

# METODIKA KONSTRUIRANJA - PAP

## UČNI NAČRT PREDMETA/COURSE SYLLABUS

<b>Predmet:</b>	Metodika konstruiranja - PAP
<b>Course title:</b>	Engineering Design Methodology - PAP
<b>Članica nosilka/UL Member:</b>	UL FS

<b>Študijski programi in stopnja</b>	<b>Študijska smer</b>	<b>Letnik</b>	<b>Semestri</b>	<b>Izbirnost</b>
Strojništvo - projektno aplikativni program, prva stopnja, visokošolski strokovni	Energetsko strojništvo (smer)	2. letnik	1. semester	obvezni
Strojništvo - projektno aplikativni program, prva stopnja, visokošolski strokovni	Industrijsko inženirstvo (smer)	2. letnik	1. semester	obvezni
Strojništvo - projektno aplikativni program, prva stopnja, visokošolski strokovni	Konstruiranje industrijskih sistemov (smer)	2. letnik	1. semester	obvezni
Strojništvo - projektno aplikativni program, prva stopnja, visokošolski strokovni	Konstruiranje strojev in naprav (smer)	2. letnik	1. semester	obvezni
Strojništvo - projektno aplikativni program, prva stopnja, visokošolski strokovni	Mehatronika (smer)	2. letnik	1. semester	obvezni
Strojništvo - projektno aplikativni program, prva stopnja, visokošolski strokovni	Procesno strojništvo (smer)	2. letnik	1. semester	obvezni
Strojništvo - projektno aplikativni program, prva stopnja, visokošolski strokovni	Proizvodne tehnologije (smer)	2. letnik	1. semester	obvezni
Strojništvo - projektno aplikativni program, prva stopnja, visokošolski strokovni	Prometni pilot letala/helikopterja (smer)	2. letnik	1. semester	obvezni
Strojništvo - projektno	Snovanje in	2. letnik	1. seme	obvezn

aplikativni program, prva stopnja, visokošolski strokovni	vzdrževanje letal (smer)		ster	i
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**Univerzitetna koda predmeta/University course code:**

0562713

**Koda učne enote na članici/UL Member course code:**

3016-V

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			40	4

**Nosilec predmeta/Lecturer:**

Ivan Demšar, Janez Benedičič, Nikola Vukašinović

**Izvajalci predavanj:**

**Izvajalci seminarjev:**

**Izvajalci vaj:**

**Izvajalci kliničnih vaj:**

**Izvajalci drugih oblik:**

**Izvajalci praktičnega usposabljanja:**

**Vrsta predmeta/Course type:**

Obvezni splošni predmet/Compulsory general course

**Jeziki/Languages:**

Predavanja/Lectures:

Slovenščina

Vaje/Tutorial:

Slovenščina

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

**Prerequisites:**

Izpolnjevanje pogojev za vpis v Visokošolski strokovni študijski program I. stopnje Strojništvo - Projektno aplikativni program.

Meeting the enrollment conditions for the MECHANICAL ENGINEERING - Project Oriented Applied Programme.

## Vsebina:

1. Predavanje - Uvod v metodiko konstruiranja
  - Konstruiranje v celem življenjskem ciklu izdelka
  - Nivoji in viri konstruiranja
  - Iskanje priložnosti za razvoj novega izdelka
  - Naravni in tehnični proces, ter razumevanje procesov
  - Primer izvedenega konstrukcijskega procesa
2. Predavanje - Konstrukcijske zahteve
  - Prepoznavanje potreb uporabnika
  - preslikava zahtev kupca v tehnične zahteve
  - QFD matrika
  - Vpliv standardov, regulative in socialno-konstrukcijskega okolja na konstrukcijske zahteve
3. Predavanje - Koraki konstruiranja
  - Faze konstrukcijskega procesa po VDI 2222
  - Konstrukcijski proces po avtomobilskem standard (zahtev, mejniki)
  - Konstruiranje za večjo zanesljivost
4. Predavanje - Sočasni razvoj
  - Značilnosti sočasnega razvoja
  - Prednosti in slabosti sočasnega izvajanja aktivnosti
  - Elementi sočasnega razvoja (metode, IT, vodenje projekta, dobavitelji in odjemalci)
5. Predavanje - Tehnični sistem in funkcijska struktura
  - Tehnični sistem, meje sistema
  - Funkcijska struktura; vloga abstraktne predstavitve problema
  - Funkcijska dekompozicija
6. Predavanje - Iskanje rešitev delnih funkcij
  - Fizikalni zakoni kot vir idej za delovne principe
  - Primer veriženja fizikalnih zakonov
  - Viri konstruiranja (topologija, material, fizikalni zakoni, geometrija)
7. Predavanje - Generiranje konceptov
  - Katalog delovnih principov, primeri
  - Morfološka matrika - predstavitev

