Safety, Sustainability and Regulative Frameworks: Satisfying the Ethical Hurdles Posed by Radical Design Process of a Lightweight Automobile

Mahmudul Alam, Electrical Engineering Junior
Texas A&M University at Qatar, Doha, Qatar
mahmudul.alam@qatar.tamu.edu

Abstract

Engineers involved in an engineering design process often confront the challenge of making tough ethical decisions. If the design process is radical, the challenge gets tougher. Radical design process is a process where the specification of the product being designed is inconsistent with, or completely different from the 'operational principle' or 'normal configuration' [1] of the product's conventional design. A good example of radical design is the lightweight automobile. Reduction in weight raises questions regarding safety and sustainability and the challenge of how to trade off between the safety and sustainability, while radical design process raises the question of how to comply with the existing regulatory framework. To resolve these issues engineers will operationalize safety, sustainability and design specification, and irrespective of procedures followed for operationalization, engineers will have to address three important ethical issues: ethical responsibility of engineers regarding safety, the extent of sustainability to be considered, the conflict between regulative framework and radical design specification. This paper advocates the solution of these ethical issues regarding safety, scope of sustainability and conflict with existing regulation through free and informed consent, modified view of Aldo Lepold's non-anthropocentric theory, and revision of current regulation, respectively. Because of the involvement of radical design process, the paper calls for all the engineers to re-echo the moral trust that public placed on them.

Background

The principal concept embedded in the design process of a fuel efficient vehicle is the reduction of automobile weight. Among many technologies that have been either developed or modified to combat the increasing fuel price through increasing the automotive fuel efficiency, reduction in automobile weight has been proved to be the most effective. Typically the practice is to produce automobile whose weight is half of normal automobiles' average weight [2]. This dramatic reduction of weight categorizes the design process as radical, because this dramatic change makes it difficult to follow the existing regulative framework. Therefore, the radical design process including the reduction of weight gives rise to issues regarding safety, sustainability, and conflict with regulatory framework. As for the safety,

first, a lightweight car is inherently susceptible to higher acceleration in collision with a car heavier than it, which leaves the passengers of the lightweight car more vulnerable to death and injury in the face of accident. Also contributes to this vulnerability is the significantly weaker stiffness of the lightweight car, which is another consequence of weight reduction. Second, the weight reduction prevents engineers from installing active security systems like Anti-locking Braking System (ABS), night vision and Electronic Stability Program (ESP), and passive systems like air bags. As for the sustainability, the principal issue is conceptual, as debate goes on how to define sustainability [3]. The definition of sustainability, provided by the American Society of Civil Engineers (ASCE) specifies that activities must operate under the following two conditions to be called *sustainable*:

- Not jeopardizing the "capacity of natural systems to absorb the effects of human activities".
- Not "compromising the ability of future generations to meet their own needs and aspirations" [4].

Engineers who worked in 2004 DutchEVO Lightweight Automobile Design Project had interpreted a similar definition of sustainability from two different perspectives: energy consumption and recyclability [5]. Since a lightweight car is fuel-efficient, it will need less fuel and correspondingly consume less energy, and hence will emit less carbon-di-oxide compared to that emit by heavier vehicles. A lightweight vehicle therefore is sustainable as it neither "compromise future generations' ability" to fulfill their needs by consuming less non-renewable energy nor "damage the capacity of absorbing human effect of nature" because of its lesser contribution to the accumulation of green house gases in the atmosphere. From the perspective of recyclability, lightweight vehicle, however, is not compatible with the ASCE definition of sustainability. The materials used in the lightweight vehicles are non-recyclable. Increasing use of lightweight vehicle will increase the amount of non-recyclable material in the waste dumped into nature, which could cause potential land pollution. Hence considering the recyclability factor, the lightweight vehicle cannot be called sustainable.

Incorporation of both safety and sustainability is a challenge because each could be incorporated only at the expense of the other. The reduction of weight may make the automobile sustainable in terms of fuel efficiency and energy consumption, but the safety of the passengers will be reduced. Oppositely, heavier vehicle is safer, but less energy efficient, which means less sustainable.

