

MONTAŽNI IN STREŽNI SISTEMI

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	Montažni in strežni sistemi
Course title:	Assembly and Handling Systems
Članica nosilka/UL Member:	UL FS

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Strojništvo - Razvojno raziskovalni program, druga stopnja, magistrski (od študijskega leta 2024/2025 dalje)	Proizvodno strojništvo (smer)	1. letnik	2. semester	obvezni

Univerzitetna koda predmeta/University course code:	0566836
Koda učne enote na članici/UL Member course code:	6048-M

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
30		30			65	5

Nosilec predmeta/Lecturer:	Marko Šimic, Mihael Debevec, Niko Herakovič
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Izvajalci predavanj:	
Izvajalci seminarjev:	
Izvajalci vaj:	
Izvajalci kliničnih vaj:	
Izvajalci drugih oblik:	
Izvajalci praktičnega usposabljanja:	

Vrsta predmeta/Course type:

Obvezni strokovni predmet na smeri Proizvodno strojništvo, ki je izbirni strokovni predmet na ostalih smereh./Compulsory specialised course in the study of Production Engineering, which is an elective specialised course in other fields of study.

Jeziki/Languages:

Predavanja/Lectures:	Slovenščina
Vaje/Tutorial:	Slovenščina

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:**Prerequisites:**

Izpolnjevanje pogojev za vpis v Magistrski študijski program II. stopnje Strojništvo - Razvojno raziskovalni program.

Meeting the enrollment conditions for the Master's study programme of Mechanical Engineering - Research and Development program.

Vsebina:**Content (Syllabus outline):**

1. Opredelitve in izzivi na področju montažnih in strežnih sistemov in procesov (MiSSP)

- Opredelitev vplivnih parametrov MiSSP za konkurenčnost podjetij, montažni in strežni procesi in sistemi kot šibka točka v proizvodnem procesu
- Zahteve trga in zmožnosti ter vpliv tehnologij MiSSP, cilji in strategije podjetij na področju razvoja in organiziranja MiSSP
- Montaža in strega v življenjski dobi izdelka, stroški in vpliv na stroške, integralni pristop za znižanje stroškov MiSSP

2. Osnove montaže in strege ter digitalizacija MiSSP

- Struktura izdelka in procesa montaže in strege
- Digitalizacija delovnih operacij procesa montaže in strege od konstrukcije do dobavne verige, koncepti, programska orodja, LPM
- Struktura in umeščenost v avtomatizacijsko piramido, vertikalna povezljivost
- Koncepti implementacije v

1. Definitions and challenges in the field of assembly and handling systems and processes (AaHSP)

- Defining the influential parameters of AaHSP for company competitiveness, assembly and handling processes and systems as a weak point in the production process
- Market requirements and capabilities and impact of AaHSP technologies, company goals and strategies in the development and organization of AaHSPs
- Assembly and handling in the life-cycle of the product, costs and impact on costs, an integrated approach to reduce AaHSP costs

2. Basics of assembly and handling and digitization of AaHSP

- Product structure and the structure of process of assembly and handling
- Digitalization of work operations of the assembly and handling process from design to supply chain, concepts, software tools, LPM
- Structure and placement in the automation pyramid, vertical

proizvodnji

3. Koncepti MiSSP ter Lean

- Koncept vleka in potiska v montažnem in strežnem procesu (Push-Pull)
- Balansiranje procesa MiSSP in dejavnosti
- Uporaba orodij Lean-a za optimiranje MiSSP

4. Koncepti MiSSP ter Lean

- Uporaba orodij Lean-a za optimiranje MiSSP
- Metoda VSM (mapiranje toka vrednosti)
- Digitalni LEAN

5. Ergonomija delovnih mest v MiSSP, Lean

- Uporaba orodij Lean-a za optimiranje MiSSP
- Vplivni parametri učinkovitosti delavca, ključni faktorji ergonomskih tveganj
- Oblikovanje ergonomskih montažnih in strežnih mest s programskimi orodji
- Primeri in uporaba programskih orodij, modeliranje človeka in delovnega mesta z izbranim programskim orodjem
- Definiranje vhodov in izhodov, analiza rezultatov