## Content (Syllabus outline):

1. Lecture - Introduction to engineering design methodology
  - Engineering design throughout the product life cycle
  - Levels and sources of construction
  - Finding opportunities to develop a new product
  - Natural and technical process, and understanding of processes
  - An example of an engineering design process performed
2. Lecture - Design requirements
  - Identifying user needs
  - mapping customer requirements into technical requirements
  - QFD matrix
  - Impact of standards, regulation and socio-structural environment on structural requirements
3. Lecture - Engineering design Steps
  - Phases of the engineering design process according to VDI 2222
  - Automotive engineering design process (requirements, milestones)
  - Engineering design for greater reliability
4. Lecture - Concurrent Development
  - Characteristics of simultaneous development
  - Advantages and disadvantages of carrying out activities simultaneously
  - Elements of concurrent engineering (methods, IT, project management, suppliers and clients)
5. Lecture - Technical system and functional structure
  - Technical system, system boundaries
  - Functional structure; the role of an abstract representation of a problem
  - Functional decomposition
6. Lecture - Finding solutions to partial functions
  - Physical laws as a source of ideas for working principles
  - An example of a chain of laws of physics
  - Sources of engineering design (topology, material, physical laws, geometry)

<p>delovnih principov</p> <ul style="list-style-type: none"> <li>- Koncipiranje delovnih rešitev</li> <li>- Matrika funkcij in funkcionalnosti</li> </ul> <p>8. Predavanje – Generiranje konceptov</p> <ul style="list-style-type: none"> <li>- Konvencionalni pripomočki za iskanje rešitev</li> <li>- Variacija konstrukcijskih značilnosti</li> <li>- Sinteza variant / rešitev</li> </ul> <p>9. Predavanje – Metode za spodbujanje kreativnosti</p> <ul style="list-style-type: none"> <li>- Nevihta možganov (brainstorming)</li> <li>- galerijska metoda</li> <li>- metoda 6 klobukov</li> <li>- bionika,</li> <li>- Sistematično reševanje problema v 8 korakih</li> </ul> <p>10. Predavanje – Vrednotenje in izbira najboljših konceptov</p> <ul style="list-style-type: none"> <li>- Vrednotenje po tehniških kriterijih</li> <li>- Vrednotenje po ekonomskih kriterijih</li> <li>- Model za ocenjevanje rešitev po tehničnih in ekonomskih kriterijih</li> <li>- Model ocenjevanja kriterijev s funkcijo</li> </ul> <p>11. Predavanje – Izvedba konstrukcije in detajliranje</p> <ul style="list-style-type: none"> <li>- Materializacija delovnega principa</li> <li>- Principi enoličnosti pri oblikovanju konstrukcije</li> <li>- Principi enostavnosti pri konstruiranju</li> </ul> <p>12. Predavanje – Izvedba konstrukcije in detajliranje</p> <ul style="list-style-type: none"> <li>- Princip podpornega delovanja, princip stabilnosti in labilnosti</li> <li>- Principi varnosti pri konstruiranju</li> <li>- Pravila pri oblikovanju konstrukcije (izravnava sil, deformabilnost, delne funkcije)</li> </ul> <p>13. Predavanje – Izvedba konstrukcije in detajliranje</p> <ul style="list-style-type: none"> <li>- Smernice pri oblikovnem konstruiranju</li> <li>- Konstruiranje in izdelovalne tehnologije</li> <li>- Modularna struktura proizvodov</li> </ul> <p>14. Predavanje – Prototipiranje</p> <ul style="list-style-type: none"> <li>- Vloga virtualnih in fizičnih prototipov v procesu razvoja izdelkov</li> <li>- Delni prototipi</li> <li>- 3D printanje in prototipiranje</li> </ul>	<p>7. Lecture - Concept Generation</p> <ul style="list-style-type: none"> <li>- Working principles catalog, examples</li> <li>- Morphological