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PROBLEMS OF TWO-WHEELED VEHICLE REPAIR

Annotation. *Existing removers of parts or assemblies of bicycles are used only for a certain model and its modification. Therefore, it is recommended to use a universal puller for repairs, which will allow you to perform the necessary operations faster and more conveniently (mechanization and automation of the process, convenience and quality of repairs are increased).*

Key words: *bike, puller, gripper, SolidWorks Simulation.*

Анотація. *Існуючі знімачі деталей чи вузлів велосипедів застосовуються тільки для певної моделі та її модифікації. Тому рекомендовано використати для ремонту універсальний знімач, який дозволить швидше і зручніше виконати необхідні операції (підвищується механізація й автоматизація процесу, зручність та якість ремонту).*

Ключові слова: *велосипед, знімач, захват, SolidWorks Simulation.*

Introduction. Repair of two-wheeled transport includes maintenance of: bicycle transmission, carriage unit, tubes and tires, wheel rims and spokes, steering cup, front fork, shock absorbers, brakes, switches, steering columns, etc.

A bicycle is a rather complex mechanism, especially modern models with multi-stage transmission and complex braking systems. For its maintenance, as the variety of components increases, so does the number of specific pullers for various nodes.

Analysis of the latest research. Let's consider the main tools needed for bicycle repair:

– magneto pullers (generator) Delta 50-70cc, Alpha 50-70cc, Honda/Suzuki, Yaben GY6 125/150 and others [1];

– universal chain pullers of various types and chain wrenches KEN TECH KL-9724C, KL-9724N and others [2];

– clutch removers of bicycle motors (2T F80 "LIPAI"), of baskets (JAWA 12V), of nuts (Delta, Zongshen, Lifan MOZBA, Lifan KOMATCU), of clutch pullers (Delta, 125J, BAJAJ Boxer, SUNRISE 332167) and others [3];

– connecting rod pullers with handle (SC-180A1 Taiwan 34-00297, KENLI KL-9725 34-00299, KENLI KL-9725L 34-00303), without handle (with adapter KENLI KL-9725B 34-00300, Taiwan SC-180P 34-00301 , KENLI KL-9725A 34-00304) and others [4];

– carriage remover (carriage cartridge removal key, 24mm key, black KL-9706A China 407032) [5];

– pullers cassettes (Spelli FM S-444045, KENLI KL-9714 34-00308, SJ-1752 34-00315) and others [6];

– pedal puller 9/16 and 15/24 mm nuts, KL-9730 China [7].

The aim of the article. Thus, at the moment there are removers of bicycle parts or assemblies that are used only for a certain model and its modification. Therefore, most of the operations of disassembling and assembling bicycles are carried out on locksmith machines. In this regard, it is recommended to use a universal puller for repairs (fig. 1), which will allow you to perform the necessary operations faster and more conveniently (mechanization and automation of the process, convenience and quality of repairs are increased).