6. Logistične aktivnosti v MiSSP

- Opredelitev logistike materiala proizvodnih sredstev in informacij
- Logistika kot instrument konkurenčnosti, proizvodna logistika
- Logistika delovnega mesta v MiSSP
- Logistično orientirani MiSSP, logistična zmogljivost in sposobnost oskrbe

7. Modeliranje, simulacija in optimizacija logističnih sistemov v proizvodnem procesu

- Simulacijski model logističnih dejavnosti
- Logistični proces kot dogodek, definiranje vhodov in izhodov
- Povezava posameznih dogodkov v verigo
- Optimizacija preko modeliranja in simulacije diskretnih dogodkov
- Primeri uporabe v realnih logističnih MiSSP, optimizacija tlorisa linij MiSSP

connectivity

- Concepts of implementation in production

3. AaHSP and Lean concepts

- Push-Pull concept in assembly and handling process
- Balancing AaHSP process and activities
- The use of Lean tools to optimize AaHSP

4. AaHSP and Lean concepts

- The use of Lean tools to optimize AaHSP
- Value stream mapping (VSM) method
- Digital LEAN

5. Ergonomics of workplaces at AaHSP, Lean

- The use of Lean tools to optimize AaHSP
- Effective parameters of worker efficiency, key factors of ergonomic risks
- Designing ergonomic assembly and handling positions with software tools
- Examples and use of software tools, human and workplace modeling with the selected software tool
- Defining inputs and outputs, analysis of results

6. Logistic activities in AaHSP

- Definition of logistics of material, production assets and information
- Logistics as an instrument of competitiveness, production logistics
- Logistics of workplace in AaHSP
- Logistically oriented AaHSP, logistical capacity and supply capability

7. Modeling, simulation and optimization of logistics systems in the production process

- Simulation model of logistic activities
- Logistic process as an event, defining inputs and outputs
- Connecting individual events into a chain
- Optimization through modeling and simulation of discrete events
- Examples of use in real logistic AaHSPs, optimization of the layout of AaHSP lines

8. Logistics of storage of components and products

8. Logistika skladiščenja sestavnih delov in izdelkov

- Vpliv logistike skladiščenja na učinkovitost MiSSP, definicija zaloge, predmetov skladiščenja in tipi skladišč
- Strategija naročanja in vpliv na zaloge ter delovanje MiSSP, zmogljivost MiSSP v odvisnosti od velikosti zalog
- Vplivne veličine pri načrtovanju skladišč
- Ročna in avtomatizirana skladišča, sledljivost izdelkov v skladiščih
- Modeliranje in simulacija skladiščne logistike

9. Logistika notranjega transporta v MiSSP z modeliranjem in simulacijo

- Dodana vrednost transporta in vpliv na pretočni čas ter vrednost izdelka, načrtovanje transporta in transportni proces
 - Transportna sredstva, posebej viličarji in avtonomno vodena vozila, določitev kapacitete transportnega sistema
 - Uporaba transporterjev v MiSSP, tipi in lastnosti, lokacije skladišč, transportne poti in optimiranje tlorisa delovnih mest MiSSP, smernice za načrtovanje transporta
 - Analiza toka materiala od skladišč do delovnih mest posameznih MiSSP, prometni količnik, skupno transportno delo, učinkovitost transportnega sistema in njegova kapaciteta, metode dobave materiala – JIT, Kanban, MRP
 - Modeliranje in simulacija transporta
- ## 10. Tehnologije industrije 4.0 v MiSSP
- Optimizacija MiSSP s simulacijskimi modeli digitalne tovarne, uporaba inteligentnih metahevrističnih algoritmov in ekspertnih sistemov
 - Robotizacija MiSSP in načini programiranja robotov v virtualnem okolju, metode za doseganje varnosti robotov in delavcev
 - Sodelovanje človeka, robota in okolja; interakcija človek-robot; samokonfiguracijske robotske celice
 - Asistenčni sistemi za pomoč delavcu, prijemala za industrijske in kolaborativne robote, aplikacije s

- The impact of storage logistics on AaHSP performance, definition of stock, items of storage and warehouse types
- Ordering strategy and impact on stock and AaHSP performance, AaHSP performance depending on stock size
- Effective parameters in warehouse design
- Manual and automated warehouses, traceability of products in warehouses
- Modeling and simulation of warehouse logistics

