

Engineering Education for a Sustainable, Just and Peaceful Society

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This text represents a presentation held at the TEK Sustainable Development Seminar, 19 November 2009, Helsinki. Notes and references have been added, and at a few places the text has been expanded somewhat as compared to the oral presentation.

Ladies and gentlemen, Mrs. chairman,

I am excited to be able to contribute to this seminar that has attracted so many participants, and I thank the Finnish Association of Graduate Engineers TEK for inviting me.

When it comes to the environment, there is a saying that engineers have caused all problems and that they will solve all problems. If the first statement is true, then it is only a small part of the truth. But will engineers be able to solve the problems? The answer is: it depends. It depends on the conditions under which engineers will be able to do their work. My talk will focus on the conditions under which engineers can hope to be successful in contributing to a sustainable, just and peaceful society.

There is little doubt that many engineers including members of TEK want to make a meaningful positive contribution to sustainability. This is witnessed not merely by the large attendance of today's seminar, but also by publications such as the *National Climate Plan for Finland* that was recently published by The Finnish Association of Graduate Engineers TEK and the Union of Professional Engineers in Finland UIL ry (TEK and UIL 2009), and reports such as *The future in our hands – A TEK approach to sustainable development*.¹

Then there is also the following:

*The mission of engineering education is to benefit people **and** the environment.*

This statement can be found, again, in a report that was prepared at TEK, as part of the Finnish National Strategy Project for the Engineering Education.² The report was based on a literature survey and interviews with key stakeholders of engineering education in Finland.

Finnish engineers are not alone. Countless engineers over the world assume that their ultimate mission is to contribute to human welfare. For many

¹ <http://www.tek.fi/index.php?1643> item NEW VERSION OF TEK SUSTAINABLE DEVELOPMENT DOCUMENT

² <http://www.tek.fi/index.php?id=3444>

engineers, this implies a paramount concern for public safety, sustainability and justice.³

I therefore assume that there is a broadly shared goal among engineers and engineering educators, namely to contribute to the accomplishment of a just, sustainable, and peaceful society.

What should engineering education do in order to empower its students for positive contributions to that goal?

This will be my question.

I will first say something about two different but related aspects of education. In the remainder of the presentation my aim is to draw your attention to the existence of knowledge that does not stem from the natural sciences but that is relevant for all engineers who want to contribute to a sustainable, just and peaceful society, and that should be transferred through engineering education. I will discuss elements of this knowledge in the form of a number of theses and I will illustrate the theses with examples. I will end with drawing conclusions for the engineering curricula.

1. Two aspects of education.

There are two different aspects of education. The first aspect is the transfer of relevant knowledge and skills. The second aspect is to instil motivation, commitment, and attitude in the students. Both aspects are always present, regardless of the nature of the subject of the teaching.

The second aspect, instilling motivation, commitment, and attitude, is certainly very important. If we focus on ethics or sustainability, then as a teacher you can only have a significant impact if your course and its teaching goals are embedded in the rest of the curriculum. That implies that the curriculum in its entirety should signal clear and consistent messages. It also helps if the university has formulated clear goals or mission statements regarding ethics and sustainability. But formulating mission statements is not enough. The activities at all levels should be consistent with the statements. Words should be consistent with behaviour, for otherwise there is no reason to take the words serious whatever those words may be.

So instilling motivation, commitment and attitude **is** important, and imposes requirements upon the curriculum and the university as a whole. Having said that, I will now turn to that other essential element of education, the transfer of appropriate knowledge and skills.

³ This can be inferred from numerous statements by both individual engineers and professional organisations, including numerous “oaths” and codes of conduct. For an extensive collection of codes of ethics, both for engineers and for other professionals, see <http://ethics.iit.edu/index1.php/Programs/Codes%20of%20Ethics> See also Colby and Sullivan (2008: 328 who identify “the overall mission of the [engineering] profession as contributing to human welfare”.

2. Necessary knowledge for engineers who want to contribute to sustainability.

One of the questions of this seminar was this: *What do the natural sciences have to give to sustainable development?* The answer is no doubt: very much. Technology depends on knowledge from the natural sciences and that remains true for sustainable technology.

In my contribution I want to ask your attention for certain other knowledge. This knowledge stems from branches of the social sciences and humanities. It is both very sound and very relevant for engineers who want to contribute to sustainability. No advanced mathematics is used in this knowledge, but part of it nevertheless has the character of mathematical truths. I want to give an impression of what this knowledge looks like, and I want to explain why it should be included in the engineering curricula.

