



National Institute for Public Health
and the Environment
Ministry of Health, Welfare and Sport

Making Innovation Safe. By Design.

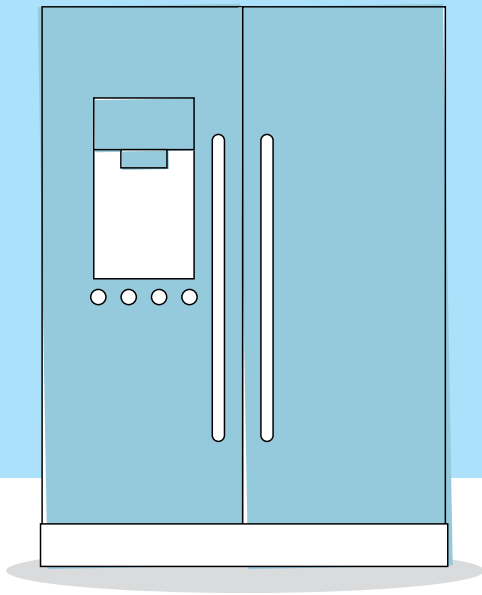
*Explore the challenge
behind Safe-by-Design*



Introduction

Here you will find exercises that will help you explore the challenge behind Safe-by-Design. The exercises help you understand and reflect on this challenge. We encourage you to adjust the exercises to your own project, class, or circumstances. You can select the exercises that fit your needs best. If you want to know more about the challenge behind Safe-by-Design, you can watch the animation or lecture.





Freon fridges' future

FOR  OR  |  30 MIN |  OR  |  ALL LEVELS

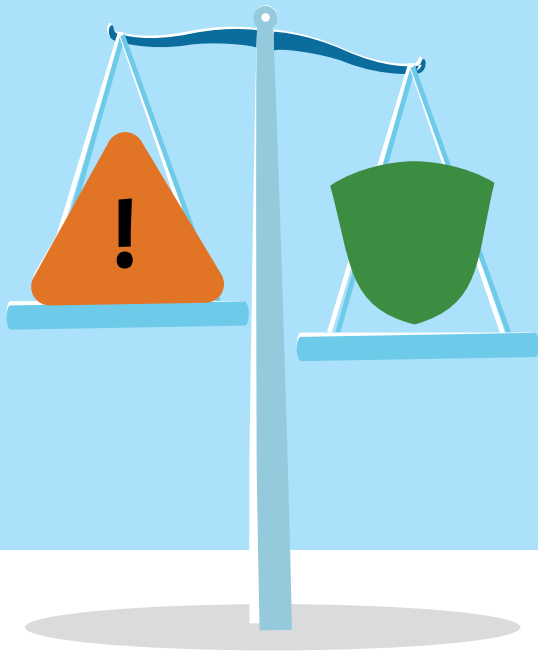
The animation *The underlying challenge illustrated* showed two ways research and innovation can affect the world. First, visualise the two ways research and innovation can affect the world by drawing a mind map with ‘freon fridge’ in the centre and branches representing the ways research and innovation can affect the world. At the end of the branches, write down as many examples for each type of impact as you can.

Then, looking at the mind map, answer or discuss the following:

- What lessons should researchers and innovators learn from the freon fridges example?
- What lessons do you personally draw regarding the types of impact for new research and innovation projects?

Include *why* these lessons are important to you in your answer.

Finally, how can you personally apply these lessons in your studies or work?



Safe enough?

FOR  |  30 MIN |  OR  |  ALL LEVELS

Nowadays, printing refers not only to documents but also objects. With a 3D printer you can print plastic objects from a file. 3D printers that can print food, metal, entire buildings and, in the future, functioning organs already exist or are being developed. Imagine you are working for a company that wants to start manufacturing and selling 3D printers.

