The algorithm for designing a part geometrical model aimed at increasing the precision control

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Abstract. The information about a part geometric shape and configuration precision is one of the life-cycle backgrounds. Actual knowledge about cylinder surface shape is principal for viscous incompressible fluid transfer (ink), in a printing system, in particular. High quality assurance management for parts engineering is one of the primary tasks, which can be solved by control automation as well as the by united concept formulation for parts precision; the offered implementation tool is the algorithm design of a geometric model part shape. The developed algorithm novelty is taking into account the element information value, coordinate planes and axis, materialized by parts data base sets. The practical realization of the algorithm is presented in this paper. The digital visualization of the transfer parameters calculation results addressed for a viscous incompressible fluid between rotating cylinder surfaces depending on contact zone varying is presented.

1. Introduction
Both shape and size geometry precision is among the top-priority parameters of precision estimation for different parts and their components during the production processes. Working parts size taken as both reference and actuating surface is determined by 2D complex values. These values are defined by two real limits; geometry precision is characterized by their difference. On the contrary, linear and angular coordinates dimension specify the positional layout precision and part elements orientation. Taking into account that mechanism dynamic is defined by counterpart precision, the new techniques of shape / configuration and size geometry precision definition are an actual problem.
Among modern research methods and tendencies the following areas are popular: configuration and parts location deviations evaluation, basics of geometry coordinate measuring, dimensions analysis basics, relative parts position norming by vector tolerances [1–4].
However, geometric visualisation of a part quality parameters is often required for the crux understanding. Despite solutions originality of the problems formulated in [1-4], geometric visualisation as one of the possibilities was not under consideration. In [5-7] it is shown that the maximum informational value is reached by geometric model-building.

An interaction mode of a part displaying as well as counterparts at the maths objects operations was offered with geometry parameters addition, if necessary. At the moment existing software for automate design systems cannot solve the task of geometric precision normalization for a real object.
2. Problem definition
The results of the finite-difference approximation application for coupled equations described viscous incompressible liquid flow contained between rotating cylinders were presented in [8-11]. Geometric shape was not taken into account.
Quantification of the transfer parameters for a viscous incompressible fluid between rotating cylinder surfaces depending on contact zone varying is advantageous practically as well as from a scientific point of view.
In particular, real configuration and surface features of printing machine cylinder numeric representation for viscous incompressible fluid transfer in a printing system as a software realization will allowed to increase both calculating accuracy and produced items quality. An algorithm development aimed to a part geometry precision control based on the geometric model is the study goal.

3. The problem solution and results
The visualization of the transfer parameters calculation results addressed for a viscous incompressible fluid between contacting surfaces was performed taking into account the current shape of printing cylinders, deformation features both of cylinders surfaces and printed substrates which happened due to liquid pressure fluctuations at the contact moment. The results are presented in figures 1-4.

Figure 1. Digital graphs of viscous incompressible fluid layer deformations without account for printing cylinder geometrical shape (at the moment of maximum compression)
Figure 2. Digital graphs of viscous incompressible fluid layer deformations without account for printing cylinder geometrical shape (at the moment the rupture of fluid)

Figure 3. Digital graphs of viscous incompressible fluid layer deformations with account for printing cylinder geometrical shape (at the moment of maximum compression)
Figure 4. Digital graphs of viscous incompressible fluid layer deformations with account for printing cylinder geometrical shape (at the moment the rupture of fluid)

The developed algorithm for the printing machine cylinder precision control is shown in figure 5. The result of the developed algorithm is illustrated in figure 6.
Beginning

Visualization of sets of basic design bases
(A, B, C, D...).
Visualization of kits from auxiliary design bases
(E, F, G, J...)

Input of information content of main and auxiliary databases

Determining axes of auxiliary coordinate systems
(O’X’Y’Z’; O”X”Y”Z”...) for the main and auxiliary bases

The choice of the coordinate system as a generalized coordinate system details OXYZ

Building a geometric model

Cycle 1 to 6

Visualization set of design bases on each projection

Calculation and visualization of angular coordinates and their primary errors
(θ±AEX, 90°±AEY, 60°±AEZ)

Calculation and visualization of linear coordinates and their primary errors
θ±EX, Y±EY, Z±EZ

Visualization of a set of really located elements forming overall dimensions.
Visualization of the deviations of the shape of the surfaces of the component parts

The derivation of the complete matrix of all bases, coordinate systems, geometric characteristics, primary errors and recommended tolerances of the real geometric model of the part

Display all labels

Ending

Figure 5. The algorithm of a printing cylinder geometry model building
At the geometry model building code modularity with the known degree-of-freedom number was applied. All model parameters were entered as a data matrix. Initially, an OXYZ-generic coordinated system is displayed in a contour part drawing (for one-three drawing). The system forms a set of the shared engineering databases, limiting the parts by six degree-of-freedom: three linear degree and three angular ones. The database group informative value materializes the coordinate system with different informativeness of the coordinate planes 3, 2, 1 as well as coordinate axis 4, 2, θ (zero). Both quantity and type of the coordinates as well as initial position precision for a base are defined in the number of movements as well as a character, which were not consumed by the base to generic coordinated system construction.

Angular synchronized size and position accuracies are recorded from coordinate axis with informative values 4 and 2. They are indicated for drawings normal to the rotation axes. Linear coordinating sizes and their accuracies exact reading are carried out along corresponding coordinates axis, including zero counts together with nominal coordinates values.

Figure 6. The printing cylinder geometry model. The algorithm realization
The part shape deviations are visualized as the main wavy lines tangent to model surface elements, their databases materialize the coordinate systems and actuating surfaces. In case of a dimension element having the position deviations we consider that such deviations are among element size structure tolerance as a complex size with extended tolerance. This tolerance contains also position tolerances.

Conclusions
To conclude, the practical implication of the problem is confirmed by the developed algorithm realization exemplified by a printing cylinder.
The graphs and computer visualization allow for expanding the process concept as well as tracing viscous incompressible fluid layer deviations at the contact zone with account for the current shape and pre-determined conditions; it obviously demonstrates monitoring stages of the process.
The solution advantages are the every imaginable type complex estimation of size, shape and surface position in coordinates relative to the part; the quality management control automation for printing machines components designing and operation; presumptive selection of printing component parts; and precision improving of ink transfer parameters.

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