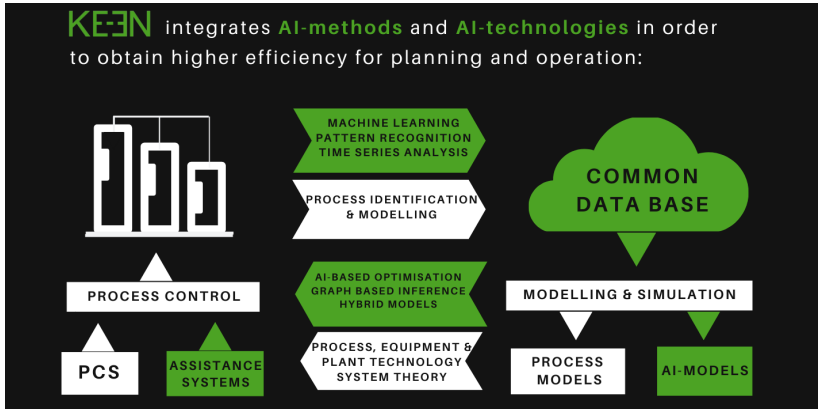
Innovation platform KE-3N

MAKING A DIFFERENCE

Artificial Intelligence Incubator Laboratory in the Process Industry

WINNER OF THE AI INNOVATION COMPETITION OF THE FEDERAL MINISTRY FOR ECONOMIC AFFAIRS AND ENERGY



The Project

The process industry, that includes i.e. the chemical and pharmaceutical industry, is Germany's third biggest industry sector. With its products, it is in multiple cases at the beginning of the value chain and thus provides the basis for innovations in many fields. The limited availability of resources, the reduction of emissions, and the demand for novel materials covering new social needs and challenges are pushing the continuous development of innovations. Ever shorter product life cycles together with the necessity to improve their sustainability aspects form a field of tension, which current plant planning and process control will not be able to withstand in the future. The extension and the complementation of established technologies by artificial intelligence methods opens up new possibilities to implement more flexible, environmentally friendly, and economic production plants in Germany.

KEEN connects 20 partners consisting of industrial companies and scientific institutions with the objective to introduce artificial intelligence (AI) technologies and methods in the process industry and to evaluate and implement their technical, economical, and social potential. The KEEN consortium investigates the implementation of AI methods in the process industry regarding the following three topics: (1) modelling of processes, product features and plants, (2) engineering of plants and processes, and (3) operation optimisation and the implementation of self-optimising plants. The approaches investigated within the KEEN platform address in particular the following central aspects of the usage of AI methods:

- Usage of previous knowledge in order to develop prognostic models with a small amount of data to avoid high costs for the implementation of experiments for data generation.
- Development of AI methods with transparent proposals for solutions and decisions in order to do justice to the operator responsibility and to guarantee the acceptance of the user.
- Realisation of human-AI cooperation in order to support engineers and plant operators and to relieve them from routine work; not least in order to master the demographic change.

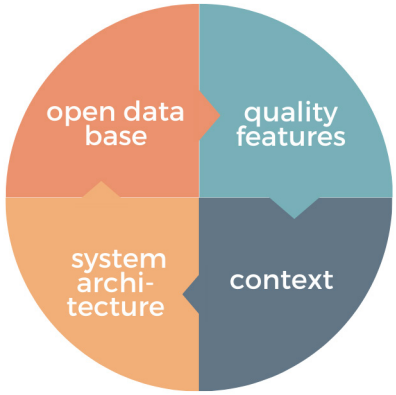
These contributions effectively strengthen the competitiveness of the German process industry. The KEEN project has the objective to improve substantially the efficiency of all engineering and production activities along the product life cycle via the implementation of AI methods. For the testing of the method real data from industrial processes will be provided. The newly developed AI methods will be tested in real working environments and production plants in order to prove the economic benefit, applicability, and reliability of the methods and technologies.

Subproject 1: Technology Roadmap and Business Model Development

By means of which strategies can the digitalisation and the usage of AI in the process industry be successfully implemented? A technology and research roadmap will answer this question, which will be written in subproject 1 on the basis of a detailed evaluation of the results of the technical subprojects. The implementation will be additionally supported by the disseminating of the project results in the relevant specialist communities and an efficient result transfer will.