3. Individual and collective problems and solutions.

It is helpful to introduce the distinction between individual and collective ethical problems and solutions.

When people think and talk about ethics in engineering and about courses on ethics in engineering, then very often the following idea is in their minds. As an engineer you will face ethical problems every now and then, and you will be required to take a decision. Hopefully, you will take the decision that is ethically right. In order to prepare you for that, there are courses on engineering ethics. There you learn to recognize and analyse ethical problems, to weigh the various conflicting values that are at stake, and finally to take the right decision.

Here, the focus is exclusively on ethical issues that are encountered by individual engineers, and that should somehow be solved by individual engineers. For that reason this approach to the teaching of ethics has been called the individualistic approach. This approach to ethical issues is very widespread, not merely in engineering education but also in science education.⁴ Unfortunately, this approach is incomplete.

For it is not true that all or even many of the ethical problems that individual engineers encounter could be solved in a satisfactory way at the individual level. Instead, many ethical problems require measures at collective level for their solution. In that sense, such problems are collective problems.

In order to solve such collective ethical problems, appropriate collective action and decision making is needed. For that to happen, people should be aware that the problems exist in the first place. And they should have the relevant

⁴ For engineering education, see Conlon and Zandvoort (2009) for substantiation. For science education, see Zandvoort (2008b).

knowledge that **is** available and that helps identifying collective solutions. To generate this awareness, and to transfer that knowledge, are tasks of education.

4. Prisoner's Dilemma problems and solutions.

One collective problem that gives rise to many ethical issues in engineering is the existence of Prisoner's Dilemma situations.⁵ Many or all environmental problems are Prisoner's Dilemma situations. Climate change caused by human emissions is most likely an example. Also, corporations that want to conduct their business in a socially responsible way find themselves in a Prisoner's Dilemma situation.

I will define a Prisoner's Dilemma situation as a situation in which two conditions hold:

- (a) Each would be better off, at least in the long run, if all would impose certain restrictions upon their behaviour.
- (b) Individual compliance with the restrictions results into a considerable disadvantage compared to non-compliers, whereas the negative overall effect of one or a few non-compliers is relatively small.

An example is whether to walk on the grass or on the paths in a public park. For each individual it may be attractive to walk on the grass. The footprints of a few individuals will not significantly affect the grass. But if every user of the park will do the same, the grass will be ruined, and all will be worse off, in their own judgement, than before.⁶

⁵ Prisoner's Dilemma situations have been studied in a specialized branch of the social sciences known as game theory. Game theory has been described as the mathematical analysis of strategic human interaction and it can be used to model situations where the decisions and actions of two or more actors jointly determine the outcomes. Introductions to game theory are provided by, among others, Luce and Raiffa (1957), McLean (1987, chapter 7), Morrow (1994), Thomas (1984). It should be remarked that many expositions on game theory do not explore situations in which (1) there is communication between "players" and (2) binding agreements between players can be made. These are exactly the conditions for which the notion, to be described in the text, of a (non-arbitrary) solution to a Prisoner's Dilemma problem applies. A source where the idea developed in the text can also be found is Mueller (2003, chapter 2) who proposes that a government is justified (and only justified) if it solves a prisoner's dilemma problem in the sense of "solving" described in the text.

⁶ A widely quoted example of a prisoner's dilemma situation was baptised "the tragedy of the commons" by its author, professor of biology Garrett Hardin (1968). A community of farmers has common grazing land (= the commons) where every farmer is allowed to let his sheep graze. Each farmer wants to improve his personal standard of living and puts as many sheep as he can out to graze. Above a certain limit, for every extra sheep there will be less grass, therefore the yield per sheep lowers. Ultimately even the total yield will decrease: the grass disappears and the sheep die. Everyone would hence benefit from a 'grazing quota' or from dividing up the pasture. The problem is that agreements on that do not develop spontaneously. For each separate farmer it is disadvantageous to invest time in that or to limit himself on the number of sheep placed in the meadow when all the others are putting all their energy into expanding their flocks. The downfall of every farmer thus seems to be unavoidable.

In a Prisoner's Dilemma situation, it is attractive for an individual not to comply with restrictions, even while that individual is convinced of the desirability of the restrictions. It is thus possible and even probable that no one complies although all are convinced of the desirability.

