1. Raziskovalna organizacija (*Research organisation)*:

Univerza v Ljubljani, *Fakulteta za strojništvo*

2. Ime in priimek mentorja (*Name and surname of a mentor*):

Prof. dr. Niko Herakovič

3. Področje znanosti iz šifranta ARRS (*Primary research field*):

2.10.02 Proizvodne tehnologije in sistemi – Izdelovalne tehnologije

4. Kontaktni e-naslov mentorja (*Contact of a mentor)*:

niko.herakovic@fs.uni-lj.si

5. Kratek opis programa usposabljanja (*Short description of the program)*:

Usposabljanje mladega raziskovalca bo potekalo v okviru raziskovalne tematike programske skupine P2-0248 Inovativni izdelovalni sistemi in procesi, ki zajema tudi raziskave konceptov Pametnih tovarn v okviru usmeritev evropske iniciative Industrija 4.0. Izdelovalni sistemi in procesi (ISP), ki vključujejo izdelovalna orodja, izdelovalne naprave, izdelovalne stroje, strežne in montažne sisteme ter procese kakor tudi tok materiala in informacij skozi celotni izdelovalni proces, so eni izmed ključnih členov v verigi vrednosti. Z metodo vnaprejšnje simulacije ISP z diskretnimi dogodki, kjer realni proizvodni proces preslikamo v računalniško okolje in postavimo "virtualno" tovarno, lahko občutno zmanjšamo motnje, ki se realno pojavljajo v proizvodnem procesu in zmanjšujejo skupno učinkovitost proizvodne opreme (OEE) do 80%, kar predstavlja približno 50% vrednosti proizvodnih stroškov. Pri tem je učinkovito uporabiti meta-hevristični pristop, ki lahko ponudi skoraj optimalno rešitev. Zato se na področju raziskav in razvoja inovativnih izdelovalnih sistemov in procesov v okviru programske skupine že več let osredotočamo na raziskave in razvoj digitalnih tovarn ter njihovega vpliva na povečanje učinkovitosti ISP. Pri tem za povečanje fleksibilnosti in samo-konfiguracije ISP poleg digitalne tovarne uporabljamo tudi druge pristope in metode kot so LEAN, AGILE in TQM. Da bi lahko dobili skoraj optimalne rezultate simulacije, želimo kot vhodne podatke uporabiti sprotne realne parametre proizvodnje in tako izvajati t.i. "on-line" simulacijo, ki bo omogočala samodejno optimizacijo ISP v realnem času. Pri tem bomo za prenos informacij uporabili distribuirane sisteme, brezžično komunikacijo in tehnologije Interneta stvari (IoT). V zvezi s prej navedenim so odprte številne raziskovalno-razvojne tematike, ki vključujejo raziskave in razvoj ustreznih algoritmov, ki bodo delovali hitreje od obstoječih, razvoj ustreznih programskih vmesnikov, ki bodo omogočili implementacijo obstoječih IoT tehnologij na posameznem ISP, razvoj algoritmov za določanje/omejevanje relevantnih podatkov na vhodu itd. Poleg omenjenega vključuje raziskovalno delo mladega raziskovalca tudi analizo ter optimizacijo ISP z uporabo empiričnih in numeričnih metod. Pričakovani rezultati so pomembni za nadaljnji razvoj ISP v okviru pametnih tovarn prihodnosti in s tem za povečanje globalne konkurenčnosti slovenskega gospodarstva. Mladi raziskovalec bo zato tudi vključen v intenzivno sodelovanje programske skupine z univerzo Chalmers na Švedskem, kakor tudi z japonskim podjetjem Yaskawa ter podjetjema BSH in Kolektor group.

The training and research work of young researcher will be a part of the research topics of the program-research group P2-0248 Innovative manufacturing systems and processes, which also include the research of concepts of Smart factories, which is in line with the European initiative Industry 4.0. The manufacturing systems and processes (MSP), which include manufacturing tools, devices, machines and assembly systems and processes as well as the flow of materials and information throughout the manufacturing process, are one of the key links in the value chain.

The method of pre-simulation of MSP with discrete events, where we map the real production process into a computer environment and set up a "virtual" factory, can significantly reduce disruptions, which realistically occur in the manufacturing process and reduce the overall efficiency of production equipment (OEE) to 80%, representing approximately 50% of the manufacturing cost. Herewith it is effective to use meta-heuristic approach, which can provide nearly optimal solution.

Therefore, we focus our research in the field of development of innovative MSP within the program group already for many years into the research and development of digital factories and their impact on increasing the efficiency of the MSP. In doing so, for the increase of flexibility and self-configuration of the MSP, in addition to the digital factory we also use other approaches and methods such as LEAN, AGILE and TQM. In order to be able to get almost optimal simulation results, we want to use as input data the current real production parameters and thus to implement the so-called "On-line" simulation, allowing the automatic optimization of the MSP in real time. For the transfer of data we will use distributed systems, wireless communication and the technology of the internet of things (IoT).

Related with the aforementioned topics, a number of research and development topics are relevant, including research and development of appropriate algorithms, which will run faster than the existing ones, research and development of relevant program interfaces which will enable the implementation of existing IoT technologies in a particular MSP, development of algorithms for determining/limiting the relevant data at the input etc. In addition to this, the research work of a young researcher includes also the analyses and optimization of MSP using empirical and numerical methods. Expected results are important for further development of the MSP in the context of smart factories of the future and for the increase of the global competitiveness of the Slovenian economy. The young researcher will therefore also be involved in the intensive collaboration of our program-research group with the Chalmers University in Sweden, as well as with the Japanese company Yaskawa and companies BSH and Kolektor group.