

The Positive Impact Factory: Transition from Eco-Efficiency to Eco-Effectiveness Strategies in Manufacturing

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How do engineers, specialized in manufacturing, deal with sustainability? If you investigate on sustainability and environmental impact, the main sources of negative environmental impacts and pollution derive, besides from agriculture, from four areas. One source is accommodation, which is also part of the reason for the second large source: cooling and heating systems. Mobility is yet another factor as transportation is significantly connected to environmental impact. Lastly, the fourth factor is the making of products. For the latter issue, we as manufacturing engineers are directly involved, as you can tell by the name of our institute, Institute of Machine Tools and Production Technology. Since this is a challenging area, it is up to us to find solutions for improvement. Naturally, technical and methodological solutions are something set in the future, so we are currently developing concepts for how factories of a more sustainable future should look like.

An advertisement for the city of Braunschweig aimed at citizens and companies says »Ten minutes to work, in five minutes at the lake.« It emphasizes

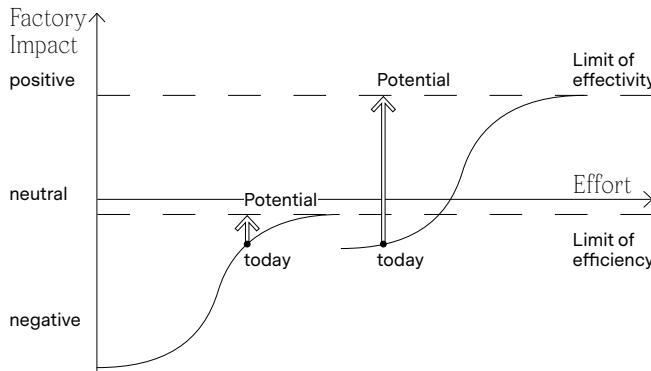
the importance of finding a work-life balance and the benefit of living close to work. This is more difficult to manage if you live in Braunschweig and work for example in the neighboring city of Wolfsburg. During rush hours commuting by car between Braunschweig and Wolfsburg takes about an hour for each journey. If you want to have a brief business lunch in Braunschweig, the time is far too short to talk reasonably and exchange ideas. Looking from a larger perspective, if for instance you have friends in the megacity of Delhi, the current commuting time is up to three hours for one way.¹ Even if you are able to sleep on the bus or train, this ultimately leaves you with roughly three hours of personal or family time a day, which does not exactly render Delhi attractive in this regard.

The common opinion of a factory is generally connoted negatively in contrast to my own positive one. We still mainly use finite fossil resources instead of renewable ones to generate energy, which leads factories to produce great amounts of waste, emission, noise, and also traffic, because they are built far off the city borders, occupying many acres of land. Thus, factories usually stay in the background behind fences, only appearing in the news when there is a major accident or some other negative event. Some jobs are monotonous and inflexible, and if not, employees can be substituted by robots, ultimately replacing jobs. Engineering has always been focusing on finding solutions for increasing efficiency, for example for a more efficient use of energy resources or labor. Coming to recognize the troubles of earlier innovations, engineers have been trying to reduce the above-mentioned negative impacts of factories for about three decades. However, as witnessed on other developments, this approach results in a function that can be described as an s-curve (S-curve). When aiming for efficiency, reducing factories' negative impacts can be achieved with a reasonable effort in the beginning. At a certain point though the required effort to reach an efficiency gain increases gradually until a disproportionately high investment is necessary without there being any noticeable progress. At this point, a limit of efficiency can be observed. This limit is mainly defined by the available technology. Therefore, an efficiency strategy for reducing the impacts of a factory can only result in

¹ IBM Commuter Pain Index

impacts that are less bad than the original state. Since our goal is not only to make things less bad, we have to find other strategies than only relying on efficiency.

[1] Technology S-Curve Concept according to Foster (1986)



The question we could ask ourselves is: Are there solutions that are not only less negative but rather positive? Today, you can find examples of engineers thinking about this challenge. It leads us to the vision of a Positive Impact Factory – a factory that not only reduces its negative impacts but also actively seeks the exchange with its environment to find new ways of creating a positive impact. And this is not only a vision with an altruistic goal for residents living next to a factory. At the same time, the strategy of aiming for greater effectiveness enables new opportunities for producing companies such as new business models. The Positive Impact Factory pursues a transition from eco-efficiency to eco-effectiveness strategies in manufacturing. In the following section, we take a closer look at some examples and selected fields of action.

Let's start with the topic of energy: In Germany, the Energiewende is frequently in discussion. Pursuing a strategy of efficiency regarding energy demand would mean to reduce the specific energy demand of a factory to lower the negative impacts connected to this (for example emissions from combusting

fossil fuels). A strategy of effectiveness on the other hand would mean to look for new ways to satisfy the energy demand of the factory, for instance with renewable energy sources and at the same time supplying the surrounding neighbors with energy generation on-site or waste heat as a positive impact. Successfully operating factories that create more energy than they consume already exist. A futuristic eco factory would emit filtered air, which is cleaner than the air outside the factory. This is already happening (inadvertently) in some densely populated areas, where living conditions have become extreme due to high population density and access to many private vehicles. In most cases at the moment, the positive impact of the air-filtering factory is not caused by a purposeful design of the factory. It is simply because the air outside is polluted that much. Nevertheless, this shows how factories are able to offer eco-services to their surroundings.

One of the key questions of the future will be how robots and humans in the context of automation will work together and how they could complement each other efficiently and risk-free. Typically, humans have to adopt to the factory. We commonly find shift work and defined tact times that are set by the machines. To make manual work less stressful we make efforts on spending money in ergonomic design of workplaces. Would it be possible to design a factory where workers could decide by themselves when to work, and having the factory adapt to them? This would require a completely different organization of current production systems. Taking this approach one step further, for example to a factory with fitness elements, the employees would come to their workplaces in the morning and by the end of the day, they would have completed a complete training session. Group meetings would be great for making little exercises; keeping people fit at the work-space and creating bonds between colleagues. These factories would still have human employees and be their workplaces, only designed differently as we know them today.

Urban integration is another key field of action. If we bring factories back to where people live, how can we organize the logistics and infrastructure

around it? There are many innovative concepts for private and public urban mobility out there today that will be able to solve this challenge in the future. For the transport of materials, one key concept is to integrate a factory into the urban material flows in a symbiotic way. This means that the factory and its production system are a part of these urban material flows, which can enable factories, for instance to recycle waste created by the inhabitants within the city to produce new products leading to local value creation. Urban integration also means considering the architecture of factory buildings and their appearance. A typical image of a factory building is not very appealing to the observer. If factories are designed to be a very attractive place also from the point of architecture, they can contribute to a higher quality of living in cities.

It remains a vision and at the same time a challenge for us to create building blocks for the Positive Impact Factory. The focus lies on two concepts: urban integration and modular design. As this is a very interdisciplinary concept, we have to learn to understand the languages of each other. In my experience, when discussing a factory related challenge, architects, civil engineers and mechanical engineers do not speak the same language. Moreover, when it comes to participation of the urban society, there are even larger mismatches in communication. This means that besides the technical competencies and those related to the specific expert fields, further skills are required for communication. As a result, the Positive Impact Factory concept incorporates a designated space for life-long, interactive learning.