But it is also clear that, if everyone would comply, all would be made better off according to their own judgement. The problem is that they cannot rely on it that all will comply. It is important to note that people's judgements are the expressions of what they value, and thus are determined by their value system.

The above means that if something indeed is a Prisoner's Dilemma problem, then a contractual agreement is possible between all players that binds them to behaviour (in the example: not to walk on the grass) that will make all better off, according to their own values, as compared to the situation without the contract. Because each evaluates the contract as an improvement according to his/her own values, such a contract represents a solution to the Prisoner's Dilemma problem in a non-arbitrary sense of the word "solution" that can be intersubjectively agreed upon.

To make such a contract credible and effective, an arbiter and sanctions for non-compliance are needed. So we need laws to solve Prisoner's Dilemma situations, and this is particularly true for Prisoner's Dilemma situations involving many persons. But the analysis reveals that it should be possible to find laws, including sanctions, that would be preferred by all to the situation without these laws and sanctions and that hence should be acceptable to all. In the example, the sanction that suggests itself is this: those who do walk on the grass will be required to repair or compensate for the damage done.

So the real problem that is posed by Prisoner's Dilemma situations is **not** that solutions do not exist, but rather that we apparently lack the effective means to enact the contracts or laws or treaties that would constitute those solutions. Based on my experiences with students at Delft University of Technology, I believe that people are generally not, or insufficiently, aware of this insight.

People sometimes fear that, in order to accomplish sustainability, draconic measures are required that must be forced upon citizens against their will. If sustainability is a Prisoner's Dilemma problem, then this fear may not be

Hardin's primary objective was to argue that people must cede their unlimited freedom to reproduce in order to prevent the degradation of the earth and its ability to support human existence. He also pointed out that: "In a reverse way, the tragedy of the commons reappears in problems of pollution. Here it is not a question of taking something out of the commons, but of putting something in--sewage, or chemical, radioactive, and heat wastes into water; noxious and dangerous fumes into the air, and distracting and unpleasant advertising signs into the line of sight." He argued that a mere appeal to conscience or responsibility is unlikely to solve any of the problems that have arisen and may yet arise in the use of a "commons": "When we use the word responsibility in the absence of substantial sanctions are we not trying to browbeat a free man in a commons into acting against his own interest? Responsibility is a verbal counterfeit for a substantial quid pro quo. It is an attempt to get something for nothing." Real solutions of problems related to the use of commons, Hardin pointed out, require "mutual coercion mutually agreed upon".

justified. Dictators that will force rules upon us that we don't agree with can be avoided. What **is** needed for solving Prisoner's Dilemma problems are adequately informed and educated citizens, as well as enlightened and inspiring leadership.

Actually, all laws could be considered in the light of the above analysis. Of any law you might require that, in order to be a justified law, it should be a solution to a Prisoner's Dilemma situation, hence should be acceptable to all who are subjected to it. There are many people who think that, actually, free acceptance is the only source for the ethically binding nature of laws. Examples of laws for which it may be true that they are accepted by all or almost all who are subjected to these laws are the laws that forbid stealing and that oblige people to keep their contractual agreements. There is broad agreement, among those who are subjected to these laws, that these laws are good, and in this agreement lies their ethical justification.⁷

5. Engineers and Prisoner's Dilemma problems.

In the beginning I said that many ethical problems that engineers may encounter in their work are caused by the existence of Prisoner's Dilemma problems requiring collective solutions. I now want to give an example.

Consider an engineer who has to choose between two different options to tackle a technological problem. Option A requires less material, or is more energy efficient, or is less toxic for the environment. Option B is cheaper. Option A might represent the Best Available Technology from the perspective of energy efficiency, following an example that was discussed earlier during this seminar. After reflection the engineer concludes: As it is my paramount obligation⁸ to take sustainability and the environment into account, I must select option A. But if the actual law does not require that option, and if the manager thinks that the additional costs will not be earned back on the market, then most likely the engineer will have to reconsider this choice.

You can say that both the engineer and her boss are involved in a complicated Prisoner's Dilemma situation for which no solution has been implemented: appropriate legislation in some form or another. It will become clear later on that this legislation need not per se involve detailed prescriptive regulation or devices such as taxes or subsidies imposed by governments. In many cases,

⁷ Those who consider free consent as the source for the ethically binding nature of laws include the "social contract" philosophers of the 17th and 18th centuries such as Locke, Rousseau and Kant, as well as many scientists who work in the Public Choice tradition. An example of the latter is Mueller, who states in chapter 2 of his (2003) that governments are justified if they are solutions for Prisoner's Dilemma situations, in the sense of "solution" described in the text. Hardin's proposed solution of commons-problems, "mutual coercion mutually agreed upon", can be interpreted in the same way.