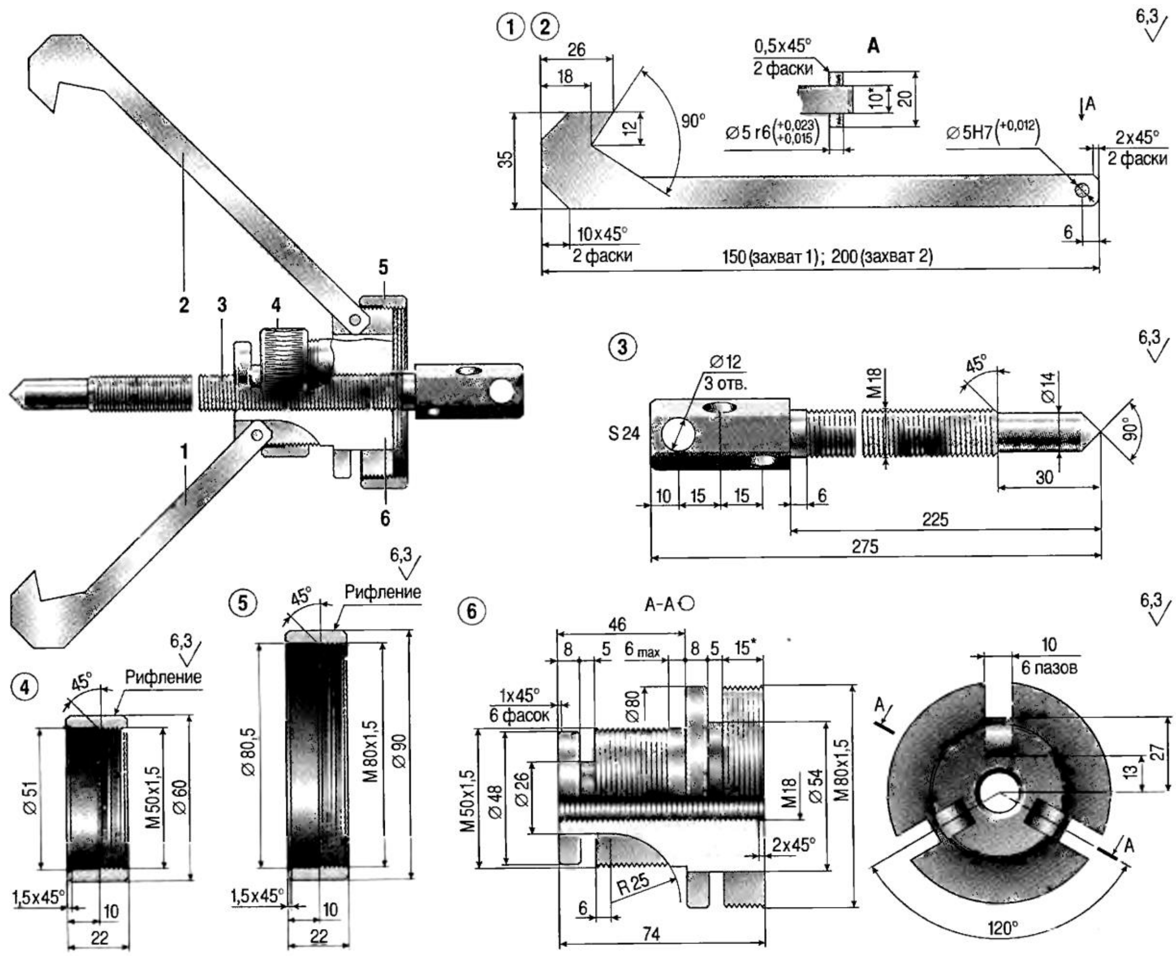


Fig. 1. Universal puller [8]: 1, 2 – grips (3 pcs. each); 3 – screw; 4, 5 – nuts; 6 – support

Two sets of grippers, which can be installed in one of the two grooves of the puller nut, significantly increase the service area. And fixing the removable part with three grippers ensures its compression without distortions. Nuts 4 and 5 serve as stops for grippers. In fig. 1 grippers are shown in the position they occupy when removing parts from the shaft. If the grippers in the grooves are turned with the hooks in the opposite direction from the axis of the puller, it can be used to press the parts out of the hole.

Removers are a huge group of mechanisms designed for mounting and dismounting various parts. Their force of impact on the part being removed ranges from a few kilograms to hundreds of tons. Working with them is convenient, characterized by increased safety for people and the mechanism. In general, pullers consist of gripping legs, a mechanism for fixing and lifting the part. Indispensable at service stations, during any assembly-disassembly work of a wide variety of mechanisms. Allows removing bearings, bushings, couplings, etc. nodes and parts without damage [9].

Research Methodology. SolidWorks (SW), an automated design system that uses the Microsoft Windows graphical interface, was used to analyze the puller. SW represents ideas in a sketch, produces models, experiments with elements and dimensions. The main concepts of SW are as follows [10, 11]:

– the SW model consists of details, assemblies and drawings;

– first a sketch (model) is drawn, and then the necessary elements are added to it;

– you can improve the drawing by adding or changing elements and their order;

– interrelationships between details, assemblies and drawings allow automatic implementation of changes made in all other types;

– drawing or assembly can be created at any stage in the design process.

