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A DEVICE AND METHOD FOR RECOMMENDING
DYNAMICALLY PREFERRED SPEEDS FOR MACHINING

BACKGROUND OF THE INVENTION

Field of the Invention

5 This invention relates to an electronic
device which measures sound emanating from a machining
process and displays preferred rotational speed
recommendations to eliminate or reduce undesirable
vibration known as chatter. More particularly, the
10 device is applicable to machining operations which
exhibit a relative rotation between a tool having one
or more cutting teeth and a workpiece. This device
provides a safe means for the operator to interactively
measure and determine the recommended speeds without
15 prior knowledge or modification of the machine tool and
workpiece.

Description of the Prior Art

 Machining processes such as turning, boring,
milling and drilling are often limited by undesirable
20 vibration in the form of chatter. The chatter is a
result of an unstable machining process caused by the
relative vibratory motion between the cutting tool and
workpiece. This common problem in industry reduces the
quality of the machined surface, limits the
25 productivity of the machining process and often reduces
the life of the cutting teeth or results in tool
failure. Many approaches are used to stabilize the
machining process and avoid chatter. One approach is

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to maximize the stability of the process through the selection a priori of the machine tool, the material of the tool and workpiece fixturing and other components which provide more desirable dynamic stiffness and damping characteristics. In these ways the stability of the machining process is increased by design, although the continuous drive for greater productivity and manufacturing flexibility inevitably pushes many machining operations to chatter.

With the continued rapid development of tool materials, cutting edge coatings and increased machine tool capabilities, the range of potential rotational speeds has widened significantly. Extensive trial and error optimization of the machining process parameters of speed, feed rate and depth of cut are often additionally required at process setup and specification or to solve a problematic condition during production. Other approaches, such as sophisticated methods and implementation means of active process monitoring, chatter detection and automatic control of instability and vibration in machining operations, have been attempted.

The efforts of most of these techniques have been unsatisfactory for a variety of reasons, including limited application to specific machining operations, conditions or tooling; modification of machinery controls and drives; numerous sensor types and integration; extensive prior knowledge required of the dynamic characteristics of the machine tool, workpiece or process program and machining limits. Automated systems additionally require frequent calibration of the sensors and associated operator training or require controlling parameters to remain within other limiting thresholds each time the tool, part program or process parameters are modified.

United States Patent No. 5,170,358, to Delio, teaches a method of controlling chatter in a machine

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tool by analyzing vibration signals from a machining operation and actively monitoring and controlling the feed of the cutting tool or the speed of rotation. The method taught by Delio requires a direct inter-
5 connection to the machine tool for control. Such an arrangement is fairly complex and may require altering the software of a preprogrammed machine tool controller.

10 In order to overcome the various limitations of prior art systems, it is the object of the present invention to provide a simplified means of measuring machining process behavior and establishing rotational speed recommendations which are likely to result in more stable machining.

15 It is another object to provide a device which measures the process through a safe, non-contact means requiring no modification or integration with the machine tool.

20 It is yet another object of the present invention to provide recommended rotational speeds without prior knowledge of the dynamics of the machine tool, workpiece or the process program and parameters.

Another object is to provide a portable, hand-held device which may be readily applied to
25 numerous machining processes and machine tools without interruption of the machining operation.

It is yet another object of the present invention to provide dynamically preferred speed alternatives for machining operations which exhibit
30 relative rotation between a tool with cutting teeth and a workpiece. The object of the device is to provide specific speed recommendations to be evaluated by the operator for their suitability for the measured machining process while tool balance, speed
35 limitations, safe machine operation and machining practice are considered.