⁸ Many codes of ethics for engineers contain clauses that require that engineers shall give priority to certain values. An example is the following well known clause, taken from the code of ethics of the American Society of Civil Engineers, which can be found on the website mentioned in note 3 above: "Engineers shall hold paramount the safety, health and welfare of the public in the performance of their professional duties."

stricter liability rules in the law could be an effective means to bring about at least partial solutions for the prisoner's dilemma situation that the engineer and her boss are involved in, as this may render the option that is more energy efficient or less harmful for the environment also the economically more attractive option.

There are many companies that aim at pro-active business policies with respect to the environment and sustainability. We have heard representatives of such companies on this very seminar. Such ambitions can lead to better products and production processes and therefore can be applauded. Yet it cannot be assumed that corporate codes and corporate social conduct alone can ever be strong enough to break the Prisoner's Dilemma situations that we are dealing with.

For also the customers and the shareholders are part of the Prisoner's Dilemma situation in which the engineer and her boss find themselves. A customer may very well be convinced that the production methods of company A, leading to a higher price, are better than those of its competitor B resulting into a lower price. Better according to his/her own values. Hence this customer is willing to pay that higher price. But without a guarantee that **all** will pay the higher price, it is very tempting to go for product B, as our analysis of a Prisoner's Dilemma situation makes clear. For the negative effect on the environment of one individual who buys a product that is environmentally less friendly is usually quite negligible, whereas that individual **does** feel the higher price of the alternative, especially if the others do not pay it. Something similar holds for the investment decisions shareholders.⁹

Therefore, we **must** address the underlying causes for these Prisoner's Dilemma situations: why they exist and persist at such a large scale, and why there is so little progress as to their resolution. For that, we must turn to a critical analysis of two of our core social institutions: the legal system, especially those parts that deal with responsibility and liability; and the procedures for taking collective (political) decisions, which are usually determined by (state) laws or constitutions.

How are Prisoner's Dilemma problems and their persistence related to specific elements in these social institutions? How (according to which criteria) can these institutions and how they function be assessed and evaluated? Which changes in these institutions would be improvements?

Engineers who want to contribute to a sustainable, just, and peaceful world must be prepared to face these questions regarding the legal system and the procedures for collective decision making. Inadequacies in these systems may

⁹ According to the *TEK/UIIL National climate plan for Finland* mentioned in note 1, 65 % of the engineers who are members of TEK or UIL and 56 % of the Finnish population as a whole are fully or partly in agreement with the statement "In order to help reduce the environmental harm and risks resulting from energy generation, I am prepared to personally accept a lower standard of living". Although these are in themselves quite significant results, the question that is suggested by the analysis in the text is whether the percentages would even have been higher if the statement had contained the qualification "on the condition that others do the same".

prevent engineers who want to contribute through technology to a sustainable and peaceful world from being successful.

There are some very basic insights available that are relevant for sound answers to these questions. Even though the insights are basic and intellectually not hard to comprehend, it cannot be expected that everyone automatically acquires them. That is why this knowledge should be transferred in formal education, including engineering education. Judging from my experiences with students, the analysis of Prisoner's Dilemma situations that I gave is an example of such an insight that is not automatically acquired. But there is much more. Something of that I will try to convey in the form of a number of theses.

6. Decision making, external costs and liability.

The first thesis I want to discuss is this:

Under a legal system characterised by limited and conditional liability, too many harm- and risk generating activities are being developed.

Limited liability means that above certain levels, harm for which there exists liability will nevertheless not be repaired or compensated. Examples are the limited liability of corporations¹⁰ and the existence of legal limits to liability that are not related to (and lower than) the actual possible harm.¹¹

Conditional liability implies that actors are exempted from liability if certain conditions apply. An example is the exclusion of liability for the so called risk of development in products liability and environmental liability law. If a product or substance proves defective in the sense that it creates harm for individuals or the environment, then the party that brought it to the market cannot be held liable if the flaw was not positively known given the state of knowledge at that time.¹²

The thesis stated above can be given a precise and objective meaning, in such a way that the statement's truth can hardly be contested. To be very precise, it is impossible to claim that the statement is not true, as that would require

¹⁰ For a brief account of limited liability of corporations and its history as well as references to that history see Zandvoort (2000).