matrix - presentation of working principles</li> <li>- Designing work solutions</li> <li>- Function and Functionality Matrix</li> </ul> <p>8. Lecture: Generating concepts</p> <ul style="list-style-type: none"> <li>- Conventional tools for searching solutions</li> <li>- Variation in structural features</li> <li>- Synthesis of variants / solutions</li> </ul> <p>9. Lecture - Methods for stimulating creativity</p> <ul style="list-style-type: none"> <li>- Brainstorming</li> <li>- Gallery method</li> <li>- Method of 6 hats</li> <li>- Bionics,</li> <li>- Systematic solution of the problem in 8 steps</li> </ul> <p>10. Lecture: Evaluation and selection of the best concepts</p> <ul style="list-style-type: none"> <li>- Evaluation by technical criteria</li> <li>- Evaluation by economic criteria</li> <li>- Model for evaluating solutions by technical and economic criteria</li> <li>- Criteria evaluation model with function</li> </ul> <p>11. Lecture: Design and detailing</p> <ul style="list-style-type: none"> <li>- Materialization of the working principle</li> <li>- Principles of uniformity in structural design</li> <li>- Principles of simplicity of engineering design</li> </ul> <p>12. Lecture: Embodiment design and detailing</p> <ul style="list-style-type: none"> <li>- The principle of supportive action, the principle of stability and lability</li> <li>- Principles of product design safety</li> <li>- Structural design rules (force balancing, deformability, partial functions)</li> </ul> <p>13. Lecture: Embodiment design and detailing</p> <ul style="list-style-type: none"> <li>- Engineering design guidelines</li> <li>- Engineering design and manufacturing technologies</li> <li>- Modular product structure</li> </ul> <p>14. Lecture - Prototyping</p> <ul style="list-style-type: none"> <li>- The role of virtual and physical prototypes in the product development</li> </ul>
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<ul style="list-style-type: none"> <li>- Verifikacija in validacija proizvodov</li> <li>15. Predavanje – Informacijska podpora pri konstruiranju</li> <li>- Tehnični informacijski sistemi in konstruiranje</li> <li>- Tipizacija gradnikov</li> <li>- Klasifikacija gradnikov</li> <li>- Posebnosti dela v virtualnih delovnih skupinah</li> </ul>	<p>process</p> <ul style="list-style-type: none"> <li>- Partial prototypes</li> <li>- 3D printing and prototyping</li> <li>- Verification and validation of products</li> </ul> <p>15. Lecture - Information support for design</p> <ul style="list-style-type: none"> <li>- Technical information systems and engineering design</li> <li>- Typing of building blocks</li> <li>- Classification of building blocks</li> <li>- Specificities of working in virtual workgroups</li> </ul>
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### Temeljna literatura in viri/Readings:

<ol style="list-style-type: none"> <li>1. Jože Hlebanja, Metodika konstruiranja, Fakulteta za strojništvo, UL, Ljubljana 2003 [COBISS.SI-ID <a href="#">123009024</a>]</li> <li>2. G. Pahl, W. Beitz, J. Feldhusen, K.H. Grote, (2007), Engineering design, A Systematic Approach, Third Edition, Springer [COBISS.SI-ID <a href="#">1391899</a>]</li> <li>3. M. M. Andreasen, Integrated Product Development, Technical University of Denmark, 2000 [COBISS.SI-ID <a href="#">642843</a>]</li> <li>4. K.T. Ulrich and S.D. Eppinger, Product Design and Development, 7th edition, McGraw-Hill, 2020, [COBISS.SI-ID <a href="#">174327811</a>]</li> <li>5. Ullman, D.G., The Mechanical Design Process, 6th Edition, 2018, [COBISS.SI-ID <a href="#">11277339</a>]</li> </ol>
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### Cilji in kompetence:

<p>Cilji:</p> <ol style="list-style-type: none"> <li>1. Razumeti konstrukcijski proces kot razvojno-raziskovalni proces za tehnični sisteme</li> <li>2. Zasnovati tehnični proces in pripraviti konstrukcijski zahtevnik</li> <li>3. Povezati med seboj delovne principe v celovit tehnični sistem</li> <li>4. Prepoznati vplive okolice tako, da bo znal opredeliti meje sisteme</li> <li>5. Uveljaviti model modularne gradnje po funkciji in funkcionalnosti</li> </ol> <p>Kompetence:</p> <ol style="list-style-type: none"> <li>1. S1-PAP, S2-PAP, S4-PAP, S5-PAP, S9-PAP, P1-PAP: Študent je usposobljen za samostojen metodičen pristop v razvoju novega izdelka tako, da bo sam prepoznaval kritične elemente procesa ter nastavil plan razvoja z upoštevanjem novih znanj iz področja</li> </ol>	<p>Objectives:</p> <ol style="list-style-type: none"> <li>1. Understand the engineering design process as a R&amp;D process for technical systems</li> <li>2. Design the technical process and prepare the engineerig design request</li> <li>3. Integrate working principles into a comprehensive technical system</li> <li>4. Recognize the effects of the environment so that it can identify the boundaries of the systems</li> <li>5. Implement the modular construction model by function and functionality</li> </ol> <p>Competencies:</p> <ol style="list-style-type: none"> <li>1. S1-PAP, S2-PAP, S4-PAP, S5-PAP, S9-PAP, P1-PAP: The student is trained in an independent methodical approach in the development of a new product, so that he / she will</li> </ol>
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<p>strojništva in drugih področij.</p> <p>2. S13-PAP: Samostojno iskanje virov znanja, selekcija virov in uporaba.</p> <p>3. S6-PAP, S11-PAP, P6-PAP: Delo v skupini in sposobnost predstavitve strokovnih problemov in rešitev.</p>	<p>identify the critical elements of the process and set the development plan and integrating new knowledge in mechanical engineering and other fields.</p> <p>2. S13-PAP: Independent search for knowledge sources, resource selection and use.</p> <p>3. S6-PAP, S11-PAP, P6-PAP: Teamwork and the ability to present professional problems and solutions.</p>
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**Predvideni študijski rezultati:**

**Intended learning outcomes:**

<p>Znanja:</p> <p>Z1. Poglobljeno strokovno teoretično in praktično znanje na področju razvoja izdelkov, podprto s širšo teoretično in metodološko osnovo.</p> <p>Spretnosti:</p> <p>S1.1 Izvajanje kompleksnih operativno-strokovnih opravil pri razvojno-konstrukcijskem procesu in sistematičnega pristopa pri reševanju problemov.</p> <p>S1.2 Obvladovanje zahtevnih, kompleksnih delovnih procesov ob samostojni uporabi znanja v novih delovnih situacijah. Samostojen bo pri iskanju in vrednotenju pridobljenih informacij.</p> <p>S1.3 Diagnosticiranje in reševanje problemov v različnih delovnih okoljih konstruiranja.</p> <p>Sposobnost izbire ustreznih metod za posamezne faze razvoja izdelka in uporabe računalniško podprtih orodij pri predstavitvi rešitev in pri komunikaciji v skupini.</p>	<p>Knowledge:</p> <p>Z1. In-depth professional theoretical and practical knowledge in product development, supported by a broader theoretical and methodological basis.</p> <p>Skills:</p> <p>S1.1 Performing complex operational and professional tasks in the development-engineering design process and systematic approach to problem solving.</p> <p>S1.2 Mastering complex work processes while independently using knowledge in new work situations. He/she will be independent in finding and evaluating the obtained information.</p> <p>S1.3 Diagnosing and solving problems in different work environments of engineering design.</p> <p>Ability to choose the appropriate methods for each stage of product development and use computer-aided tools to present solutions and in team communication.</p>
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**Metode poučevanja in učenja:**

