5].

Influence of feed per tooth

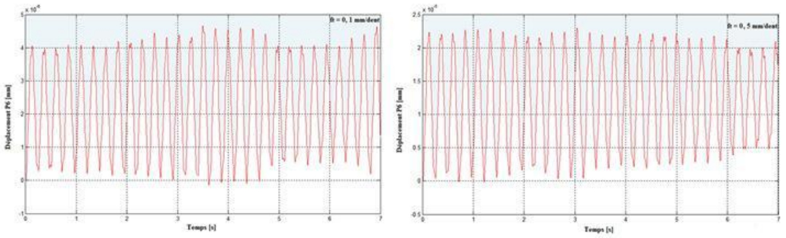

Figure 7 Move Support P6

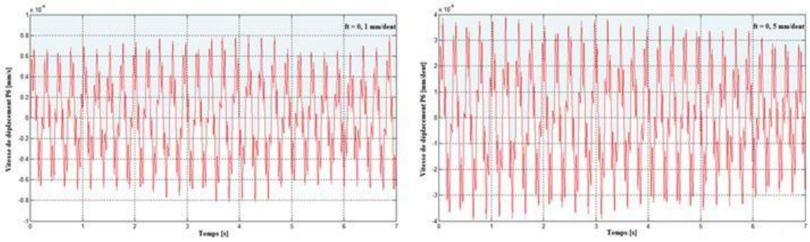

Figure 8 Travel speed Support P6

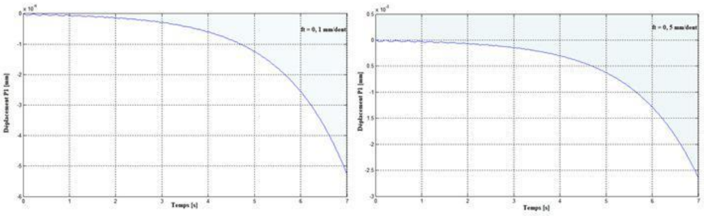

Figure 9 Move Support P1

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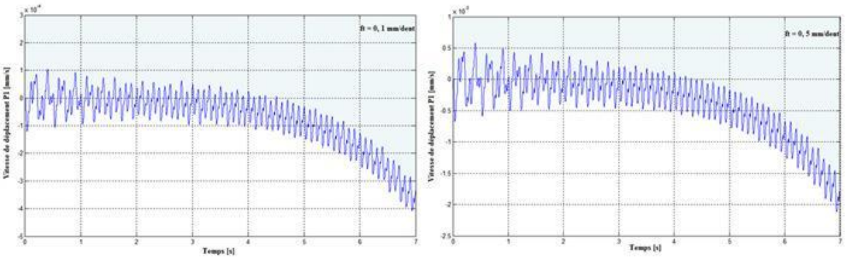