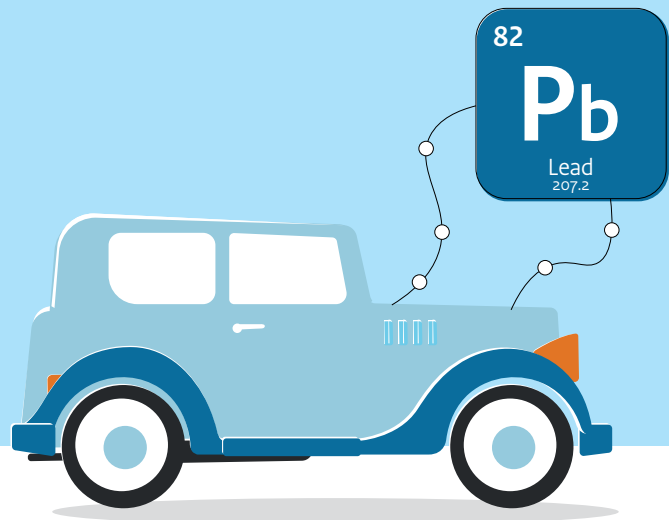
First, brainstorm for ten minutes about the potential negative impacts or harms related to the following steps of developing and selling of 3D printers and of consumers owning and using them. Write down as many potential negative impacts or harms as you can think of:

- Designing and developing the printer
- Manufacturing the printer
- Distributing of the printers to stores and consumers
- Using of the printer by consumers
- Recycling or disposing of the printer when the consumer discards it

Second, spend ten minutes to list as many questions as possible the company would need to answer to think that their 3D printer is safe and can be safely used by consumers.

Finally, brainstorm for ten minutes to explore how the list of potential negative impacts and safety questions can be used to inform the development of a safe 3D printer.

Long-lasting effects



FOR  OR  |  30-45 MIN |  OR  |  ALL LEVELS

A timeline can help you see and reflect on the impacts of an innovation. In this exercise, you will make a timeline for leaded gasoline. First, look up the years and periods of the following events and draw a timeline. (Tip: Start by reading all the points and periods so you know how to divide your timeline before you start marking.)

1. 'First car', for the year when (combustion engine driven) automobiles were first sold.
2. 'On the market', for the year Dr Midgley Jr invented leaded gasoline. Between the year cars were invented and the year Dr Midgley Jr invented leaded gasoline, write down which problem he intended to solve by writing 'problem: [your answer]'.
3. 'Replaced traditional gasoline', for the year leaded gasoline had fully replaced unleaded. Mark the period between its invention and replacement of unleaded fuels as 'roll out'.
4. 'First warning', for the year when negative impacts of leaded gasoline were first reported.
5. 'Consensus on harm', for when scientific consensus arose that the negative impacts of leaded gasoline outweigh the positive impacts.
6. 'Ban', for the year it was decided to ban leaded gasoline by the first country (Japan).

7. 'Off the market', for the year in which leaded gasoline for cars was globally no longer sold. Mark the period between 'ban' and 'off the market' as 'phase out'.
8. Leaded gasoline has impacts to this day. How long do you think it will take to deal with all the negative impacts of leaded fuel? When do you think the harms and negative effects of leaded gasoline will have been dealt with? Write down 'No more harms', for the year in which there will be no more harms or negative impacts from leaded gasoline.

Then, your timeline visualises the history of leaded gasoline. The positive and negative impacts of leaded gasoline will be interpreted differently by different people and in different years. Place yourself in the shoes of the following people and consider how you feel about leaded gasoline and write down your main thoughts or feelings:

- Dr Thomas Midgley Jr in the 1920s
- A car owner in the 1920s
- A scientist specialising in toxicology in the 1930s
- A family living next to a gas station in the 1960s
- A scientist specialising in toxicology in the 1970s
- An executive of a gasoline manufacturer in the 1980s
- A family living next to a gas station in the 2000s

Does placing yourself in their shoes influence how you feel about leaded gasoline? Why (not)?