9. Logistics of internal transport in AaHSP through modeling and simulation

- Added value of transport and impact on throuputh time and product value, transportation planning and transport process
 - Transport means, especially forklifts and autonomously driven vehicles, determining the capacity of the transport system
 - Use of conveyors in AaHSP, types and properties, warehouse locations, transport routes and optimization of AaHSP workplaces, transport planning guidelines
 - Analysis of material flow from warehouses to workplaces of individual AaHSPs, traffic quotient, joint transport work, efficiency of the transport system and its capacity, methods of material supply - JIT, Kanban, MRP
 - Transport modeling and simulation
- ## 10. Technologies of Industry 4.0 in AaHSP

- AaHSP optimization with digital factory simulation models, use of intelligent metaheuristic algorithms and expert systems
- Robotization of AaHSPs and methods of programming robots in a virtual environment, safety methods for workers and robots
- Collaboration between human, robot and environment; human-robot interaction; self-configuring robotic cells
- Assistance systems for worker assistance, grippers for industrial and collaborative robots, machine vision applications, implementation criteria

<p>strojnim vidom, kriteriji za implementacijo</p> <ul style="list-style-type: none"> - Fleksibilni MiSSP z uvajanjem avtonomno vodenih vozil, tehnologija RFID za sledenje izdelkov, medsebojno komuniciranje objektov in povezava z digitalnim dvojčkom <p>11. Načrtovanje montažnih in strežnih sistemov in procesov (MiSSP)</p> <ul style="list-style-type: none"> - Osnovne montažne in strežne metode, kriteriji izbire - Integralni model načrtovanja montaže in strege - Uporaba teorije sistemov pri načrtovanju MiSSP, naloga in funkcija MiSS, transformacijski model MiSSP - Osnovni model načrtovanja MiSSP, koncentrični model načrtovanja MiSSP - Model LASFA za načrtovanje pametnih MiSSP <p>12. Oblikovanje izdelka za učinkovito montažo in strego</p> <ul style="list-style-type: none"> - Kompleksnost in število sestavnih delov v različnih izdelkih - Pomen oblikovanja izdelka za montažo in strego (DFAH) - Osnovna pravila DFAH - Posebne smernice za oblikovanje izdelkov in poenostavitev procesa montaže in strege <p>13. Uporaba metode DFAH za optimiranje avtomatiziranih MiSSP</p> <ul style="list-style-type: none"> - Smernice za izboljšanje organiziranosti in fleksibilnosti procesa montaže in strege - Metoda in elementi DFA hiše, naloge sistema, komponente, lastnosti komponent, procesa in montaže ter strege - Načini uporabe DFA hiše, alfa in beta simetrija ter vpliv na avtomatizirane MiSSP - Primer uporabe DFA hiše <p>14. Vpliv modularne gradnje in standardizacije izdelkov na MiSSP</p> <ul style="list-style-type: none"> - Osnovna vodila za modularno gradnjo izdelka in MiSSP, načela modularne gradnje izdelkov in MiSS - Izzivi, prednosti in slabosti modularne gradnje - Glavni kriteriji za povečanje 	<ul style="list-style-type: none"> - Flexible AaHSP with autonomous guided vehicle deployment, RFID technology for product tracking, object interconnection and digital twin connection <p>11. Design of assembly and handling systems and processes (AaHSP)</p> <ul style="list-style-type: none"> - Basic assembly and handling methods, selection criteria - Integral model of assembly and handling design - Use of system theory in AaHSP design, task and function of AaHS, AaHSP transformation model - Basic AaHSP design model, concentric AaHSP design model - LASFA model for the design of smart AaHSP <p>12. Product design for efficient assembly and handling</p> <ul style="list-style-type: none"> - Complexity and number of assembly parts in different products - The importance of product design for assembly and handling (DFAH) - DFAH Basic Rules - Special guidelines for product design and simplification of the assembly and handling process <p>13. The use of the DFAH method to optimize automated AaHSP</p> <ul style="list-style-type: none"> - Guidelines for improving the organization and flexibility of the assembly and handling process - Method and elements of the DFA house, system tasks, components, component features, process and assembly and handling - Ways of using DFA house, alpha and beta symmetry and impact on automated AaHSPs - Example of using a DFA house <p>14. Impact of modular construction and product standardization on AaHSP</p> <ul style="list-style-type: none"> - Main guidelines for modular product design and AaHSP, principles of modular product design and AaHS - Challenges, advantages and disadvantages of modular design - Main criteria for increasing AaHSP flexibility and productivity - Examples of real production use
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<p>fleksibilnosti in produktivnosti MiSSP</p> <ul style="list-style-type: none"> - Primer uporabe v realnem okolju - Modeliranje in simulacija diskretnih dogodkov za različne pristope <p>15. Zanesljivost in razpoložljivost MiSSP</p> <ul style="list-style-type: none"> - Osnovni pojmi in definicije - Tipi in vrste motenj in napak v MiSSP, upravljanje z motnjami v MiSSP - Zanesljivost MiSSP, vpliv serijske in paralelne postavitve delovnih mest in linij - Razpoložljivost in izkoriščenost MiSSP - Diagnoza napak in analiza kritičnih mest v MiSSP, metodologija postavitve kontrolnih mest, FMEA, uporaba strojnega vida 	<ul style="list-style-type: none"> - Modeling and simulating discrete events for different approaches <p>15. AaHSP reliability and availability</p> <ul style="list-style-type: none"> - Basic concepts and definitions - Types of disturbances and errors in AaHSP, fault management in AaHSP - AaHSP reliability, the impact of serial and parallel layout of workplaces and lines - AaHSP availability and utilization - Diagnosis of errors and analysis of critical points in AaHSP, methodology of control points layout, FMEA, use of machine vision
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Temeljna literatura in viri/Readings:

1. Liker, Jeffrey K.: The Toyota way : 14 management principles from the world's greatest manufacturer, 2nd ed., New York [etc.] : McGraw Hill, cop. 2021, [COBISS.SI-ID [67462403](#)].
2. Boothroyd, Geoffrey: Assembly automation and product design, 2nd ed., Boca Raton, FL : Taylor & Francis/CRC Press, 2005, [COBISS.SI-ID [26842117](#)].
3. Myerson, Paul: Lean supply chain and logistics management, priročnik ; neleposlovje za odrasle, New York : McGraw-Hill, 2012, [COBISS.SI-ID [2349411](#)].
4. Groover, Mikell P.: Automation, production systems, and computer-integrated manufacturing, neleposlovje za odrasle, 5th ed., New York (NY): Pearson, cop. 2019, [COBISS.SI-ID [146606595](#)].
5. Khojasteh, Yacob: Production control systems : A Guide to enhance performance of pull production systems, Tokyo [etc.] : Springer, 2016, [COBISS.SI-ID [14331675](#)].
6. Kalpakjian, Serope: Manufacturing engineering and technology, Addison-Wesley, cop. 1995, [COBISS.SI-ID [1455131](#)].

Cilji in kompetence:

Objectives and competences:

<p>Cilji:</p> <ol style="list-style-type: none"> 1. Usvojiti osnove montažnih in strežnih procesov in sistemov (MiSSP) s poudarkom na digitalizaciji 2. Usvojiti osnove metodologije izbire, snovanja, analize in vrednotenja avtomatiziranih montažnih in 	<p>Objectives:</p> <ol style="list-style-type: none"> 1. Develop the basics of assembly and handling processes and systems (AaHSP) with a focus on digitization 2. Gain the basics of the methodology of selection, design, analysis and evaluation of automated assembly
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<p>strežnih sistemov (MiSS) in njihovo integracijo v celoten proizvodni proces</p> <ol style="list-style-type: none"> 3. Usvojiti osnove koncipiranja in načrtovanja montažnih in strežnih procesov v skladu z metodologijo LEANa. 4. Usvojiti osnovne koncepte logistično orientiranih montažnih in strežnih sistemov, vključno z notranjim skladiščenjem in transportom <p>Kompetence:</p> <ol style="list-style-type: none"> 1. Razumevanje vloge montažnih in strežnih sistemov in procesov v proizvodnji in konceptov njihove digitalizacije v luči I4.0 2. Sposobnost izbire, snovanja, analize in vrednotenja avtomatiziranih in robotiziranih MiSS, ter njihove integracije v proizvodni process 3. Razumevanje in sposobnost načrtovanja montažnih in strežnih procesov in sistemov po načelih Lean-a in z metodami Digitalnega Lean-a 4. Sposobnot načrtovanja učinkvitih logističnih procesov pri koncipiranju tlorisa in procesa montaže in strege 	<p>and handling systems (AaHS) and their integration into the entire production process</p> <ol style="list-style-type: none"> 3. Gain the basics of drafting and designing assembly and handling processes in accordance with the LEAN methodology. 4. Use basic concepts of logistically oriented assembly and handling systems, including with internal storage and transportation <p>Competencies:</p> <ol style="list-style-type: none"> 1. Understanding the role of assembly and handling systems and processes in production and the concepts of their digitization in light of I4.0 2. Ability to select, design, analyse and evaluate automated and robotic AaHS, and integrate them into the production process 3. Understanding and ability to design assembly and handling processes and systems according to Lean principles and using Digital Lean methods 4. Ability to design efficient logistics processes in conceptualizing the layout and process of assembly and handling
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Predvideni študijski rezultati:

Intended learning outcomes:

<p>Znanja:</p> <p>Študent pozna in razume: osnove avtomatiziranih montažnih in strežnih sistemov in procesov (MiSSP), zakonitosti delovanja in modelov, njihovih struktur, relacij, in aplikacije robotov v avtomatiziranih MiSSP. Pridobljena znanja uporabi študent za holistično obravnavanje koncipiranja in optimiranja MiSSP, za njihovo načrtovanje in oblikovanje v smeri doseganja čim večje učinkovitosti procesov in izkoriščenosti montažnih in strežnih sredstev.</p>	<p>Knowledge:</p> <p>A student knows and understands: the basics of automated assembly and handling systems and processes (AaHSP), the laws of operation and models, their structures, relationships, and the application of robots in automated AaHSP. The acquired knowledge is used by the student to holistically address the conception and optimization of AaHSP, to draft and design them in order to maximize the efficiency of processes and utilization of assembly and handling resources.</p>
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<p>Spretnosti:</p> <ol style="list-style-type: none"> 1. Optimizacija obstoječih in načrtovanje novih, vitko orientiranih MiSSP 2. Uporaba računalniško podprtih simulacijskih orodij za optimiranje in načrtovanje MiSSP 3. Razvoj strategije digitalizacije pomembnejših podprocesov MiSSP 4. Uporaba logističnih konceptov pri snovanju novih MiSSP 	<p>Skills:</p> <ol style="list-style-type: none"> 1. Optimization of existing and design of new, lean-oriented AaHSPs 2. The use of computer-aided simulation tools for AaHSP optimization and design 3. Development of a strategy for digitizing major AaHSP subprocesses 4. The use of logistics concepts in the design of new AaHSPs
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Metode poučevanja in učenja:

Learning and teaching methods:

<ol style="list-style-type: none"> 1. P1, P2 Avditorna predavanja podprta z interaktivnim prikazom praktičnih primerov 2. P3 Avditorne vaje z reševanjem praktičnih primerov 3. P4 Laboratorijske vaje s timskim reševanjem aplikativnih problemov in uporabo programske opreme ter njihova predstavitev z razpravo. 4. P5 Uporaba študijskega gradiva v e-obliki, skripta in e-verzija predavanj. 5. P6 Interaktivna predavanja 6. P7 Študij literature in razprava 7. P9 Skupinsko delo 	<ol style="list-style-type: none"> 1. P1, P2 Lectures supported by interactive presentation of practical examples 2. P3 Tutorials solving practical examples 3. P4 Laboratory exercises with team solving of application problems, using software and presenting them with discussion. 4. P5 Use of study material in e-form, lecture notes and e-version of lectures. 5. P6 Interactive lectures 6. P7 Literature review and discussion 7. P9 Team work
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Načini ocenjevanja:

**Delež/
Weight**

Assessment:

<p>- Teoretične vsebine (predavanja, timsko delo): Kolokviji, prezentacija/zagovor timskega dela, pisni in/ali ustni izpit</p>	<p>60,00 %</p>	<p>- Theoretical contents (lectures, team work): Colloquium, team work presentation/defense, writing and/or oral exam</p>
<p>- Samostojno delo na avditornih in laboratorijskih vajah (vključno s poročili)</p>	<p>40,00 %</p>	<p>- Individual work in exercises, individual laboratory work (including reports)</p>

Ocenjevalna lestvica:

Grading system:

<p>5 - 10, pri čemer velja, da je pozitivna ocena od 6 - 10</p>	<p>5 - 10, a student passes the exam if he is graded from 6 to 10</p>
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Reference nosilca/Lecturer's references:

Niko Herakovič:

1. **HERAKOVIČ, Niko**, METLIKOVIČ, Peter, DEBEVEC, Mihael. Motivational lean game to support decision between push and pull production strategy. International journal of simulation modelling, ISSN 1726-4529, Dec. 2014, vol. 13, nr. 4, str. 433-446, ilustr., doi: 10.2507/IJSIMM13(4)4.275. [COBISS.SI-ID [13828379](#)], [JCR, SNIP, WoS, Scopus].
2. RESMAN, Matevž, PROTNER, Jernej, ŠIMIC, Marko, **HERAKOVIČ, Niko**. A five-step approach to planning data-driven digital twins for discrete manufacturing systems. Applied sciences. Apr. 2021, vol. 11, iss. 8, str. 1-25, ilustr. ISSN 2076-3417. [COBISS.SI-ID [61630723](#)], [JCR, SNIP, WoS, Scopus].
3. ZUPAN, Hugo, **HERAKOVIČ, Niko**, ŽEROVNIK, Janez, BERLEC, Tomaž. Layout optimization of a production cell. International journal of simulation modelling, ISSN 1726-4529, Dec. 2017, vol. 16, nr. 4, str. 603-616, ilustr. http://www.ijssimm.com/Full_Papers/Fulltext2017/text16-4_603-616.pdf. [COBISS.SI-ID [15898139](#)], [JCR, SNIP, WoS, Scopus].
4. TURK, Maja, RESMAN, Matevž, **HERAKOVIČ, Niko**. Ergonomic evaluation of basis manual assembly operations with integration of simulation tools. V: Scientific proceedings of the Scientific-technical Union of Mechanical Engineering : Technical Sciences, Industrial Management, (International Conference for Young Researchers Technical Sciences and Industrial Management (Online), ISSN 2535-020X, Vol. 1). [S. l.]: Scientific-technical Union of Mechanical Engineering. 2018, vol. 3, iss. 1, f. 34-38, ilustr. <http://stumejournals.com/journals/i4/2018/1/3> [COBISS.SI-ID [16355867](#)].
5. **HERAKOVIČ, Niko**, ZUPAN, Hugo, DEBEVEC, Mihael. Feasibility study of new robot production in Europe : report of the project (done in year 2015). Ljubljana: Fakulteta za strojništvo, Laboratorij LASIM, 2015. 35 f., ilustr. [COBISS.SI-ID [16025627](#)].

Marko Šimic:

1. TURK, Maja, PIPAN, Miha, **ŠIMIC, Marko**, HERAKOVIČ, Niko. A smart algorithm for personalizing the workstation in the assembly process. Applied sciences. Dec. 2020, vol. 10, iss. 23, f. 1-19, ilustr. ISSN 2076-3417. <https://www.mdpi.com/2076-3417/10/23/8624/htm>, DOI: 10.3390/app10238624. [COBISS.SI-ID [40663299](#)].
2. **ŠIMIC, Marko**, HERAKOVIČ, Niko. Reduction of the flow forces in a small hydraulic seat valve as alternative approach to improve the valve characteristics. Energy conversion and management. [Print ed.]. 2015, vol. 89, str. 708-718, ilustr. ISSN 0196-8904. DOI: 10.1016/j.enconman.2014.10.037. [COBISS.SI-ID [13766683](#)].
3. **ŠIMIC, Marko**, HERAKOVIČ, Niko. Advanced composite spools used as alternative approach to reduce the actuation force in pneumatic valves. V: PEPELNJAK, Tomaž (ur.), CAR, Zlatan (ur.), KUDLÁČEK, Jan (ur.). IN-TECH 2017: proceedings. International Conference on Innovative Technologies, Ljubljana, [11. - 19.] 2017. Rijeka: Faculty of Engineering, 2017. Str. 209-212, ilustr. Proceedings (International Conference on Innovative Technologies). ISSN 1849-0662. [COBISS.SI-ID [15673883](#)].
4. DEBEVEC, Mihael, **ŠIMIC, Marko**, JOVANOVIĆ, Vukica, HERAKOVIČ, Niko. Virtual factory as a useful tool for improving production processes. Journal of manufacturing systems. Oct. 2020, vol. 57, str. 379-389, ilustr. ISSN 0278-

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