A Comparison of American & Dutch Engineering Students' Views on Safety & Sustainability for Ultra-lightweight Vehicles

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Motivation

- SUCCEED grant designed to pair international junior scholars for engineering ethics case development
- Case developed about a multidisciplinary design effort at the Delft University of Technology
  - Design of an ultra-lightweight vehicle
  - Focus on safety and sustainability
- Case given to University of Virginia and Delft University of Technology engineering students
- Case and responses to questions posted on onlineethics.org website

The onlineethics.org case

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en español
text version
main page

organizations
conferences

topics index
codes of ethics

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Ethical Issues in the Design of Ultra-Lightweight Vehicles

Introduction

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A multidisciplinary design team consisting of undergraduate and graduate students from Aerospace Engineering, Applied Earth Sciences, Industrial Design and Mechanical Engineering at the Delft University of Technology in the Netherlands is designing a lightweight, sustainable car. [1] Their goal is to design a family car with a maximum mass of 400 kg. Mass is an important factor in the fuel consumption of a car, a light car can be very energy efficient. The target mass is less than half of that of normal cars. (European family cars usually weigh about 1200 kg and the average American car weighs 1360 kg). Another requirement is that the car should be manufactured at affordable mass production costs. [2]

Safety & Sustainability Issues

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organizations
conferences

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Safety Issues in the Design of Ultra-Lightweight Vehicles

Ethical Issues in the Design of Ultra-Lightweight Vehicles

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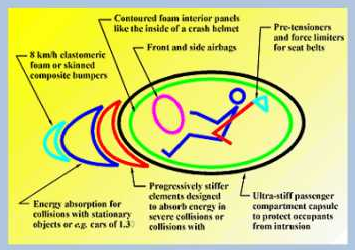
The goal of reducing the mass to 400kg has generated a debate over safety concerns when building a lightweight car. A car that is relatively light always has a disadvantage in collisions with larger cars in that it will always experience the greater acceleration. Traditional automobile safety considerations have resulted in designs of very heavy and stiff vehicles, protecting the driver and passengers in a collision but at the same time constituting a hazard for other road users in lighter vehicles because of their significantly reduced stiffness and mass. In addition, heavier vehicles are not as fuel efficient.



Recent developments in automobile safety have led to the increasing use of passive safety systems [1] such as airbags and active systems like Anti-lock Braki
conventional way means that safety systems are included as much as economically feasible. In a car of 400 kg or less it is very difficult to include extensive
necessitates a reconsideration of the ideas of what constitutes adequate car safety. Is it a car that performs well in crash tests, or is it a car that helps the dri

There is a theory within safety science that states that people have a target risk that guides their behavior, and this is called risk homeostasis. People will tr
and protected by her car will speed more. This could lead to accidents with higher speeds involved and therefore more injuries and damage. The same driver
more vulnerable. Therefore, there might be good arguments to build a car with less active and passive safety systems. The Delft student designers have chos
the driver feel a bit vulnerable. This choice is inspired by the lightweight criterion and the risk homeostasis theory.

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glossary

en español
text version
main page

organizations
conferences

topics index
codes of ethics

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Ethical Issues in the Design of Ultra-Lightweight Vehicles

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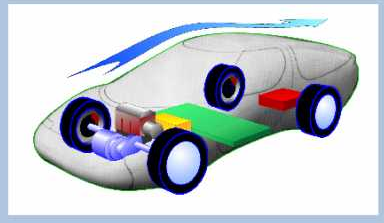
The World Commission on Environment and Development, the Brundtland-commission (WCED, 1987) proposed the following definition of sustainable development: Sustainable Development is a development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It contains within it two key concepts:

1. The concept of 'needs', in particular the essential needs of the world's poor, to which overriding priority should be given.