Research results. In fig. 2 shows the puller drawn in SW.

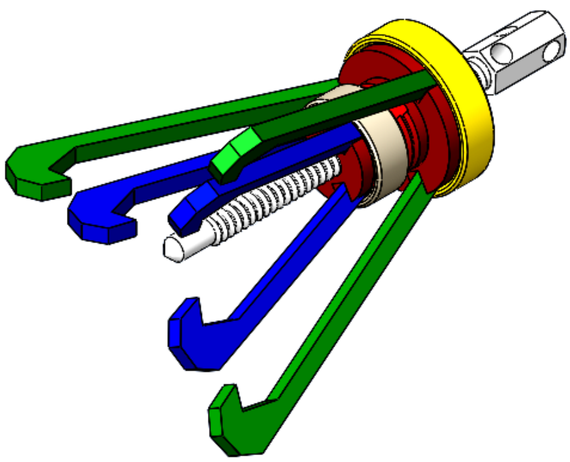


Fig. 2. The puller drawn in SW

The next stage is to determine the performance of the film remover. We will use SolidWorks Simulation (SWS) for this – a solution integrated into the SW environment, which is intended for engineering calculations and analysis of products using the finite element method. SWS provides modeling solutions for frequency, stability, temperature, fatigue, optimization analyses; ofshock load tests; of linear and nonlinear static and dynamic analysis [12].

Using SWS allows [13]:

– to reduce the duration of research and development works thanks to the analysis of the working modes of the product in the digital environment;

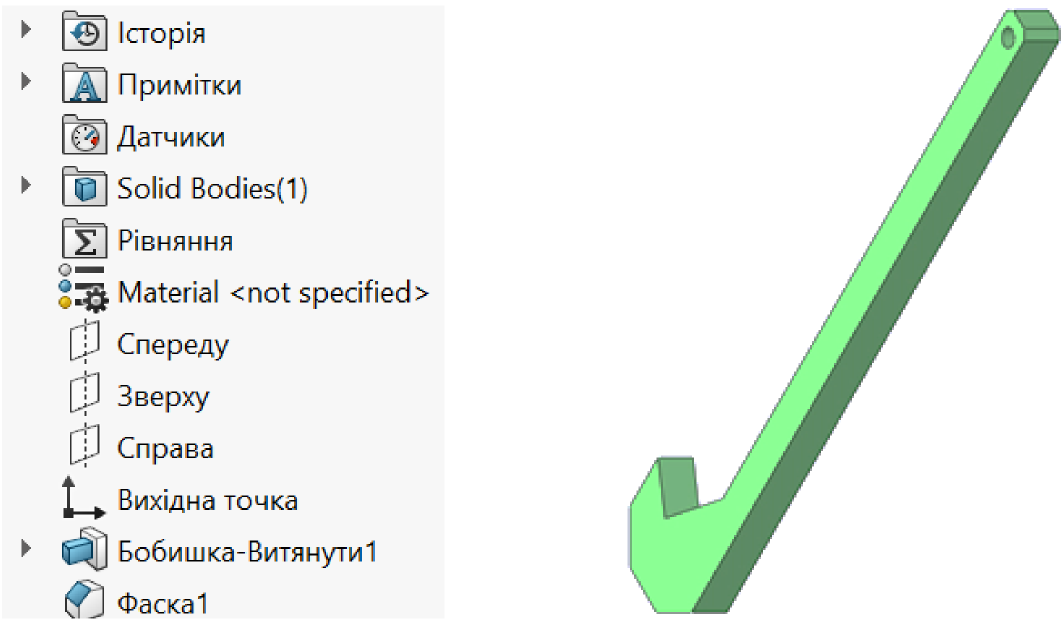
– reduce material costs due to optimization of structural elements of the part;

- explore several options of products at once within the framework of one calculation.