In order to ensure the activities beyond the project duration, business models will be developed with the partners and presented in show-cases. The organisation of hackathons for students from relevant fields enables the integration of young scientists into the usage of AI methods.

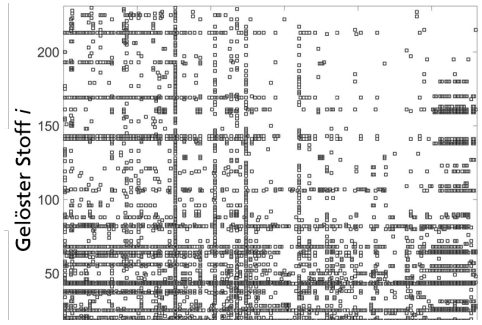
Subproject 2: Common data base



ZIH TU Dresden

A big effort for the implementation of AI methods lies in the appropriate data recording, data processing and data provision. The coordination and standardisation of the processing (system architecture) and the description (meta data) of the data represents a fundamental basis in order to significantly facilitate the transferability of AI solutions to other plants of the process industry. It is the objective of this subproject to provide the necessary basis for the application-specific subprojects. This includes the implementation and the operation of an open data basis, coordination, and standardisation regarding the quality features and its correlations, as well as the implementation of appropriate system architectures for the integration of this data basis into specific applications..

Subproject 3: Substance data

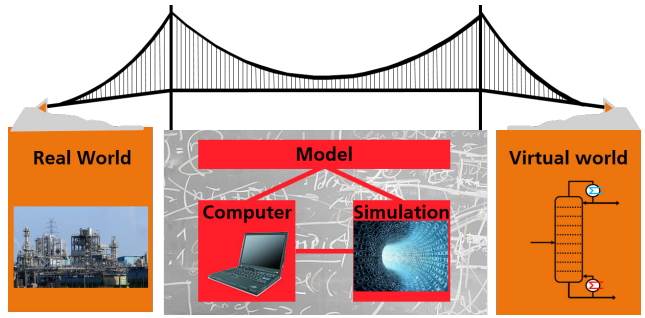


Michael Bortz, Fraunhofer ITWM

Recommender Systems are known from the daily life: e.g. movie platforms make suggestions on movies, which users might like, based on already watched movies. AI based solutions shall be developed by using these methods in order to describe the thermodynamics of substances. This is the foundation for the model-based optimisation of chemical production processes in order to, e.g., improve resource efficiency. AI offers methods which can make predictions on so far not examined substances from comparably few available data.

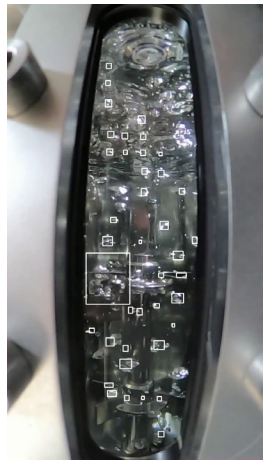
Subproject 4: Surrogate Models

From a mathematical point of view, simulations of chemical production processes involve the solving of large non-linear equations systems. The solution set – from the process view the possible operating window of a plant – is thereby a priori unknown, but hidden in the structure of the equation system. Here, AI methods shall be implemented in order to learn the solution set as a first step. It represents the operation window of the production process. With this knowledge, it will be possible to identify significantly better plant designs and operation strategies than previously done.