¹¹ Such limits are a normal phenomenon in modern Western law. Examples pertaining to large scale technological operations are the limits to liability of operators of nuclear facilities and oil tankers. See Zandvoort (2005).

¹² The European Directive on environmental liability (2004/35/CE) allows EC member states to exempt actors from liability for damage caused by an activity or an emission which was expressly authorised (Art. 8.4(a)), or which "was not considered likely to cause environmental damage according to the state of scientific and technical knowledge at the time when the emission was released or the activity took place" (Art. 8.4(b)) (EUI 2006, p. 86). The European Directive on product liability (85/374/EEC) likewise exempts producers from liability if the state of scientific and technical knowledge at the time when the product was put into circulation was not such as to enable the existence of the defect to be discovered (article 7(e)).

certain factual assumptions that have no sound basis, as well as certain ethical assumptions that very few people will want to defend.

Consider a decision maker who is considering whether or not to undertake an activity that he expects to generate certain benefits but that will also impose harm or risks upon others. The decision maker will weigh the expected benefits from the activity against its expected costs, and if he considers the balance favourable he will undertake the activity.

But this decision maker need and will only take into account the benefits and costs that will fall upon him, or upon those in whose service he stands. Hence, if liability is at best limited and conditional, then at best only part of the costs represented by harm and risks for others will be taken into account by the decision maker. If it is assumed that any activity should be socially beneficial, or at least should not be socially harmful, then it follows that, under a legal system characterised by limited and conditional liability, more harm and risk generating activities are being undertaken than can be justified.

It can be seen that the only assumptions that must be satisfied in order for the thesis to be true are these: (1) The decision maker will try to optimise his net expected benefits.¹³ (2) No activity is allowed that is socially harmful.¹⁴

The actual legal systems are largely based on conditional and limited liability. For many technological activities that generate risks and/or harm for others, liability is even completely lacking. If our goal is a sustainable society, then it is a priority to make the liability laws less conditional and less limited.

Given the potential for physical harm to humans and the environment that is inherent in much of contemporary technological activities, the thesis discussed above is very relevant for (the ethics of) technology and engineering.¹⁵ But the relevance of the thesis is not limited to this. Thus, the recent banking crisis appears to be a demonstration of the thesis.

¹³ There is a mathematically precise theory available on decision making under uncertainty. It was formulated independently by Von Neumann and Savage during the middle of the 20th century. Good sources for this theory, which is sometimes called utility theory, include French (1986), Lindley (1971) and Raiffa (1968).

¹⁴ Economists call the risks and/or harm from an activity that fall upon others and that are not taken into account by a decision maker: negative external effect or external costs. Similarly, any positive effects for others that are not taken into account by the decision maker are called positive external effect or external benefits. An example of the latter is the pleasure that neighbours or passengers may draw from seeing a well kempt garden, whereas the owner's efforts to create and maintain the garden are merely motivated by his own desire to enjoy a well kempt garden. Assuming this terminology, a possibility to evade the conclusion in the text would be to assume that the positive external effects of the activity might outweigh negative external effects. As I do not know of any sound reason why this should be the case, I consider this assumption to be the result of wishful thinking and nothing more.

¹⁵ Someone who has pointed to the relationship between liability and the ethics of engineering and technology is Tribe (1972).

7. Majority rule and progress.

The second thesis I want to discuss is this:

Political majority decision making does not safeguard social progress.

This statement reflects a well known insight from the field of Public Choice.¹⁶ Again, its verification is straightforward, as the following example of an incinerator will show.

Consider a proposal to build an incinerator (to burn waste). Suppose that the expected benefits after subtracting the costs of building and operating the facility are 20 Euros/year for 10.000 people, hence 200.000 E/y. Suppose that for 100 people living nearby the expected costs (nuisance + health risks) amount to 5000 Euros/year, totalling 500.000 E/y.¹⁷

This project is not a Pareto improvement. A Pareto improvement is a change that makes at least one person better off, but no one worse off.¹⁸ Also, no compensation scheme is possible that would result into a Pareto improvement. The project can be said to represent social retrogression. It does not represent social progress under any non-arbitrary definition of that term. Nevertheless the proposal is adopted as 99 % of the voters benefit from it, hence are in favour.

