

# Is it sustainable to educate engineers? Reflections on the purpose of Engineering Education.

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## Keynote synopsis

Since the beginning of the industrial revolution at the end of the 18<sup>th</sup> century, engineers worldwide have contributed to improve the conditions for human life through, among other things, the development of automated production systems, transportation and communication infrastructure, and health and information technologies. For instance, the total global food production has increased with about 170 % during the past 70 years (FAO 2012). We can also easily accept the fact that the standard of living has increased several times over at least in industrialized countries and countries with emerging economies. This is largely due to effects from increased economic growth, which in many cases stems from products and services created by engineers.

On the other hand, engineers have also contributed to create more effective weapons that are estimated to have contributed to violent war deaths of 5.4 million people between 1955 and 2002 (Obermeyer, Murray & Gakidou, 2008). The industrial revolution has also given rise to a dramatic increase in greenhouse gas emissions, causing a 36% increase in atmospheric CO<sub>2</sub>-levels since the middle of the 18<sup>th</sup> century (IPCC 2007) and concerns about dramatic effects such as increased global average temperature, flooding of low island states, and higher occurrences of severe weather. Increased welfare comes with a price since many of the products and services that contribute to the increase in the present cause serious harm to the environment in the future. For instance, increased energy consumption today, with the current technology, leads to increased emissions of carbon dioxide, which will affect future generations detrimentally. New technology has even indirectly contributed to the spreading of serious health problems such as heart diseases, obesity and diabetes due to dietary changes (e.g. Trowell & Burkitt 1981) and less physical labor. Also, people in countries with high standards of living spend more and more time doing things that do not make them happy, such as commuting (Helliwell, Layard & Sachs 2012).

Considering these diverse effects of technological development on human life and natural ecosystems, we ask ourselves the following provoking questions: Is it sustainable to educate engineers? Can we consider engineering education as an activity that contributes to sustainable development (SD) when viewed from a holistic perspective? If engineers create products that benefit the present but cause distress for future generations, or products that benefit people in rich countries at the expense of those in low-income countries, could engineering practices still be called sustainable? Or, would the world become a better place if most prospective engineering students were trained in liberal arts instead?

These questions oversimplify the situation, but they inspire us to raise critical issues related to engineering education. They allow us to investigate and discuss what is considered to be the purpose of engineering education today, and what it may mean to be “Rethinking the Engineer” as the theme of this conference has called for. A historical outlook on the development of engineering education in the

context of industrial and societal development reveals that engineering education started out as “hands-on apprenticeship” (Seely 2005, p.115), serving the needs of local small-scale industries. With the beginning of the industrial revolution, engineering education became more science-oriented to live up to the industry’s need of engineers who were able to work in an environment of a dramatically increased pace of innovation. (Wankat 2002; Lohman 2008). Other driving factors for the development of engineering education have been military developments after World War II, and the space programs of the 1950s and 60s (Wankat 2002). Later, the demands on engineering education have become more diverse and complex. For example, design is today seen as an important corner stone, as is practical experience from working in the industry. Globalization and increased diversity present other challenges as an increasing number of diverse stakeholders are seeking to influence the content and structure of engineering education (Wankat 2002; Lohman 2008).

In the context of EESD, these challenges are aggravated since the concept of SD itself is highly ambiguous and contested (e.g. Connelly 2007; Kates, Parris & Leiserowitz 2005). From our teaching experience, we also conclude that engineering students who are enrolled in SD courses have very diverse opinions about the meaningfulness and appropriateness of such a course in the context of their curriculum. Hanning and Priem Abelsson (2010) have interviewed a number of CEOs on their opinions about the Swedish industry’s needs of competences in SD among engineering graduates. The participating CEOs stressed the importance of such competences for the industry, which suggests that the industry’s needs may be an appropriate guidance for designing EESD activities. After all, engineers serve society indirectly through their work in the industry. But do industry representatives necessarily have the same idea of what is needed in terms of competences for SD as do other stakeholders? What conceptions do students have? What do national goal statements and regulations prescribe? And what do engineering educators see as important?

All of these stakeholders have different interests in relation to EESD. In our keynote presentation, we will discuss with the plenum which of these interests are given precedence today in different contexts, and which ones we would like to give a stronger focus in the future. In this context, we also reflect on our own experiences as recent students in engineering nanotechnology and engineering physics, and why we have chosen to become engaged in engineering educational reform efforts and EESD research on engineering students’ use of multiple perspectives as they approach complex sustainability problems (Johanna), and the industry’s needs for sustainability related competences among engineering graduates (Andreas). We discuss engineers’ responsibilities for creating a just and sustainable society, and aim to inspire participants to create visions for the future of engineering education in general and their own work in particular.

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