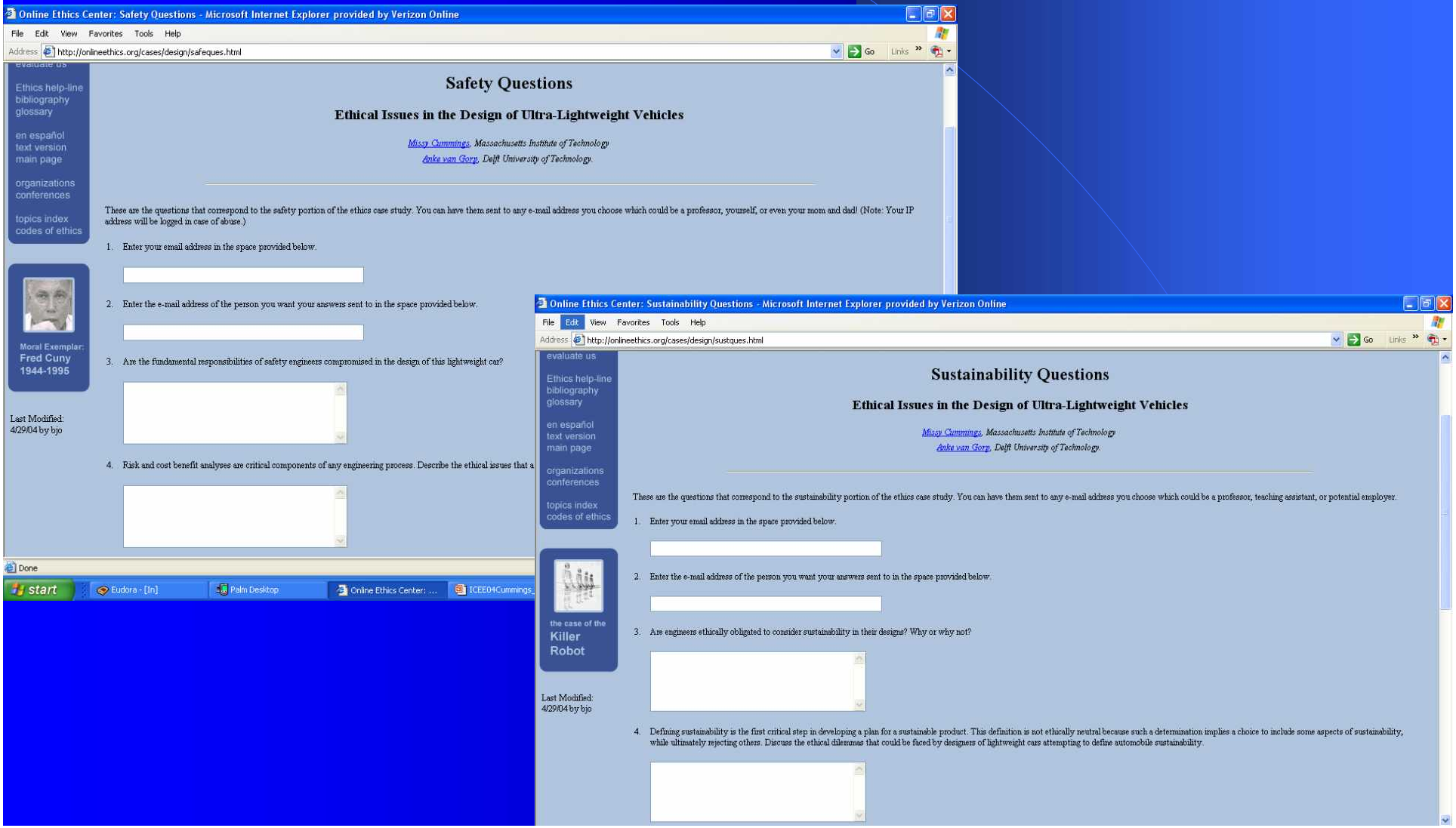
2. The idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present and future needs.