**Learning and teaching methods:**

<p>P1 Avditorna predavanja z reševanjem izbranih - za področje značilnih - teoretičnih in praktično uporabnih primerov.</p> <p>P4 Laboratorijske vaje z namenskimi didaktičnimi pripomočki:</p>	<p>P1 Lectures by solving selected - typical - theoretical and practical examples.</p> <p>P4: Laboratory exercises with dedicated didactic aids:</p> <ul style="list-style-type: none"> <li>• computer workstations</li> </ul>
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<ul style="list-style-type: none"> <li>• računalniške delovne postaje</li> <li>• namenska programska oprema za vodenje razvoja izdelkov</li> <li>• namenska programska oprema za 3D modeliranje in simulacije</li> </ul> <p>P6 Interaktivna predavanja</p> <p>P8 Izdelava in predstavitev aplikativnih seminarskih nalog</p> <p>P9 Skupinsko delo (viharjenje možganov, projektno delo, uporaba specifičnih metod v skupini)</p>	<ul style="list-style-type: none"> <li>• dedicated software for managing product development</li> <li>• dedicated software for 3D modeling and simulations.</li> </ul> <p>P6 Interactive Lectures</p> <p>P8 Preparing and presentation of applied project tasks</p> <p>P9 Teamwork (structured discussion, brainstorming, project work, specific methods for teamwork)</p>
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### Načini ocenjevanja:

### Delež/ Weight

### Assessment:

- Teoretične vsebine (predavanja).	50,00 %	- Theoretical content (lectures).
- Samostojno delo na laboratorijskih vajah.	30,00 %	- Independent work in laboratory exercises.
- Projektna naloga.	20,00 %	- Project work.

### Ocenjevalna lestvica:

### Grading system:

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

#### Janez Benedičič:

1. DEMŠAR, Ivan, **BENEDIČIČ, Janez**. *Lahko predalčno kolo za povečanje oprijema in stabilnosti terenskih vozil : patent : SI25967 A, 2021-08-31*. Ljubljana: Urad Republike Slovenije za intelektualno lastnino, 2021 9 f., 5 f. pril., ilustr.  
<https://worldwide.espacenet.com/patent/search/family/077439481/publication/SI25967A?q=SI25967>, <http://www3.uil-sipo.si/PublicationServer/getpdf.jsp?cc=SI&pn=25967&ki=A&lg=sl>. [COBISS.SI-ID 77196803]
2. **BENEDIČIČ, Janez**, BERNIK, Rajko. Vpliv pretoka zraka na sušenje krme na sušilnih napravah. *Acta agriculturae Slovenica*. [Tiskana izd.]. 2019, letn. 114, št. 1, str. 5-11, ilustr. ISSN 1581-9175.  
<http://ojs.aas.bf.uni-lj.si/index.php/AAS/article/view/1214/343>,  
<http://www.dlib.si/details/URN:NBN:SI:doc-VJC1RXKJ>, DOI: 10.14720/aas.2019.114.1.1. [COBISS.SI-ID 9322105]
3. VUKAŠINOVIČ, Nikola, **BENEDIČIČ, Janez**, ŽAVBI, Roman. Evolution of communication skills in virtual product development process : experience from EGPR. V: HESSAMI, Ali. *Harnessing knowledge, innovation and competence in engineering of mission critical systems*. London: IntechOpen, 2020. Str. 1-20, ilustr. ISBN 978-1-78984-109-1, ISBN 978-1-78984-467-2.  
<https://www.intechopen.com/books/harnessing-knowledge-innovation-and-competence-in-engineering-of-mission-critical-systems/evolution-of->