Discussion

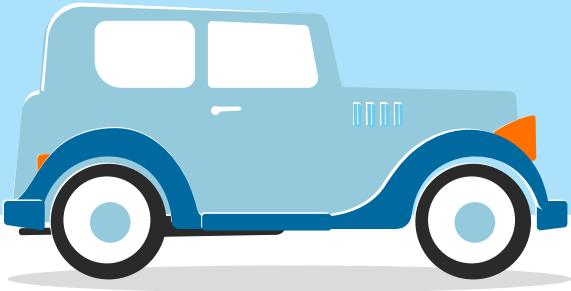


FOR  |  20-30 MIN |  OR  |  ALL LEVELS

In groups, discuss one of the following statements. If you find your group to be in agreement, appoint a (couple of) ‘devil’s advocates’ to bring up the arguments that outsiders to your group could use to challenge your group’s position.

- We should only develop new things if we know they are safe, both short and long-term.
- Companies should focus on innovation as well as economic competitiveness and the government should safeguard the safety of the products on the market.
- Safety and Safe-by-Design should be limited to known health hazards and exclude other sources of unsafety.
- It is not possible to create inherently safe products so Safe-by-Design is not possible either.
- Harms or negative impacts that will happen in the future are always and solely the concern and responsibility of people in the future.

Safe-by-Design and cost-benefit analysis



FOR  OR  |  20 MIN |  OR  |  ALL LEVELS

Before investing a lot of money in R&D, companies first develop a business case. If the business case is sound, a company can give the green light for the project. Must haves; nice to haves; constraints on time, budget, and other resources that are based on the business case all inform the requirements for the R&D process. Safe-by-Design may be included in the business case and development process of a product. Let's look at an example. Read the textboxes and then answer the corresponding questions.

Business case

In the late 1960s to early 1970s, Ford noticed the popularity of subcompact cars and wanted to have its own on the market. Ford gave its engineering team a design brief for a car that was to cost no more than \$2,000 to produce, weigh 2,000 pounds,ⁱ and would be on the market as fast as possible. Like any car, prototypes were submitted to tests, including crash tests. In 1971, the car was produced according to the design requirements and marketed for the retail price of \$2,062.ⁱⁱ Ford expected to sell more than ten million of these cars.

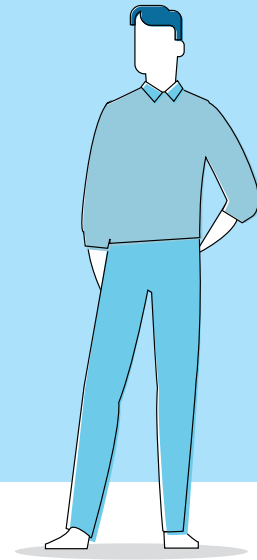
Read the textbox 'Business case'. Why do you think the business case is (not) sound?

Problem and solution

Already in crash testing, it became clear that rear-end collisions could set fire to the cars. Even at relatively low speed. Engineers identified the cause and came up with a solution. However, the solution would cost around \$11 per car plus an unknown amount to alter the production line.

Ford decided not to adopt the solution. One reason was that it would make the car more than \$2,000 to produce. The same issue plagued a light truck manufactured by Ford. Even without factoring in the alterations to the production line, for the 11 million cars and 1.5 million trucks Ford expected to sell the bill would be $(12,500,000 \times \$11 =) \$137,500,000$.ⁱⁱⁱ

Another reason for not adopting the solution was the following calculation. Ford estimated its car, even with the identified risk of fire, would not result in many fatalities. (The number of fatalities would be comparable to similar cars in similar circumstances.) Ford calculated that it was cheaper to pay (families of) victims the sum calculated by the National Highway Traffic Safety Administration for a fatality (at that time \$200,725^{iv}) or injury (\$67,000). An estimated 180 fatalities and another 180 injuries plus compensation for lost cars $(2,100 \times \$700)$ would approximately cost $((180 \times 200,000) + (180 \times 67,000) + (2,100 \times 700) =) \$49,500,000$.



