Modulbezeichnung (Kürzel)	**Engineering ICPS** (EICP)
Modulbezeichnung (eng.)	Engineering ICPS
Semester (Häufigkeit)	WPM (nach Bedarf)
ECTS-Punkte (Dauer)	5 (1 Semester)
Art	Wahlpflichtmodul
Sprache(n)	Englisch
Studentische Arbeitsbelastung	60 h Kontaktzeit + 90 h Selbststudium
Voraussetzungen (laut MPO)	
Empf. Voraussetzungen	
Verwendbarkeit	MII
Prüfungsform und -dauer	Klausur 1,5h oder mündliche Prüfung
Lehr- und Lernmethoden	Vorlesung, Seminar
Modulverantwortliche(r)	A. W. Colombo

Qualifikationsziele
ICPS are not merely networked embedded systems but software-intensive, distributed systems with the capability to evolve, to adapt in a structural and behavioral manner, to collaborate and to generate emergent behaviors not specified during the design phase. These new industrial infrastructures are complex System of Systems (SoS) that are empowering new sophisticated engineering, enterprise-wide monitoring, control and management approaches. To this end, supporting engineering tools also need to be networked and integrated. Students will understand the different phases of the ICPS Life Cycle, e.g. design through development, commissioning, deployment, operation and maintenance of the digitalized industrial environment and will be enabled to apply formal mathematical modelling techniques to analyse the behavior of these collaborating distributed systems.

Lehrinhalte
Applying the 5 Mayer principles and the standard IEC 62890, the students will learn, using examples and case studies from real industrial ICPS, the product and production system engineering life cycle with the value streams it contains. Life cycles in various dimensions that are of relevance to the engineering of ICPS will be studied, such as e.g.: (i) Product; (ii) Production Order; (iii) Factory: A factory also has a life cycle, it is financed, planned, constructed and recycled. A factory integrates production systems and machines from various manufacturers; and (iv) Machine: A machine is ordered, designed, commissioned, operated, serviced, converted and recycled. The students will learn how to deal with a consistent data model during the whole life cycle of an ICPS and how to combine value chain for types and instances of ICPS in a unique model. Engineering Methods, based on High-level Petri Nets Theory, Queue Theory, Process Algebra and Functional Analysis, for modelling, qualitative and quantitative analysis, validation and prototype implementation of ICPS will be learnt by applying them to real industrial ICPS case studies.

Literatur

- Jamshidi, M.: Systems of Systems Engineering. Principles and Applications. CRC Press, 2009.
- IEC CD 62890: IEC 62890: Life-cycle management for systems and products used in industrial-process measurement, control and automation.
- Towards a European Roadmap on Research and Innovation in Engineering and Management of Cyber-Physical Systems of Systems. Available: www.cpsos.eu.
- Fokkink, W.: Introduction to Process Algebra. Springer Verlag 2007.
- Adan, I., J. Resing: Queueing Systems. Eindhoven University of Technology, The Netherlands.
- Groote, J.F., M.R. Mousavi: Modeling and Analysis of Communicating Systems. MIT Press, 2015.

Lehrveranstaltungen

Dozenten/-innen	Titel der Lehrveranstaltung	SWS
A. W. Colombo	Life Cycle Engineering of ICPS	2
A. W. Colombo, G. J. Veltink	Mathematical Modelling of ICPS	2