[communication-skills-in-virtual-product-development-process-experience-from-egpr](https://repositorij.uni-lj.si/IzpisGradiva.php?id=117420), <https://repositorij.uni-lj.si/IzpisGradiva.php?id=117420>, DOI: [10.5772/intechopen.90059](https://doi.org/10.5772/intechopen.90059). [COBISS.SI-ID [21167363](https://doi.org/10.5772/intechopen.90059)]

4. **BENEDIČIČ, Janez**, KREK, Janez, LEBEN, Vilko, VELEZ VÖRÖS, Gusztav, BERAUS, Tadej, POTOČNIK, Simon, ŽAVBI, Roman. Development of an automatic marketplace using virtual collaboration. *Tehnički vjesnik : znanstveno-stručni časopis tehničkih fakulteta Sveučilišta u Osijeku*. ožu.-tra. 2015, god. 22, br. 2, str. 431-441, ilustr. ISSN 1330-3651. DOI: [10.17559/TV-20140904230909](https://doi.org/10.17559/TV-20140904230909). [COBISS.SI-ID [13981723](https://doi.org/10.17559/TV-20140904230909)]
5. TAVČAR, Jože, **BENEDIČIČ, Janez**, ŽAVBI, Roman. Knowledge management support in the engineering change process in small and medium-sized companies. *International journal of agile systems and management*. [Print ed.]. 2019, vol. 12, no. 4, str. 354 - 381, ilustr. ISSN 1741-9174. <https://www.inderscience.com/info/inarticle.php?artid=104587>, DOI: [10.1504/IJASM.2019.104587](https://doi.org/10.1504/IJASM.2019.104587). [COBISS.SI-ID [17025307](https://doi.org/10.1504/IJASM.2019.104587)]

### **Nikola Vukašinić:**

1. ŽAVBI, Roman, **VUKAŠINOVIĆ, Nikola**. A concept of academia-industry collaboration to facilitate the building of technical and professional competencies in new product development. *International journal of engineering education*. 2014, vol. 30, no. 6, str. 1562-1578, ilustr. ISSN 0949-149X. [COBISS.SI-ID [13757979](https://doi.org/10.13757979)], [JCR, SNIP, WoS]
2. **VUKAŠINOVIĆ, Nikola**, DUHOVNIK, Jože. *Aktivacijski ventil iz plastičnih mas z možnostjo ročne ali elektromagnetne aktivacije : SI 24183 (A), 2014-03-31*. Ljubljana: Urad Republike Slovenije za intelektualno lastnino, 2014. 6 f., 2 f. pril., ilustr. [COBISS.SI-ID [13405467](https://doi.org/10.13405467)] patentna družina: Številka prijave: P-201300253
3. **VUKAŠINOVIĆ, Nikola**, VASIĆ, Dušan, TAVČAR, Jože. Application of knowledge management system to injection mold design and manufacturing in small enterprises. V: MARJANOVIĆ, Dorian (ur.), et al. *Design 2018 : excellence in design : proceedings USB*. Zagreb: Faculty of Mechanical Engineering and Naval Architecture; Glasgow: Design Society, 2018. F. 1733-1744, ilustr. Proceedings of the ... International Design Conference. ISBN 978-953-7738-59-4. ISSN 1847-907 <https://doi.org/10.21278/idc.2018.0160>. [COBISS.SI-ID [16250651](https://doi.org/10.21278/idc.2018.0160)]
4. FAIN, Nuša, ŽAVBI, Roman, **VUKAŠINOVIĆ, Nikola**. The influence of product complexity on team performance within NPD. V: MARJANOVIĆ, Dorian (ur.), et al. *Design 2016: excellence in design*. Zagreb: Faculty of Mechanical Engineering and Naval Architecture; Glasgow: Design Society, 2016. Datoteka papers/367 (f. 2069-2080), ilustr. Proceedings of the ... International Design Conference. ISSN 1847-9073. [COBISS.SI-ID [14656283](https://doi.org/10.14656283)], [Scopus do 26. 11. 2021: št. citatov (TC): 2, čistih citatov (CI): 1, čistih citatov na avtorja (CIAu): 0,33]
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