ADVANCED MACHINING TOWARDS IMPROVED MACHINABILITY OF DIFFICULT-TO-CUT MATERIALS

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Chapter 8

Role of the Frequency of Secondary Serrated Teeth in Chatter Formation during Turning of Carbon Steel AISI 1040 and Stainless Steel

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1.0 INTRODUCTION

High metal removal rate with a desired quality of surface finish is the ultimate objective in machining, but it depends on a large number of factors, which include chip-tool interaction, cutting temperature, wear mechanism and wear rate, cutting force, chatter and dynamics behavior of the machine tool system. Chatter causes instability of the machine tool system. Though there has been a large number of works on identifying the causes of chatter and its behavior there is still no congruence of opinion on the causes of chatter formation and hence there is a need for further studies to identify the physical causes of chatter so that the issue of chatter control can be addressed more effectively. Taylor was the first to suggest that vibration during the cutting of metals was due to force variations created by periodic shearing in chip formation [1]. In the beginning, the question was to decide whether fluctuations during the cutting process are a result of vibration in the system or the cutting process itself has an inherent natural periodicity. If the latter were the case, then even with an infinitely rigid machine-tool-workpiece system, force fluctuations and thus vibrations would be observed. Available evidence suggests that this is the case. There are inherent features of the cutting process that make it periodic.

Among the types of inherent fluctuations in metal cutting are *built-up-edge* (BUE) formation, *chip segmentation, element and discontinuous chip formation.* Kuznetsov [2], Shteinberg [3], Kudinov [4], considered that the vibration caused by the BUE is responsible for chatter. However, the natural frequencies of the system were significantly higher than the frequencies of buolt-up-edge. Moreover it is not explained why chatter also exists at relatively higher cutting speeds where BUE is absent. Eliasberg [5] considered that the cause of chatter is the formation of a crack in the chip above the tool point when viewed using a video camera from the side of the chip. However, Loladze [6] established that at higher cutting speeds, the chip fully adheres to the tool surface. As such, there cannot be any cracks formed at the tool point at those cutting speed ranges. Doi [7], Doi and Kato [8], and later Kato [9] and Tashlickii [10] concluded that chatter was established primarily due to a phase lag of the cutting force with respect to the fluctuation of chip thickness. However Smith [11] and Smith and Tobias [12] suggested that the findings by Doi and Kato [8] and later by Tashlickii [10] found a force phase lag only because the frequency