¹⁶ Public choice is the science that studies the factual and normative properties of rules or procedures for collective decision making. An important source for results obtained in this field is Mueller 2003. The insight that only unanimity decision making is certain to lead to Pareto improvement hence progress was first formulated by the Swede Knut Wicksell (1851-1926) who in 1896 presented "a new principle of just taxation". Under Wicksell's view on just taxation, the government's legitimate role is to bring the citizens together under an arrangement (a tax law specifying both a tax and how it is spent) that benefits all or at least does not harm anyone (in their own judgement) and hence can and must be consented to by all. The arrangement should therefore specify: (1) which public good will be produced, in which amounts, and how the taxes will be distributed that must be needed to cover the costs of production; (2) how those who are subjected to the harms or nuisances that may be associated with the production or consumption of the public good will be compensated. For the example of the incinerator discussed in the text this implies that a scheme should be found that obtains the consent of all involved and that specifies both the compensation for those who experience a net loss, and the tax that is needed to cover the costs of construction and operation of the site as well as the compensation. It should be noted that unanimity decision making does not require a referendum on any topic. A representative body that takes decisions with unanimity is also a possibility, provided that the members really represent those who voted for them.

¹⁷ I assume, together with many economists including Wicksell and Pareto, that individual utilities cannot be objectively compared. That means that the (expected) costs and (expected) benefits mentioned in the example can only be based on the amounts that the individuals who are in favour of the facility are willing to pay for it, and on the amounts of compensation that those who have a net disadvantage require in order to be adequately compensated.

¹⁸ The concept was introduced into economics by the Italian engineer and economist Vilfredo Pareto (1848-1923).

8. Liability, sustainability and ethics.

It may already have become apparent that the issues of majority decision making and of liability can be considered in conjunction. The following recommendation makes this clearer:

As long as political decisions on technological activities are being taken with majority rule (hence not all those who experience the consequences have consented), the standard of legal liability for those activities should be unconditional (no defences such as “no fault”) and unlimited (no caps).¹⁹

The basis for this recommendation is that it is required in order to safeguard social progress, and that it is mandated by two ethical principles that are shared by many people. These ethical principles will be called here restricted liberty and reciprocity.

9. Restricted liberty and reciprocity.^{20 21}

The ethical principle of restricted liberty holds that *everyone is free to do what he/she pleases as long as he/she does not harm others*. An equivalent is the right to be safeguarded, sometimes also called the “no harm” principle: *Everyone has the right not to be affected by the consequences of another person's (avoidable) actions*.

It follows from this principle that, for all (avoidable) activities that may have consequences for others, the informed consent of those others is required.

The ethical principle of reciprocity is a necessary addition to restricted liberty: *He/she who violates a right of another may be reacted to in a reciprocal way. That means that somebody who infringes a right of another will him/herself lose that same right insofar as is necessary (and no more than that) in order to correct the original violation or to compensate for it and in order to, if necessary, prevent further infringement*.

Reciprocity and restricted liberty together imply liability for actions for which there was no consent: If an activity results into damage for others who had not consented to the activity, then the actors can be required to repair or (if repair is impossible) fully compensate for the damage.

¹⁹ Whereas majority rule is the predominant rule for taking collective (political) decisions at the level of nations, the decision making at international level has much more the character of consensus decision making. However, because of majority decision making at national level, unanimity decisions between governments do not imply unanimity among the represented citizens even if it would be assumed that elected politicians truly represent their voters.

²⁰ This section recapitulates formulations and results obtained by Van Velsen (2000; 2003).

²¹ This section was skipped in the oral presentation.

Van Velsen (2000, 2003) has shown that the two principles taken together are both necessary and sufficient for peaceful coexistence. Hence, there are good reasons for believing, as many people do, that the above two principles, or principles that are close to them, are good or desirable.

10. The impact of liability upon negotiations aimed at solving Prisoner's Dilemma problems.

In the discussion of Prisoner's Dilemma problems and solutions in Section 4, I have ignored the effect of liability or the absence of liability as the case may be. I will now correct that important omission.

