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Standardization of Terminology in the Kinematics of Cutting and Surface Shaping

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Abstract—New definitions are proposed for some terms in State Standard GOST 25762–83. Additional terms and definitions are proposed to describe surface shaping by cutting tools. The new terms eliminate some omissions in our general concepts regarding the kinematics of cutting and surface shaping.

Keywords: cutting tools, general concepts, kinematics of cutting, surface shaping, generative surface, cutting generative surface

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The geometric theory of surface shaping by cutting tools consists of a logical component (a set of logically interconnected concepts) and an analytical component (the corresponding mathematical apparatus) [1].

In the present work, we refine some of the concepts, terms, and definitions in State Standard GOST 25762–83 [2]. We also introduce additional terms in the standard, so as to take account of developments in the logical component of geometric theory [3, 4]. The definitions are as follows.

(1) A machined surface is a surface subjected to machining and is defined, in the general case, by a network of coordinate lines: generatrices *Ei* and directrices *Fi* [5].

In State Standard GOST 25762–83, this term is wrongly defined as the external surface of the workpiece removed in machining. That does not correspond to the literature [5, 6].

(2) The resultant cutting motion is the overall tool motion relative to the workpiece, consisting of all the linear and rotary motions of the tool and workpiece in the course of cutting.

(3) The primary cutting motion is a linear or rotary motion of the tool or workpiece in the course of high-speed machining. Note that, in theoretical terms, for a consistent approach to all cutting tools, a primary cutting motion is understood to mean the motion of the tool relative to the workpiece.

(4) A cutting motion is motion of the tool relative to the workpiece. It forms part of the resultant cutting motion and consists of interrelated linear and rotary motions. including the primary cutting motion.

For example, when a circular broach cuts the teeth of a conical spur gear, the cutting motion is the total motion consisting of the rotary primary cutting motion and the related linear motion of the broach parallel to the bottom of the groove between the gear teeth.

(5) An auxiliary cutting motion is linear or rotary motion of the tool relative to the workpiece, which contributes to the cutting motion together with the primary cutting motion and is related to the primary cutting motion.

An example is the rotation of a hob around the axis of a worm-gear workpiece, which is matched with the primary cutting motion of the hob around its axis. Another example is the linear motion of chasers, taps, and dies for thread cutting.

(6) Insertion motion is motion of the tool relative to the workpiece in the direction of the machined surface, at the instant of tool–surface contact.

(7) Supply motion is motion of the tool relative to the workpiece along one of the coordinate lines (generatrix or directrix) of the machined surface. It consists of correlated linear and rotatory motion of the tool or workpiece.

For example, in the cutting of a multiturn thread by a hobbing cutter, the supply motion of the cutter along the helical directrix of the machined surface is helical motion consisting of interrelated linear and rotary motions. In the cutting of spur gears by gear shapers, the supply motion of the shapers along the generatrix of the machined surface is the composite motion consisting of rotation of the shaper around its axis and its coordinated rotation around the gear axis.

(8) The finishing cutting edge is a cutting edge in which some points contact the machined surface in rotation of the cutter.

(9) The final machined surface is a surface that consists of sections of the cutting surfaces tangential to

the machined surface and is produced by the finishing cutting edges.

(10) The roughing cutting edge is a cutting edge whose points are not in contact with the final machined surface but are involved in margin removal.

(11) The shaping part of the finishing cutting edge consists of the points of the finishing cutting edge responsible for shaping sections of the machined surface that will constitute the final machined surface.

(12) The main section of the shaping part of the finishing cutting edge consists of the points of the finishing cutting edge that are in contact with the machined surface during machining.

(13) The nonshaping part of the finishing cutting edge consists of the points of the finishing cutting edge that do not shape the final machined surface but are involved in margin removal.

(14) The generative surface of the tool is the notional surface of a multicutter tool on which the points of its finishing cutting edges lie.

(15) The cutting generative surface of the tool is the notional surface corresponding to the cutting trajectory of the finishing cutting edges of the tool or to the envelope of the tool's generative surface in cutting.

(16) The productive cutting generative surface of the tool is the surface formed as the cutting trajectory of the tool's finishing cutting edges.

(17) The envelope cutting generative surface of the tool is the surface formed as the envelope of the tool's generative surface in cutting motion.

Note that, if the cutting motion of the tool with a generative surface is simply the motion of its generative surface, the resulting productive cutting generative surface will also be the generative surface of the tool.

For example, the productive cutting generative surface of drills, reamers, countersinks, and disk cutters is the same as their generative surface of revolution. Thus, tools may be divided into two classes: those that form a productive cutting generative surface as they move; and those that form an envelope cutting generative surface.

(18) Auxiliary shaping motion is defined as reciprocating linear motion of the tool relative to the workpiece, independent of the cutting motion and the supply motion.

An example is the reciprocating motion of a grinding wheel along a rack in which the wheel forms the auxiliary cutting generative surface of the rack.

(19) The auxiliary cutting generative surface is the envelope of the tool's productive cutting generative surface, which is formed in the auxiliary shaping motion.

The additions to State Standard GOST 25762–83 here proposed fill gaps in existing general concepts regarding the kinematics of cutting and surface shaping. They permit a deeper understanding of surface shaping by cutting tools and represent an advance beyond current global standards.

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