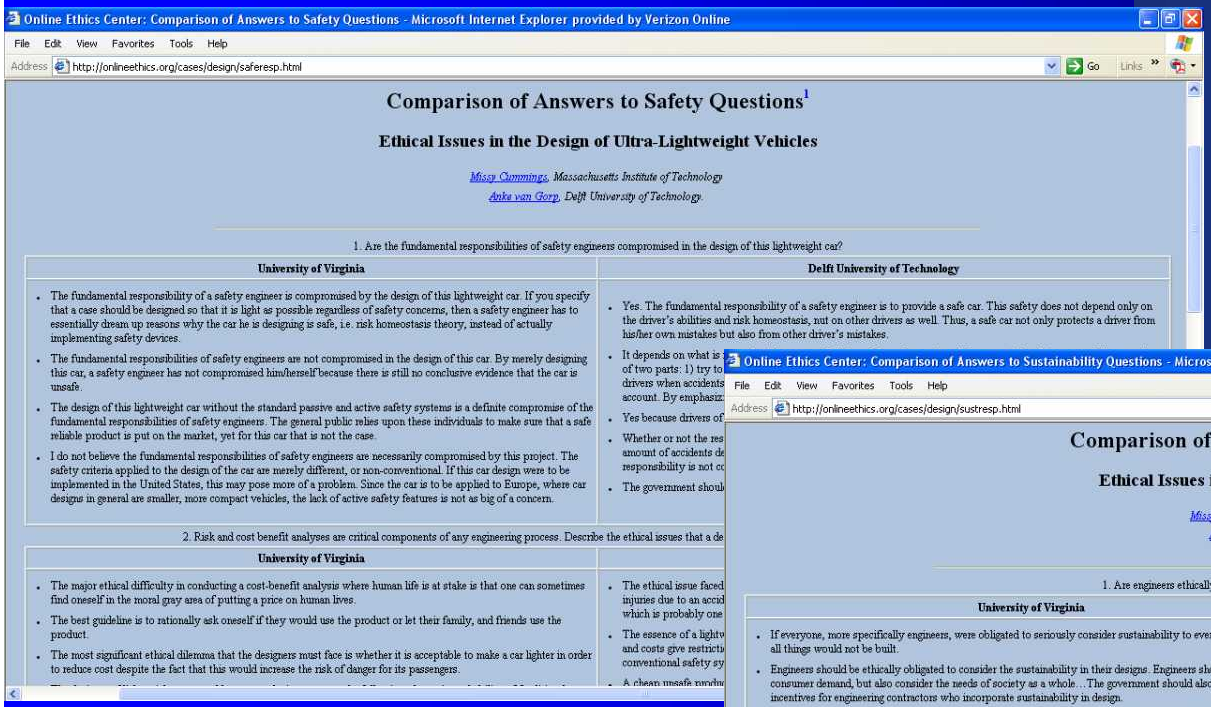
When following the Brundtland definition it is not clear what makes a car sustainable - should the car be recyclable, be lightweight, or should it not be built in the first place in order to be sustainable? Designers within the same design team interpret the term sustainability differently as can be seen in the answers given when asked what sustainability means. Some refer to the closing of the material cycle by recycling, others refer to energy and resource efficiency during production and use, and some focus on the energy consumption during the use phase (90% of the total life cycle energy is used during the use phase) of the car.