Consider as an example the international negotiations on reduction of greenhouse gas emissions to mitigate climate change. These negotiations²², which **can** be considered as negotiations aimed at finding a solution for a Prisoner's Dilemma problem, are fundamentally affected by the nature of actual legal liability. If there would be clear and enforced principles in international law that hold emitters of greenhouse gases liable for negative effects, then this would drastically change the perspectives and interests of the negotiating parties. It would be an enormous stimulant for arriving at effective measures to mitigate climate change.²³

International law **does** contain principles that, while reflecting at the level of states the two ethical principles that were stated in Section 9, provide a basis for liability for the consequences of emitting greenhouse gases and other risk or harm generating activities. Unfortunately, these international law principles are often vague, and/or lack standing and enforcement.²⁴

²² Raiffa 2003 is a valuable source for empirical and theoretical insights into the topic of negotiation, including some of its ethical aspects. The book is based on an MBA course on Competitive Decision Making that the author gave for many years at the Harvard Business School.

²³ Liability for climate change has not yet received a great deal of attention in the media, but the topic is increasingly studied by serious legal scientists and specialists of risk management and insurance. Examples are Cullet (2007), Farber (2007), Faure and Nollkaemper (2007), Kunreuther and Michel-Kerjan (2007), Tol and Verheyen (2004). According to Faure and Nollkaemper (2007), climate change litigation—and more particularly, liability suits—may not be the panacea that will bring about a miraculous solution to the problems that the world faces as a result of global warming; however, “the threat of such litigation may have an important effect on the negotiations concerning further reductions of GHG emissions. Thus, exploring the possibilities of such international climate change litigation can be seen as a useful device for furthering the international process and negotiations aiming at the reduction of GHG emissions. (p 179)

²⁴ Tol and Verheyen (2004) summarise the situation in public international law (which regards states as opposed to individuals who are regulated by private law) as follows: “One of the basic rules of international law is that States shall not inflict damage on or violate the rights of other States. In environmental law, this rule is captured in the so-called “no harm principle” which in turn has its foundations in the principle of good neighbourliness between States formally equal under international law. Principle 2 of the 1992 Rio Declaration, which echoes Principle 21 of the 1972 Stockholm Declaration, reiterates this rule of customary international

Another example²⁵ of international negotiations that are affected by the lack of liability in (international) law are the negotiations on genetically modified organisms (GMO's) which led to the Cartagena Protocol on Biosafety (CPB). The protocol addresses transboundary movements of GMO's. It was adopted in 2000 and entered into force in 2003. While it is the first binding international legal instrument addressing some of the environmental and health impacts of modern biotechnology, it does **not** contain any provision on liability, as the negotiating parties did not succeed in reaching a consensus on a liability regime under the CPB. As a consequence, the CPB merely contains a clause stating that rules and procedures regarding liability and redress for damage resulting from transboundary movements of GMO's should be elaborated within four years after the Protocol's entry into force. (IELRC 2002; UNEP 2002, p 45 no 8) More than five years after the entering into force of the CPB, the goal of establishing a liability regime under the protocol has not been reached.²⁶

Like in the case of climate change, some of the parties have argued, unsuccessfully up till now, for legal liability for the activities under consideration.²⁷ From the perspective of someone who endorses the ethical principles stated in section 9, there is something very strange to the situation. For those principles require that if, regarding activities with potential for negative effects for others, no agreements have been made between acting and affected parties, then the default principle should be unconditional and unlimited liability for the consequences of those activities. Having to negotiate

law, outlawing transboundary environmental injury: "*States have, the sovereign right to exploit their own resources pursuant to their own environmental and developmental policies, and the responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of other States or of areas beyond the limits of national jurisdiction.*" (emphasis added). Although the exact boundaries and elements of this rule are heavily discussed in international law, the basic rule exists, as emphasised by the ICJ in its 1996 Advisory Opinion on the Legality of the Threat or Use of Nuclear Weapons' and, for example, in the 3rd Restatement of US Foreign Relations Law.' The no-harm rule also forms the basis of international environmental law, such as, *inter alia*, the 1992 UN Framework Convention on Climate Change (FCCC) and its 1997 Kyoto Protocol. This rule also contains an obligation to minimise risk, i.e. to prevent harm when it is foreseeable. This is of particular importance in the context of adaptation to climate change, and the question of who has to bear the costs of such measures. Moreover, in international law, states are responsible for violations of public international law and are obliged to compensate the indirectly or directly affected states for the damage caused. This rule forms the basis of the law of state responsibility, a body of law, which has recently been codified by the International Law Commission (ILC), a UN body entrusted with promoting the codification and development of international law. While the rules developed by the ILC do not automatically represent international law but have to be accepted (e.g. ratified) by States, they can serve as a useful tool to examine the conditions and consequences of state responsibility for climate change damage." [Notes and references omitted.]

²⁵ This example was skipped in the oral presentation.