In the investigated puller (fig. 2), the most responsible part is gripper 2 (pos. 2 in fig. 1), the end of which ends with a hook that secures the pressed part. Grips of the puller work in conditions of complex stretching and bending resistance, that is, in conditions of eccentric stretching. They are made with a large margin of strength to exclude deformation during operation [9].

Therefore, the task of the research is to determine the maximum force that can be applied to the grip of the designed puller with a given safety factor n = 3 [9].

The general method of building a solid-state model of a gripper in SW is shown in fig. 3.



a b

Fig. 3. The general method of building a solid-state gripper model in SW (a) and the model itself (b)

Information about the grip model is given in fig. 4.

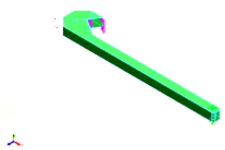
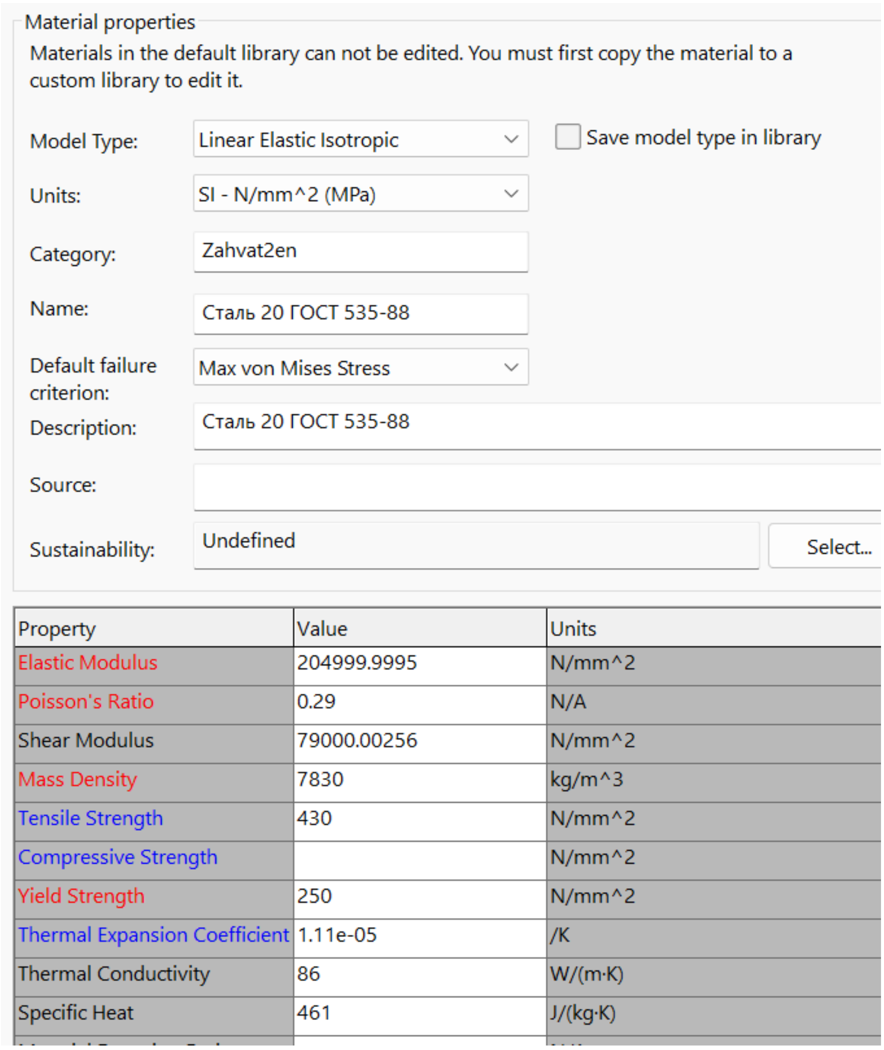
Solid Bodies			
Document Name and Reference	Treated As	Volumetric Properties	Document Path/Date Modified
Фаска1 	Solid Body	Mass:0,195837 kg Volume:2,50112e-05 m^3 Density:7 830 kg/m^3 Weight:1,91921 N	D:\Zahvat2_en\Zahvat2en.SLDPRT

Fig. 4. Information about the grip model

We apply the SWS software module to the capture model. We choose:

– static analysis, as a type of study of its stress-strain state.

