

Impact of Industry 4.0: The Concept, the Future of Work and Future Research

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The concept of *Industry 4.0* was born in an innovative project in Germany. The collaboration of experts in *Industry 4.0* was initiated by the President of the German National Academy of Science and Engineering, Henning Kagermann. It involved more than 300 experts over several months and led to an equally important successor project: industry 4.0 and the Smart Service World which foresaw the digital integration of manufacturing and service industries. Following the presentation of the alarming results in regard to competitiveness of the German industry, so called Wake-up Calls gave reason for concern. As a consequence, new research programmes were launched by the German government which covered several technological fields as well as educational and vocational issues and defined new framework conditions for German firms.

Interestingly, *Industry 4.0* was a joint effort of many experts working together in a *triple helix mode* (industry, science/ universities, unions and other). Goal of the initiative was to identify generic enablers and holes in the ecosystem of the new industrial landscape evolving. The experts tried to find solutions for different industries and to outline new business models. As an unintended outcome, the project addressed digitalization in industry and society in a way unheard before.

The extent of the concept *Industry 4.0* can be captured in terms of transformation and the 6th Kondratieff. It touches industry, science and academic research and sheds light on the way we will organize industrial production, science and research in our societies. The main message is: Disruptive innovations lie ahead of us and we are coming to an end of traditional production models. What does this mean? Technologies will dramatically change the organisational landscape, which is still on a level of organization 2.0 and lags behind technology 4.0. Clouds, Data Platforms, Artificial intelligence, big data analytics and applications as well as the merger of behavioural and social sciences in ICT will not only revolutionize the production of manufactured goods in cyber physical systems but will also change the international division of labour and the future of work in our societies. Hybrid Technologies will redefine our working and living space and affect the social fabric of societies. We will do things differently in terms of

man machine interaction, in new virtual collaborative styles and in automated and non-automated interaction schemes. Innovation, new research fields and governance models will become the success factor for implementing the concept.

For the research infrastructure the relationship with industry and society will become more important and Triple helix interaction in innovation clusters and platform design must be reinvented in terms of governance of innovation and better management. At the moment many research gaps are opening up: We see insufficient methodology and lack of methods in general to integrate social/ behavioural and (natural) sciences. We sense resistance for change and helplessness in regard to integration of informal networking, shared services, and trust-based interaction on the one hand side and formalized regulations, processes, standards and legal frameworks that provide security for action on the other side.

At the same time, there are no research designs to capture the impact science fiction phenomena like singularity or global IT governance in networking organizations. We still cannot link trusted zones and resilience of human centred ecosystems in smart cities and lack ideas how to design the system 3 mode for adaptive networks like innovation clusters and integrate humans in the loops. We must visualize and design these new models in such a way that citizens can participate in these developments. They are not only study objectives for behavioural pattern recognition, but rather a part of this future and their active engagement is crucial. There is empirical evidence that there will be no societal basis for these technologically triggered developments and for new research if professions and vocations are lagging behind the scientific development. The management of innovation and integration in big transformations is a topic that has been ignored by politicians and neglected by science for too long. However, it is not only a phenomenon to be studied but rather a responsibility that has to be taken on.