²⁶ Thus, executive secretary of the Convention on Biological Diversity (CBD), mr Ahmed Djoghla, at the fifth anniversary of the entry into force of the protocol on 11 September 2008, could not point to any achievement regarding such a regime. See <https://www.cbd.int/doc/newsletters/bpn/bpn-03-04-high-en.pdf> (Accessed October 2008)

²⁷ See IATP (2004) for an expression of the claim that liability for transboundary GMO trade should be unconditional and unlimited, and that liability insurance should be mandatory for GMO traders.

for that principle, hence being forced to trade something else for it, appears unjust in the light of these principles. It resembles a situation in which a robbed person finds himself if he negotiates with the robber about the sum of money that he should pay the robber to get the stolen property back.²⁸

From the above examples and discussion it can once more be concluded that liability, and more specifically the lack of liability for activities that may harm others who have not given their informed consent, is a key to understanding and solving the fundamental issues of sustainability and peace that we are discussing here. We live in an expanding and globalising society, driven by innovative science and technology, where the activities of individuals are increasingly affecting increasingly many others. If such a society develops under a legal system characterised by limited, conditional or even completely absent legal liability, while the predominant procedure for taking collective decisions within nations is majority rule, then it cannot be expected to be a peaceful or sustainable society.

The choice for a common basic ethical and legal framework can itself be described as a Prisoner's dilemma problem. When placed in a completely detached and disinterested situation, people might opt for the ethical principles stated in Section 9, and hence for strict liability in law as the default liability rule, because each individually would consider the results, at least in the long run, better than would be the case under alternative ethical and legal principles. However, we cannot design society and its basic institutions from scratch. Instead, we must work from the actually existing situation, including the inherited legal and political systems and including the effects that these systems have had upon the world as it is now. But that does not mean that change is impossible. Legal and political systems are, like technology, the creations of human beings, and can at any time be changed by humans.

11. History of liability law.²⁹

Some people, including legally trained persons, say that the introduction of stricter forms of liability would be a deviation from historical norms. This is a mistaken belief. As the history of liability law reveals, the currently dominant principles of legal liability such as "fault" and limited liability are a relatively recent phenomenon. A fundamental transformation occurred during the 19th century, from principles of unconditional and full liability that had up till then dominated Western and Non-Western law, to limited and conditional forms of

²⁸ It should be noticed that even a consensus between states to abolish liability for a specified activity would not make the resulting situation acceptable from the perspective of the ethical principles of Section 9, as long as the votes cast by nations are based on majority decision making within those states.

²⁹ This section was skipped in the oral presentation.

liability. The transformation was motivated, at least in the USA, by the explicit desire of legislators and judges to stimulate the industrial revolution.³⁰

With hindsight, this legal transformation can be considered unfortunate in view of the environmental and sustainability problems that it has given rise to in the subsequent 150 or so years. For although in the 20th century certain steps have been taken back in the direction of more unconditional and full liability, this return to historical standards has up till now been only very partial and incomplete. As a consequence, enormous liability gaps occur in the present legal systems, with enormous impact on sustainability.

The history of legal liability thus shows that stricter liability would not embody a deviation from historical norms. As such, some knowledge of this history may help to motivate people to support or contribute to the changes of current liability law that are conditions for a sustainable and peaceful society.

12. Conclusions pertaining to engineering education.

More explanation can and should be provided on almost any of the topics that I have addressed. But that is impossible in the time span of one lecture. Rather, a fully fledged course would be required.

So let me conclude with summing up my conclusions, as far as these pertain to (engineering) education:

1. Students in engineering must be made aware of the existence of ethical problems at the collective level, and the existing relevant knowledge for analysing and solving those problems should be transferred.
2. Sources for this knowledge that have been invoked in this presentation include: the theory of decision making; public choice; critical analysis of law; history of law.
3. The individualistic approach to the teaching of ethics to engineers is incomplete and fails to transfer the knowledge of which examples have been given here. Existing courses that are based on this approach should be broadened, and/or other relevant courses should be introduced.

³⁰ Conditional and limited liability represented a “subsidy” for industry as it relieved industry from (part of) the burden of the external costs caused by its operations. The transformation has been described in much detail for the USA by Horwitz (1977, 1992). Despite important differences between the Western legal systems, the transformation described by Horwitz took place in all Western legal systems. For a sketch of this history as well as references to the primary sources including Horwitz see Zandvoort (2008a).

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