– is connected (all nodes are connected);
– has Hamiltonian chain (path which visits each node only once);
– does not have Hamiltonian and Eulerian cycles.

Therefore such classical problems as "travelling salesman problem" and "seven bridges problem" do not have solution for the graph since it does not have Hamiltonian and (or) Eulerian cycles.

For designing of tourist trails we tested shortest path algorithms such as Dijkstra's algorithm, Floyd-Warshall algorithm, Bellman-Ford algorithm. In figure 3 the results of Dijkstra's algorithm is presented. The initial and end points of the trail are station and Polotsk Sofia consequently.

All of three algorithms for the current trail presented equal results. Beyond that Hamiltonian path and Eulerian cycles are tested. Dijkstra's algorithm is the simplest in computations. Also for spatial tasks Dijkstra's algorithm is often enough.

For problem of trails designing solving the list of objects and their characteristics for cafeterias, restaurants, hotels, squares, giftshops, different kinds of shops, pedestrian zones, roads, means of transport, public transport routes is to be expanded. The scope of criteria determining weights of edged and nodes is also to be expanded in order to use the opportunity of indicating tourist trail themes, age of tourists, means of transportation including public transport with stops and timetable. Study area is also to be enlarged and to be included Polotsk region and Novopolotsk.

GIS of historical center of Polotsk may be used for:

– recording and systematizing of data about historical, architectural and cultural sights of Polotsk,
– designing of excursion tours and trails of diverse theme, focus and timing in Polotsk,
– planning and optimization of touristic infrastructure,
– designing of excursion trails for city schoolchildren of different age,
– designing of mobile application, virtual tours,
– implementation of similar projects for other places as well as designing tourist trails at the republic-wide level,
– teaching geoinformation systems and tourism management.

Graph theory has great perspectives in geographical science what says about the actuality of such research. Joint use of GIS and graph theory makes possible to solve problem of tourist trails designing using different criteria. The list of criteria and their quantification effecting the weights of edges and nodes needs additional correcting.

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RESEARCH OF SURFACE ROUGHNESS AT MILLING BY FACE BLOCK-MODULAR MILLING CUTTER

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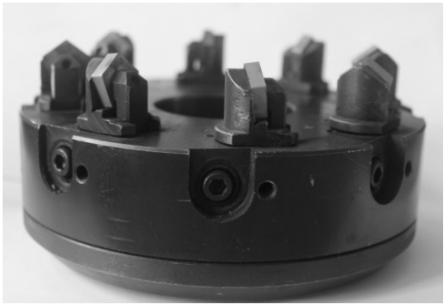
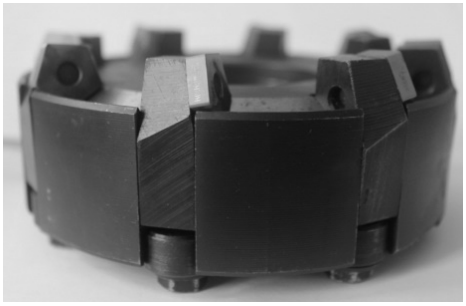
The results of research of surface roughness during machining by face block-modular milling cutter compared to milling cutter designed by VNII instrument are presented.

One of the most commonly used processes in industry and mechanical workshops for machining with the exact size and shape is milling. With the release of high-quality tools for milling using the modular principle layout , which provides inter-type unification and reducing the cost of the cutting tool. Production of modular mills in domestic enterprises is limited by high demands on their reliability and the need to use modern high-precision equipment for it production. Therefore, in the department of technology and equipment of machine-building industry design modular face mill was developed, which allows to minimize the disadvantages of used mills. The modularity of it millings is achieved by using a unified cutting block [1, 2]. The reliability of the developed system of fixing the cutting insert in the cutting block and cutting block in housing module considered in [3, 4]. Stiffness of modular cutting tools discussed in [5].

One of the quality and efficiency criteria of mills is the roughness of the machined surface of the workpiece. The roughness depends on machining conditions and accuracy of the structural elements of the cutting tool. experimental studies of surface roughness in the processing of face modular milling cutter (fig. *a*) compared with milling cutter designed by VNII instrument (fig. *b*) were conducted.



