KI-ENGINEERING – AI SYSTEMS ENGINEERING

The Karlsruhe Way

CC-KING
Competence Center
KI-Engineering

Definition and Goals of AI Systems Engineering

The term KI-Engineering originates from Germany and translates to AI Systems Engineering. It is defined as follows:

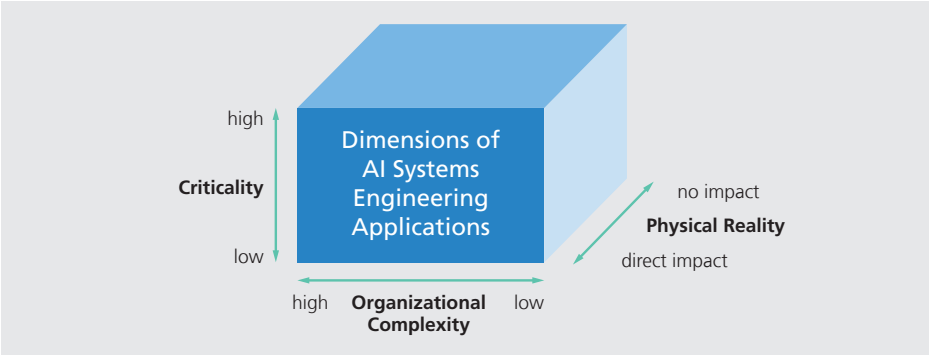
> AI Systems Engineering addresses the systematical development and operation of AI-based solutions as part of systems that master complex tasks.

The goals of AI Systems Engineering are to

- ***Enable* the use of AI** as part of a **principled and systematic engineering practice.**
- ***Develop* methods, tools and processes** to help in the development and operation of AI Systems Engineering solutions. This includes a **formal characterization of their performance** (not just purely empirical performance observations) that can be used already during the design phase.
- ***Establish* AI Systems Engineering as a discipline** that brings together computer science and data-driven analytics with systems engineering and traditional engineering disciplines.

Dimensions of AI Systems Engineering Applications

The following three dimensions show typical differences between applications that need AI Systems Engineering and "any other AI application". The methods, tools and processes of AI Systems Engineering can be located in (a range within) these dimensions as well. The impact of a single dimension is already enough to motivate the use AI Systems Engineering.



Criticality Dimension
Refers to the impact of a non-performing system on safety, business-critical functions, data protection, or other risks.
Impact for AI Systems Engineering: When the criticality is high, special measures and possibly an official certification are required to ensure correct performance of the entire system that the AI solution is a part of.
How to measure: Failure mode and effects analysis (FMEA), or in general (corporate) risk management.

Organizational Complexity Dimension
Refers to coordination overhead for the development and operation of an AI-based system. This could be due to a large, distributed and heterogeneous teams or due to the need for cross-organizational alignment.
Impact for AI Systems Engineering: AI development often relies on individual key developers akin to „cowboy coding". Large systems development in complex organizational settings needs more structured coordination. *How to measure:* Organization Theory defines metrics for the coordination effort of organizational structures.

Physical Reality Dimension
Refers to the application being grounded in the physical world with a direct relation to natural sciences (physics, chemistry, etc.) and traditional engineering disciplines (mechanical / electrical / industrial / civil engineering, etc.). This dimension is an indicator for criticality, but not all critical applications are close to the physical reality (for example an AI-based intrusion detection for cyber security).
Impact for AI Systems Engineering: The more immediate an AI is related to the physical reality, the more natural laws and phenomenological models can be integrated as prior knowledge. This requires new methods and tools. Furthermore, collaboration with traditional engineering disciplines often requires an adjustment to their practices (which are defined for good reason and possibly as a legal requirement).
How to measure: Are the theories of natural sciences applicable? Does the application require collaboration with traditional engineering disciplines?

The Competence Center KI-Engineering (CC-KING) systematically addresses the underlying research questions of AI Systems Engineering. Furthermore, it is practically applied in projects with industrial partners. Find out more at https://www.ki-engineering.eu.

Fraunhofer IOSB
FZI
KIT Karlsruher Institut für Technologie
Funded by
Baden-Württemberg
MINISTERIUM FÜR WIRTSCHAFT, ARBEIT UND WOHNUNGSBAU