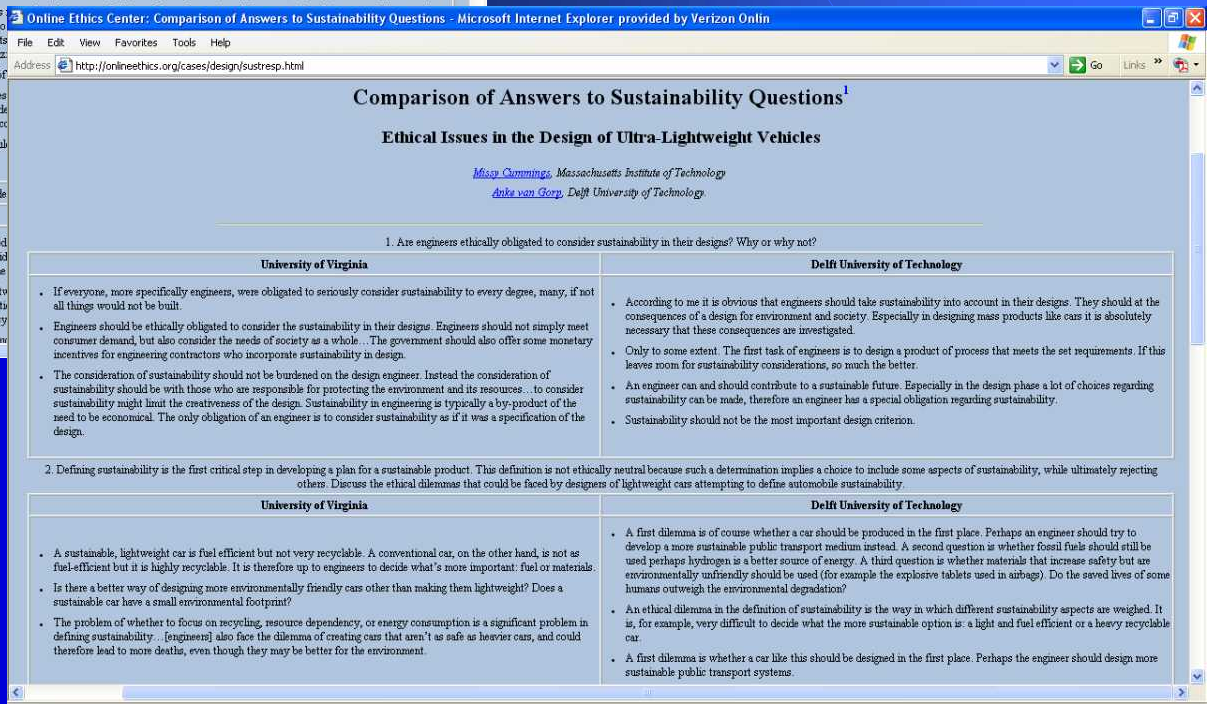
These different definitions are not always compatible. Lightweight materials are often difficult to recycle, but the energy consumption of a very light car is very low. European legislation requires that within ten years 95% [1] of the materials in cars should be recyclable. The design team does not want to comply with this percentage; they would rather build a very light "throw-away after use car" than a heavy steel car that can be recycled. Their

Safety & Sustainability Questions



Response Comparison





If the theory of risk homeostasis is correct, is it ethical to design cars for perceived levels of risk? Why or why not?

- DUT: It is ethical "when the consumer is informed that he/she [will] not only feel more vulnerable but is more vulnerable in an accident. [This is comparable to] driving motorcycles."
- UVA: "Assuming that the theory of homeostasis is correct, it is still unethical to design cars for perceived risk levels…the driver of a lightweight car would have no way of surviving, because his one and only defense was his perception, and he cannot perceive the negligence of others."

Are engineers ethically obligated to consider sustainability in their designs? Why or why not?

- DUT: “According to me it is obvious that engineers should take sustainability into account in their designs. They should look at the consequences of a design for environment and society. Especially in designing mass products like cars it is absolutely necessary that these consequences are investigated.”
- UVA: “The consideration of sustainability should not be burdened on the design engineer. Instead the consideration of sustainability should be with those who are responsible for protecting the environment and its resources…to consider sustainability might limit the creativeness of the design. Sustainability in engineering is typically a by-product of the need to be economical. The only obligation of an engineer is to consider sustainability as if it was a specification.”

In your opinion do you think sustainable cars are feasible? Why or why not?

- DUT: “It will be difficult to create sustainable cars because very different aspects need to be compared. I think, however, that the question is wrong. I think that it is impossible to find an ideal and perfect sustainable solution for cars, this does not mean that we should not try to attain such a solution. I think it is possible to improve existing cars with existing technology and this process should be repeated. The question is not sustainable or not sustainable, but to what extent a car is sustainable.”
- UVA: “In my opinion, the market for sustainable cars is very small relative to the market for big trucks and SUVs (sport utility vehicles). Sustainable cars are not feasible, especially in the United States. Generally the consumers’ attitudes towards cars are that bigger means better, stronger, and more durable. Sustainable cars do not have the market for mass production.”