a



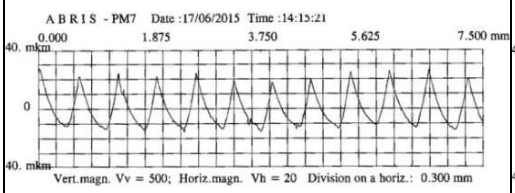
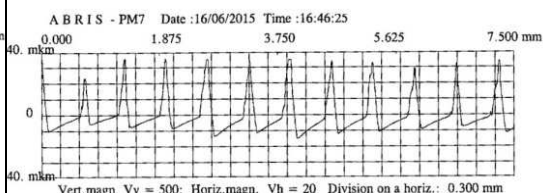
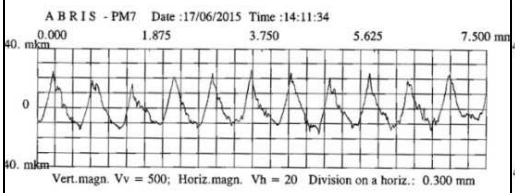
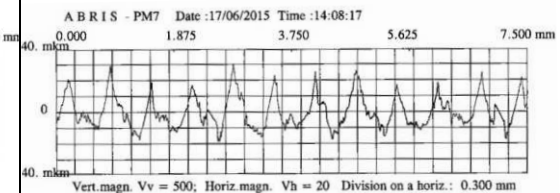
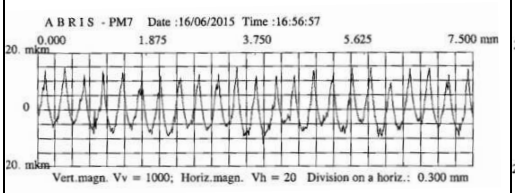
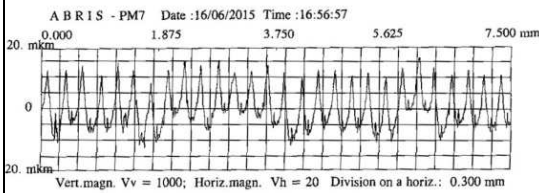
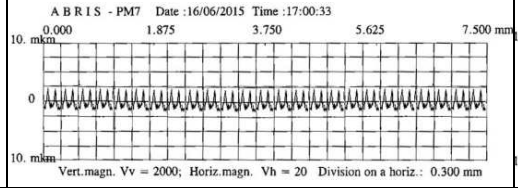
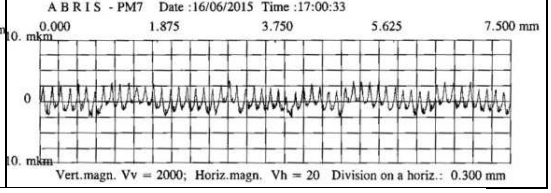
b

Milling cutters used in experimental researches
a – block-modular milling cutter; *b* – milling cutter designed by VNII instrument

During the experiment the effect of rotation frequency of the tool on roughness of machined surface of the workpiece were detected. During the experiment workpiece of steel 45 were processed with the following cutting conditions: constant feed s_m = *85mm/min*, constant cutting depth *t = 2 mm* and changing rotation frequency of the tool *n = 125, 250, 400, 630* min^{-1}.

Table showed the results of experiment.

Table 1 – Surface roughness for different designs and rotation frequency of mills

№	Rotation frequency of the tool, min^{-1}	Profilogram of surface during processing by	
		block-modular milling cutter	milling cutter (VNII instrument)
1	*2*	*3*	*4*
1	125		
2	250		
3	400		
4	630		

Analyzing the profilograms we can draw the following **conclusions**:

1) the surface roughness machining by block-modular milling cutter below, indicating tool work is smoother and has less vibration,

2) profilogram of surfaces machining by block-modular milling cutter no explicit jump microroughnesses values, which may indicate more precise positioning of the cutting block in the housing module and less elastic forced off of the cutting inserts.

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STIFFNESS OF THREADED CONNECTIONS IN MODULAR BORING TOOLS

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Modeling of precision treaded connections in SolidWorks. Experiments were carried out to reduce the backlash in threaded connections of boring tools.

Introduction. Important advances in electronics, electrical engineering and machine tool industry in recent years have helped to create automated machine tools with numerical control (CNC), which became widely used in the series, and even small-scale production. They have given possibility not only to improve performance but also production flexibility through fast change of control programs on the machine. Due to the use of CNC machines multioperational machines (machining centers) were created, which have made it possible to handle parts in a single setup with automatic change of a greater number of tools installed in the machine shop.

The unification of the individual elements of cutting and auxiliary tools has created tool systems for CNC equipment that can quickly and easily be readjusted by changing the nomenclature of manufactured parts.

Aggregate-modular design principle of modular tool units can be illustrated by an example of the creation of tools for bore holes (Fig. 1). Unit is connected with the spindle by means of cartridge 1 with cone 7:24. Extender 2 of enlarged diameter helps to increase stiffness of the mandrel. Adapter 3 is for adjusting the length and number 4 is the boring head.

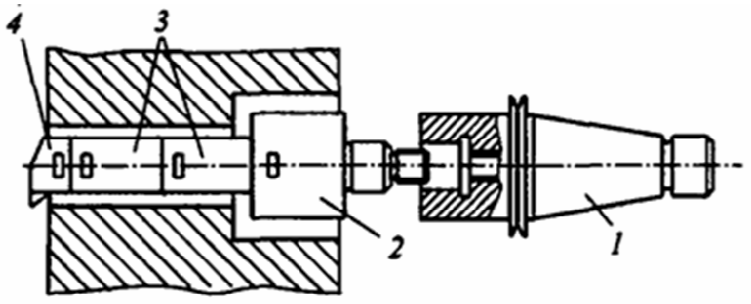

Fig. 1. Tool boring block of standard modules:
1 – insert; 2 – extension; 3 – adapter; 4 – boring head

The disadvantages of modular tool units are their reduced stiffness and accuracy as compared with solid tools. The more modular elements are in the block, the lower is stiffness and accuracy. In order to increase the accuracy of blocks, it is recommended to use elements for adjusting the size of the cutting tools [1].