– from the SW library, the material from which the gripper is made is steel 20 DSTU 535-88 (fig. 5).



Material properties

Materials in the default library can not be edited. You must first copy the material to a custom library to edit it.

Model Type: Linear Elastic Isotropic

Save model type in library

Units: SI - N/mm^2 (MPa)

Category: Zahvat2en

Name: Сталь 20 ГОСТ 535-88

Default failure criterion: Max von Mises Stress

Description: Сталь 20 ГОСТ 535-88

Source:

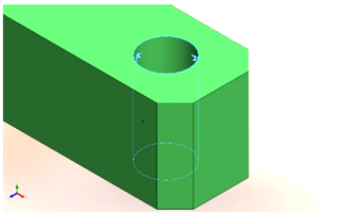
Sustainability: Undefined

Select...

Property	Value	Units
Elastic Modulus	204999.9995	N/mm^2
Poisson's Ratio	0.29	N/A
Shear Modulus	79000.00256	N/mm^2
Mass Density	7830	kg/m^3
Tensile Strength	430	N/mm^2
Compressive Strength		N/mm^2
Yield Strength	250	N/mm^2
Thermal Expansion Coefficient	1.11e-05	/K
Thermal Conductivity	86	W/(m·K)
Specific Heat	461	J/(kg·K)

Fig. 5. Assignment of the capture model of steel properties 20

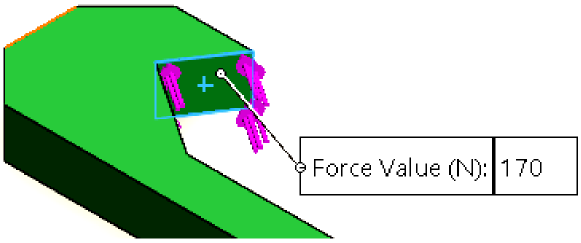
We select the attachment points of the gripper model (in this study – the fixed geometry) and apply external loads to it (fig. 6).

Fixture name	Fixture Image	Fixture Details
Зафіксований-1		**Entities:** 1 face(s) **Type:** Fixed Geometry

Resultant Forces

Components	X	Y	Z	Resultant
Reaction force(N)	141,434	0,0518193	94,3028	169,99
Reaction Moment (N.m)	0	0	0	0