As for the regulatory framework, the conflict arises because a radical design process is different from normal design process, which often requires engineers to come up with completely new specification. These new specifications will contradict with existing regulatory framework like governmental law because the existing laws were produced based on the crash tests performed by heavier vehicles. For example, the EU regulation requires that the materials used in

building automobile to be recyclable. European engineers building a lightweight automobile will hence find it hard to comply with the regulation as the reduction of weight needs the use of non-recyclable materials.

Because of the complex relationship existing among safety, sustainability and regulative framework, any attempt of operationalization of safety and sustainability and balancing between current regulative framework and radical design specification precipitates the need to address the following three ethical issues:

- Will engineers be ethically responsible if the final lightweight automobile is less safe than a heavier vehicle?
- To what extent engineers should consider sustainability in their design?
- How to reconcile between the radical design specifications with the existing regulatory framework?

Managing the Ethical Dilemmas

In the process of balancing between sustainability and safety, lightweight automobile engineers are essentially required to trade-off some safety, and this is usually done based on the theory of *homeostasis* [6]. The theory of homeostasis states that if an automobile is not accommodated with all kinds of active and passive security systems, the driver will remain more alert about accidental injuries and damage that could cause from over speeding and will drive more carefully. This extra alertness resulting from fewer security systems, according to the theory of homeostasis, promotes safe driving. Since the theory of homeostasis is not empirically verified yet, the application of this theory requires the engineers to make ensure the following conditions to prevent themselves from litigation or being held ethically responsible.

- The risk of fatality associated with driving a lightweight automobile is well below the accepted risk level defined by risk and safety experts.
- The public is not forced to take any involuntary risk.
- Free and informed consent [7] is ensured.

To confirm that the moral agency of the public is not hampered through the production and commercialization of lightweight automobiles, individual engineers, or engineering associations at large, should take all possible steps to obtain the free and informed consents from each and every buyer and would-be user of lightweight automobiles. In order to obtain meaningful and autonomous informed consent, engineers should communicate the risk to the public in such a way that the people acquire adequate information regarding associated risk and obtain no false or exaggerated impression.

In regards to the question of determining the extent to which sustainability should be considered, different possible options are open for engineers. One possible option is to follow the modified view of Aldo Lepold's non-anthropocentric ethics, stated as follows:

> "An action is right if it preserves and protects natural world, even it is not necessarily promote human welfare, but it is justifiable to take actions that harm the environment if the production of a human good is sufficiently great" [8].

According to this theory, it can be concluded that engineers should strive for attaining sustainability as long as it is not required for them to make lightweight automobiles that would surpass the boundary of accepted risk defined by risk experts. No doubt engineers have special ethical obligations to sustainability, but the scope of sustainability can't override the greater good of human being, and that is the danger of exposing them to too much risk.

As for the issue concerning the conflict between existing regulative framework and radical design specification, the scientists, technologists, safety and risk experts, legal personnel and government representatives should convene to review and modify the existing regulation. It is apparent that when the change in design is radical and too innovative, it is almost impossible to comply with the current regulation. Hence reconciliation and modification is the solution.

Conclusion

Any engineering design process is integrally related with engineering ethics. In the lightweight automobile design process, the key ethical issues are the safety, the scope of sustainability, and the inapplicability of the current regulative framework. The safety issue should be solved by acquiring free and informed consent to make sure that public takes no involuntary risk because of ignorance. The sustanibity issue could be addressed by modified view of Aldo Lepold's non-anthropocentric ethics, which restraints the scope of sustainability consideration below the level of accepted risk. It would be unethical to cross this boundary for the sake of increasing sustainability; hence engineers and technologist should research to come up with new ways of increasing sustainability without transgressing the limit. The inapplicability of the current regulative framework needs to be addressed through modification of existing regulations. Despite the modification, regulation will never be able to provide a complete ethical guide of radical design process, as voids will often be created because of radical design process' close correlation with and innovation and creativity. Ethical decisions made by engineers will fill these voids [9], which underscores that engineers need to re-echo their highest ethical commitment, "safety, health and welfare of the public".

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