Michael Bortz, Fraunhofer ITWM

Subproject 5: The extraction of characteristics from process data

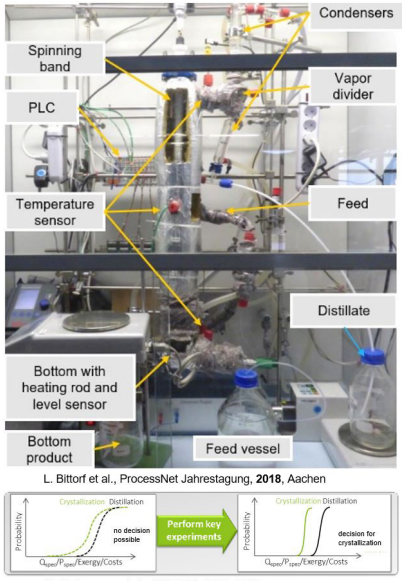


P2O-Lab und ZIH der TU Dresden

Besides the information apparent at a first glance, correlations can be extracted from process data, which can support the understanding of the behaviour of processes and plants. These relations can be identified via AI supported information retrieval from process conditions and product characteristics from measured data, i.e. time series and image data in laboratory and production. Thereby, uncertainties about the actual operation regime shall be reduced, interruptions or erroneous trends shall be early identified, and systematic deviations shall be automatically diagnosed and considered for the process control. This enhances the economic efficiency of chemical and biotechnical production processes by the optimal usage of secure operating windows, higher plant availability, and process and plant security.

Subprojekt 6: AI-based Smart Engineering

Even in the plant planning and project management, the use of AI methods promises a great advantage: Via numeric modelling and optimisation, complex planning processes can be supported and thereby accelerated. This includes the security engineering expecting a significant reduction of time and work effort via systematic hazard and risk analyses. For the development of the methods in this field, existing data from open literature and from sources of various project partners shall be used and analysed.



L. Bittorf et al., ProcessNet Jahrestagung, 2018, Aachen und M. Ostermann et al., CIT 88(9), 1223, 2016 TU Dresden

Subproject 7: Self-optimising plants

The implementation of AI methods for the optimisation of process plants shall significantly enhance the efficiency and profitability of chemical and biotechnical production processes. The learning of optimal operating points and operating strategies for complex plants, model-predictive control on the basis of machine learning, and an AI based consulting system for the support of the operating staff shall be examined and tested. The validation and demonstration of the methods will be executed on a pilot and a testing plant, i.e. by Merck, Evonik, and Air Liquide

Air Liquide Forschung und Entwicklung GmbH

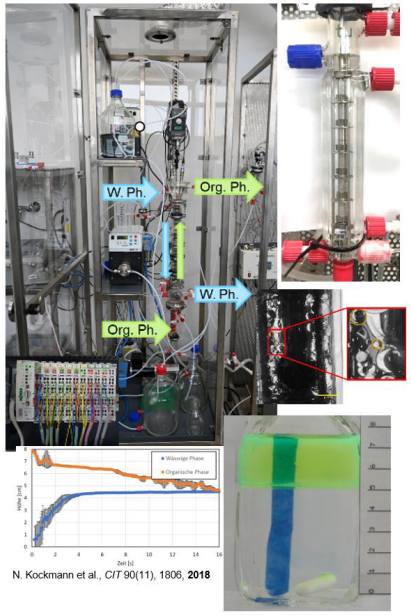
Incubator Lab TUD-P2O

The Process-to-Order-Lab (P2O-Lab) at TU Dresden raises the question which requirements innovative approaches of the industry 4.0 have to be met in order to transform actual challenges of the process industry into added value. In order to guarantee a continuous improvement process, concepts in the area of modular plants, integrated engineering, life cycle accompanying Digital Companion Technologies, Added -Value-Services, and Big data and Smart Analytics are developed, implemented, and validated, as well as represented in show-cases.

P2O-Lab der TU Dresden

Incubator Lab TUDO-AD

The research group Equipment Design develops and characterises modular laboratory and pilot equipment for the continuous chemical and pharmaceutical production. Besides small columns for extraction and distillation, the equipment for continuous crystallisation and microstructured reactors with integrated measuring and control techniques are developed. Simulations and X-ray measurements of multi-phase flows as well as bionic design of equipment elements complement the scientific profile. The experimental work is supported via modelling, optimised experimental design, AI-supported image evaluation, and advanced analysis techniques.



N. Kockmann et al., CIT 90(11), 1806, 2018

Incubator Lab ITWM

ITWM

The incubator lab at Kaiserslautern consists of the professorial chairs of thermodynamics and machine learning, both at TU Kaiserslautern, and of the department “Optimierung – Technische Prozesse” at the Fraunhofer-Institut für Techno- und Wirtschaftsmathema¬tik (ITWM). The professorial chairs bring along an international competence in the application domain of process engineering and expertise in AI/ML. The Fraunhofer ITWM has a long experience in the implementation of innovation in the form of software solutions, proven by numerous successful cooperation projects, both bilateral with industrial customers as well as in research collaboration.

Projektpartner

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Imprint

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