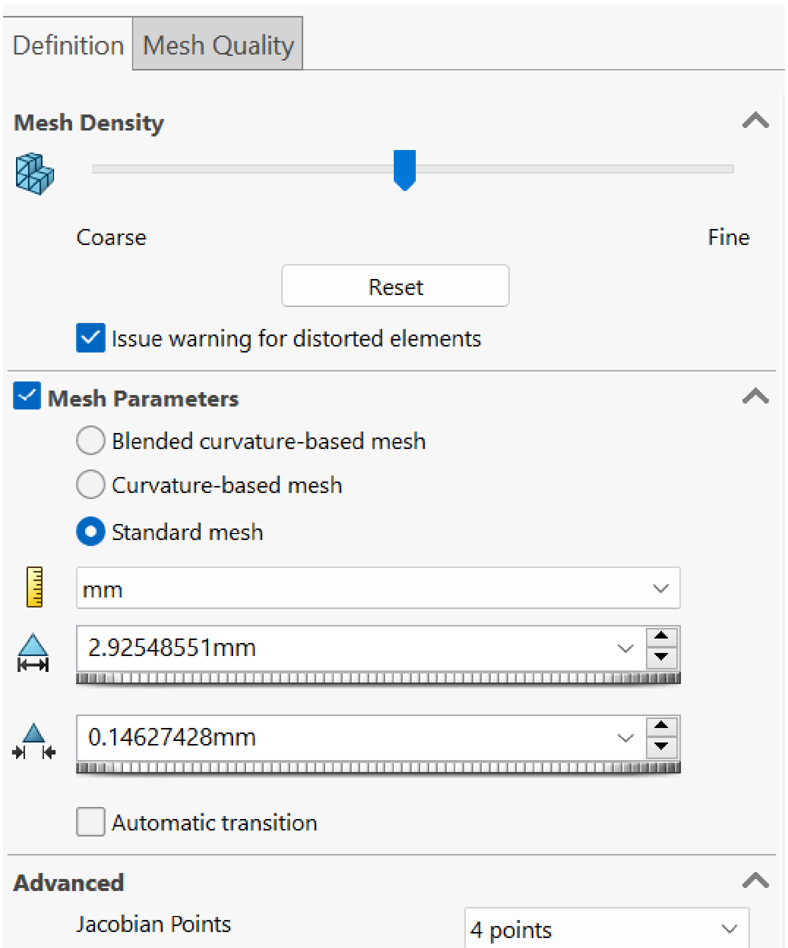
a



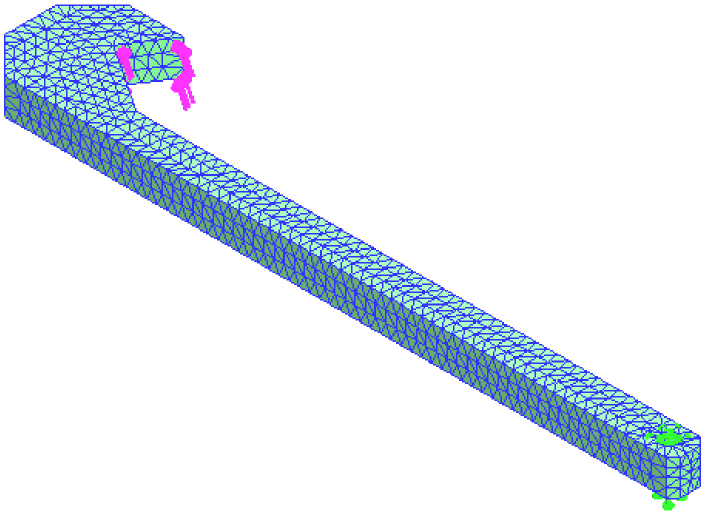
b

Fig. 6. Fixing the grip model (a) and forming the load pattern (b)

We create a grid on the capture model (fig. 7).



a



b

Fig. 7. Grid parameters (a) and its display (b) on the capture model

Calculations determined the resulting forces and moments of reaction acting on the grip. The following stages:

– a stiffness matrix is built and a finite-element model of the gripper is synthesized from its individual elements (the conditions for fixing the gripper at nodal points are taken into account);

– the resulting system of algebraic equations is solved and the components of the stress-strain state are determined (fig. 8).

Name	Type	Min	Max
Напруження1	VON: von Mises Stress	2,183e+05N/m^2 Node: 8060	8,313e+07N/m^2 Node: 26

a

Name	Type	Min	Max
Переміщення1	URES: Resultant Displacement	0,000e+00mm Node: 1	7,671e-01mm Node: 743

b

Name	Type	Min	Max
Деформація1	ESTRN: Equivalent Strain	2,222e-06 Element: 217	2,876e-04 Element: 1041

c

Name	Type	Min	Max
Запас міцності1	Automatic	3,007e+00 Node: 26	1,145e+03 Node: 8060

d

Fig. 8. Calculation results of von Mises stresses (a), total displacements URES (b), total deformations ESTRN (c) and margin of safety FOS (d) of the gripper model

Conclusions. It was established that the maximum stresses and deformations occur in the opening of the gripper. With a specified safety factor n = 3, the maximum force that can be applied to the gripper is 170 N (fig. 6). But since the design of the puller contains 3 grips, it can develop a force of 510 N.