Figure 10 Travel speed Support P1

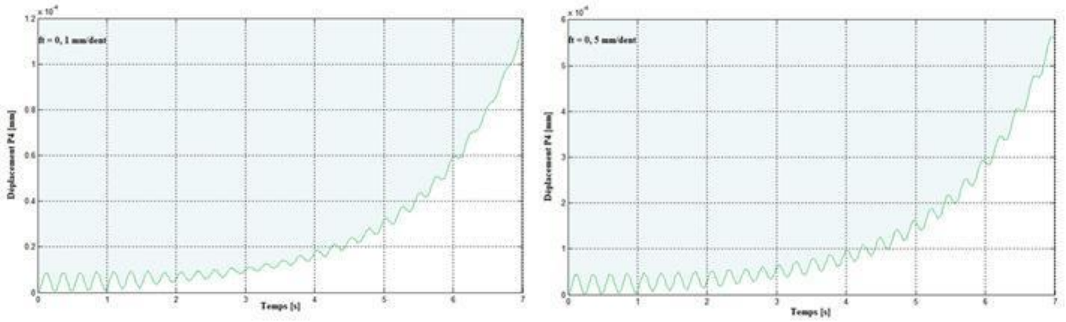

Figure 11 Move Support P4

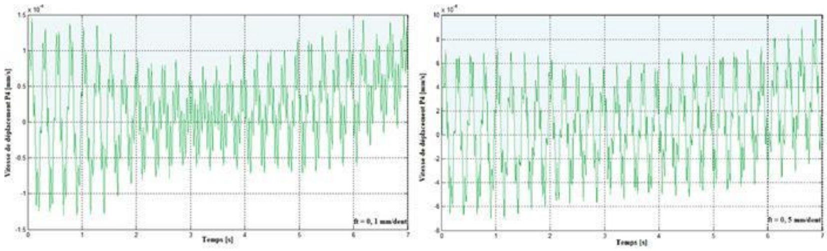

Figure 12 Travel speed Support P4

V. CONCLUSION

As conclusion, we can say that the axial depth is a value that affects the values of displacements of the cutter and cutting forces, and also we can say that this value affects the stability of the machining system,This simulation shows the dynamic response for two values of the feed per tooth (ft). For the case of cut milling, we notice that increasing the feed per tooth leads to increasing values of the displacements of the part and its speed. We clearly notice that the graphs of displacement and cutting forces retain the same forms of shapes but with increased amplitude.In conclusion, we can say that the feed per tooth influences the values of displacements of the part and on the cutting forces, and also can be said to affect the stability of the machining system.

REFERENCES

[1] A. Molinari, X. Soldani, and M. H. Miguélez, Adiabatic shear banding and scaling laws in chip formation with application to cutting of Ti–6Al–4V, *Journal of the Mechanics and Physics of Solids*, 61(11) pp. 2331–2359, Nov. 2013.

[2] G. Campatelli, A. Scippa, Prediction of milling Cutting Force Coefficients for Aluminum 6082 – T4. 5th CIRP Conference on High Performance Cutting 2012; 563 – 568
[3] H.Z. Li, W.B. Zhang, X.P. Li. Modelling of cutting forces in helical end milling using a predictive machining theory. Department of Mechanical and Production Engineering, The National University of Singapore, 10 Kent Ridge Crescent, Singapore 119260, Singapor, 2000.
[4] Hédi YENGUI. Modélisation du comportement dynamique non linéaire d'un système machine-outil-pièce lors d'une opération de fraisage. EcoleCentrale Paris, 2011
[5] J. Pei, Research on Physical Simulation in Cutting Process and Technical Parameters Optimization, Northeastern University, Shenyang, China, 2011, (Chinese).
[6] L. Zhu, C. Zhu, J. Pei, X Li, and W. Wang. Prediction of Three-Dimensional Milling Forces Based on Finite Element, Hindawi Publishing Corporation Advances in Materials Science and Engineering Volume 2014, Article ID 918906.
[7] Liu, X, et K Chen. Modelling the machining dynamics of peripheral milling. International Journal of Machine Tools & Manufacture; pp 1301-1320; Volume 45, 2005.
[8] Li XP, Nee AYC, Wong YS, Zheng HQ. Theoretical modelling and simulation of milling forces. Journal of materials Processing Technology1999; 89 –90:266–72.
[9] Oxley PLB. « Mechanics of Machining. Chichester: Ellie Horwood Limited, 1989.
[10] Z. Fu, W. Yang, X. Wang, and J. Leopold, Analytical Modelling of Milling Forces for Helical End Milling Based on a Predictive Machining Theory, Procedia CIRP, Volume 31, pp. 258–263, 2015.
[11] Tlusty, J, et F Ismail. Basic non linearity in machining chatter. Annals of the CIRP 24 (1), pp 463-466, 1981
[12] Zheng HQ, Li XP, Wong YS, Nee AYC. Theoretical modelling and simulation of cutting forces in face milling with cutter runout. International Journal of Machine Tools Manufacture 1999; 39: 2003–18.
[13] R. Rahul, Multi Objective Optimization of Cutting Parameters In Turning Operation of Stainless Steel (Ss304) To Reduce Surface Roughness and Cutting Forces. *International Journal of Mechanical Engineering and Technology*, 6(4), 2015, pp. 56–64.
[14] Zhao, M.X. et B Balachandran. Dynamics and stability of milling process. International Journal of Solids and Structures, pp 2233–2248, Volume 38, 2001.