

with a different normal configuration or operational principle. So while parts of a regulative framework often become inapplicable in radical design, other parts may still be applicable and relevant.

Another reason why existing regulative frameworks were not used in the radical design cases, especially in the lightweight car case, was that the engineers rejected, for moral reasons, parts of the framework in particular the EuroNCAP crash tests. These crash tests were considered morally inadequate because they stress the safety of people inside the car at the cost of sustainability and the fuel efficiency of a car. Note that in this kind of situation, the causal arrow can be reversed. Considering a regulative framework at the start of the design process can cause design engineers to reject parts of it and to develop a more radical design.

It is likely that the differences between how ethical issues are dealt with in normal and radical design holds beyond the four case studies presented here. Regulative frameworks exist for most products. The use of such frameworks can be required by law, or, if that is not the case, following the framework is often interpreted as compliance with the requirements of the law.¹⁰ This legal or semi-legal status of regulative frameworks is clearly a strong incentive to use such frameworks to make ethically relevant choices in design.

In radical design, however, regulative frameworks often become partly inapplicable. In our case studies we found one particular reason for this to happen: the use of another type of material. One might expect, that a design that is either based on a new operational principle or a new normal configuration, or both, will often cause parts of an existing regulative framework to become inapplicable. However, in general, the general goals of a regulative framework, like safety, will still be relevant in the case of radical design. Yet specific operationalizations or prescriptions designed to promote safety will often become inapplicable or contradictory. For example, designing an automatically guided vehicle using the existing regulative framework on traffic would lead to contradictions and strange situations. In the current regulative framework pertaining to traffic safety a vehicle should always have a driver but the goal of designing an automatically guided vehicle is to design a vehicle that can move safely without a driver.¹¹ One goal of the traffic safety regulative framework is to achieve safe vehicles and safe traffic flows and this higher level goal is still relevant for the design of automatically guided vehicles. So the rationale behind the regulative framework remains important but most of the legislation and standards contained in the traffic regulative framework will not be applicable in the case of an automatically guided vehicle.

If a design team or a customer rejects, parts of, a regulative framework because they think that the regulative framework leads to morally unacceptable products, this can lead to the rethinking of normal configurations and operational principles.

¹⁰The latter leaves open the possibility to meet the law by other means than following the regulative framework.

¹¹Because Dutch legislation requires vehicles in public space to have a driver, special social arrangements need to be made to carry out tests with automatically guided vehicles.

Some more detailed and prescriptive parts of regulative frameworks are formulated with certain operational principles and normal configurations in mind. If a design team thinks that these parts lead to morally unacceptable products, then they will rethink the normal configurations and operational principles as was done in the lightweight car case. Rejecting, parts of, regulative frameworks can lead to the design process becoming radical.

From the foregoing it can be concluded that even if a regulative framework is available to guide, parts of, a radical design process, it will be rejected or not be, completely, applicable. This would mean that, in general, a regulative framework cannot, or can only be partly, used in radical designs to help design engineers decide on ethical issues. Engineers in these circumstances will, in general, refer more to internal design team norms. If such norms do not exist, then norms will be developed during the design process. The design team members will use their field of education, design experience and personal experience to develop such internal design team norms.

We want to end our contribution by briefly sketching the moral relevance of our findings. Some engineers maintain that technology is morally neutral and that no ethical decisions are made during design. We have provided ample (empirical) evidence why this position is mistaken. Nevertheless, the distinction between normal and radical design is relevant for how moral considerations are taken into account during design. In normal design, moral considerations are embedded in the regulative frameworks that are used for making ethically relevant considerations. Such moral considerations are introduced during the formulation, and reformulation, of such regulative frameworks at the level of the engineering community and society. So even if individual design engineers are unaware of the moral issues in their design process, or are not inclined to take into account moral considerations, such considerations enter the design process through existing regulative frameworks. This mechanism is absent in the case of radical design. Therefore, whether and how moral considerations are taken into account depends to a large degree on the design engineers themselves. The moral responsibility of the design engineers for the products they design, as a result, becomes larger (cf. Van de Poel and Van Gorp, 2006). Sometimes, this might mean that relevant ethical issues are neglected, as with respect to traffic safety in the trailer case. Conversely, it might also lead to more attention for moral issues than found in normal design. In the lightweight car case, for example, the design engineers chose a radical design at least partly on moral grounds.

The distinction between normal and radical design is also relevant for the grounds on which the public can have morally warranted trust in the work of engineers and the resulting products (Van Gorp, 2005). Regulative frameworks are usually socially sanctioned; they are the result of recognized and socially legitimized processes of decision-making. Therefore, such frameworks can provide grounds for morally warranted trust in engineering and in technical products. In radical design, this basis for trust is lacking. This raises the question of what the trust placed in engineers by the rest of society can be based on in such situations. We will not try to answer this question in detail here, but we will mention one possibility: in such situations trust