A Computer Science Perspective on Digital Transformation in Production

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The Industrial Internet-of-Things (IIoT) promises significant improvements for the manufacturing industry by facilitating the integration of manufacturing systems by Digital Twins. However, ecological and economic demands also require a cross-domain linkage of multiple scientific perspectives from material sciences, engineering, operations, business, and ergonomics, as optimization opportunities can be derived from any of these perspectives. To extend the IIoT to a true *Internet of Production*, two concepts are required: first, a complex, interrelated network of Digital Shadows which combine domain-specific models with data-driven AI methods; and second, the integration of a large number of research labs, engineering, and production sites as a World Wide Lab which offers controlled exchange of selected, innovation-relevant data even across company boundaries. In this article, we define the underlying Computer Science challenges implied by these novel concepts in four layers: *Smart human interfaces* provide access to information that has been generated by *model-integrated AI*. Given the large variety of manufacturing data, new *data modeling* techniques should enable efficient management of Digital Shadows, which is supported by an *interconnected infrastructure*. Based on a detailed analysis of these challenges, we derive a systematized research roadmap to make the vision of the Internet of Production a reality.

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