Thus, the capabilities of modern personal computers provide with the help of SWS various processes of obtaining an acceptable result without time-consuming natural experiments.

References

1. 1. Знімачі магнето (генератора). URL: https://motozilla.com.ua/ua/category/semniki-magneto-all/ (дата звернення: 29.02.2024).
2. 2. Знімачі ланцюга. URL: https://motozilla.com.ua/ua/category/semniki-tsepi-all/ (дата звернення: 29.02.2024).
3. Знімачі зчеплення. URL: https://motozilla.com.ua/ua/category/semniki-stsepleniya-all/ (дата звернення: 29.02.2024).
4. Знімачі шатуна. URL: https://motozilla.com.ua/ua/category/semniki-shatuna-all/ (дата звернення: 29.02.2024).
5. Знімачі каретки. URL: https://motozilla.com.ua/ua/category/semniki-karetki-all/ (дата звернення: 29.02.2024).
6. Знімачі касети. URL: https://motozilla.com.ua/ua/category/semniki-kassety-all/ (дата звернення: 29.02.2024).
7. Знімачі педалей. URL: https://motozilla.com.ua/ua/category/semniki-pedaley-all/ (дата звернення: 29.02.2024).
8. Росс Твег. Пристосування для ремонту автомобілів. URL: http://mlab.org.ua/forum/viewtopic.php?f=14&t=57 (дата звернення: 29.02.2024).
9. Короткий огляд різних знімачів або навіщо потрібний знімач гідравлічний. URL: http://ukrindustry.org.ua/article/semnik-gidravlichesky.html
10. Rudyk O. Yu. Application of SolidWorks is for professional preparation of specialists / O. Yu. Rudyk, P. V. Kaplun, V. A. Gonchar. *ІІ Міжнародна науково-*

практична інтернет-конференція «Ресурсно-орієнтоване навчання в «3D»: доступність, діалог, динаміка» : збірник тез доповідей (електронне видання) (м. Полтава, 22–23 лютого 2022 року). – Полтава : ПУЕТ, 2022. С. 140-146. URL: http://elar.khmnu.edu.ua/jspui/handle/123456789/12794 (дата звернення: 29.02.2024).

11. Рудик О. Застосування SolidWorks для підготовки висококваліфікованих фахівців / О. Рудик, П. Каплун, В. Гончар. *Актуальні проблеми в системі освіти: заклад загальної середньої освіти – доуніверситетська підготовка – заклад вищої освіти: зб. наук. праць матеріалів VIII Всеукраїнської науково-практичної конференції, 17 лютого 2022 р., м. Київ, Національний авіаційний університет.* С. 699-706. URL: https://jrnl.nau.edu.ua/index.php/APSE/issue/view/879 (дата звернення: 29.02.2024).

12. Боровик О.В. Застосування SolidWorks Simulation у навчальному процесі / О. В. Боровик, О. Ю. Рудик, В. С. Паска. *Актуальні проблеми в системі освіти: заклад загальної середньої освіти – доуніверситетська підготовка – заклад вищої освіти: зб. наук. праць матеріалів V Всеукраїнської науково-практичної конференції, 18 квітня 2019 р., м. Київ, Національний авіаційний університет / наук. ред. Н. П. Муранова*. – К. : НАУ, 2019. С. 39-42.

13. Рудик О. Застосування SolidWorks для підготовки висококваліфікованих фахівців / О. Рудик, П. Каплун, В. Гончар. *Актуальні проблеми в системі освіти: заклад загальної середньої освіти – доуніверситетська підготовка – заклад вищої освіти: зб. наук. праць матеріалів VIII Всеукраїнської науково-практичної конференції, 17 лютого 2022 р., м. Київ, Національний авіаційний університет.* – К.: НАУ, 2022. С. 699-706. URL: https://jrnl.nau.edu.ua/index.php/APSE/issue/view/879 (дата звернення: 29.02.2024).