Read the textbox ‘Problem and solution’. Does this information change your view on the business case? Identify any arguments or feelings that you have and consider them carefully: why do you think this way?

What would someone with the opposite view say and how would you rebut his or her view?

The aftermath

The car Ford produced was named the Pinto. The Pinto performed similarly to other subcompact cars with regards to safety^v and sold quite well. In 1977, the Pinto’s fire risk in rear-end collisions, Ford’s decision-making, and lawsuits regarding safety were discussed in an influential article in *Mother Jones*. It is not known how much the following controversy has cost Ford, but the company had to pay legal fees, court-ordered damages, the costs of a recall to eventually fix the problem, and has lost revenue – all the cars they had expected to, but did not sell – and its reputation suffered for years.

Read the textbox ‘The aftermath’. As said, companies need sound business cases. Safe-by-Design means trying to identify and address safety from the earliest stages onwards. In the Ford Pinto case – and many others^{vi} – there were early warnings about safety concerns that were not addressed. In your view, what is the role of Safe-by-Design in business cases?

ⁱ Dowie, M. (1977). ‘Pinto Madness’, *Mother Jones*, September/October issue; Strother, S. (2018). ‘When making money is more important than saving lives’, *Journal of International & Interdisciplinary Business Research*, vol 5, article 11.

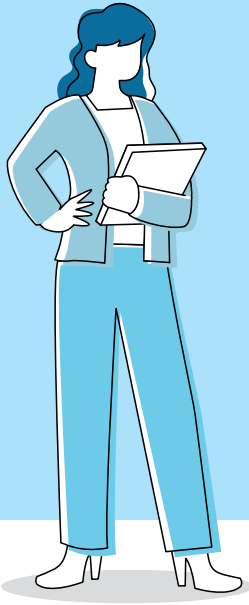
ⁱⁱ In reality, the different models of the Pinto were sold for different prices during the years they were on the market. The 1971 Pinto Runabout was priced at \$2,062 (Editors (nd). ‘1971-1980 Ford Pinto’, *How stuff works*).

ⁱⁱⁱ Dowie (1977); Strother (2018); Matteson & Metivier (2022). ‘Case: The Ford Pinto’, *Business Ethics*; Schwartz, G.T. (1991). ‘The myth of the Ford Pinto case’, *Rutgers Law Review*, vol 43, 1013-1068.

^{iv} Dowie (1977); Schwartz (1991).

^v Schwartz (1991).

^{vi} See the reports by the European Environment Agency *Late lessons from early warnings: lessons from the precautionary principle 1896-2000* (2001) and *Late lessons from early warnings: science, precaution, innovation* (2013).



SciFi your research part I: Setting the scene

FOR  OR  |  15 -30 MIN |  OR  |  ALL LEVELS

Chances are you have watched or read at least one of the following titles: Jurassic Park, Inferno, The Circle, Minority Report, Black Mirror, Gattaca, Wall-e, Brave New World, or The Matrix. What they have in common is that they explore *what the future world could be like* if research and innovation develop further and further. Science fiction is so captivating because it uses exaggeration and a great story line. SciFi also asks questions that are relevant for present day developments in research and innovation. This exercise is split into three parts that are connected to the three modules. This is the first part.

Science fiction includes both technological (what is the science and technology like) as well as social (how do people react) foresight. In science, foresight does not mean predicting the future. Rather, it is based on (studies of) science and technology, decision-making, and communication of both technological advances as well as decisions. Foresight leads to scenarios of the future that can be used in the present.

First, brainstorm to come up with an idea for a SciFi movie that is set a hundred years from now and is *based on the research or innovation (project or field) you are currently working on or studying*. (If you are not currently working on or studying research and innovation, pick a field or topic you previously worked on or are interested in.) How has the research and innovation progressed over the coming century?

A story premise is the basic idea of the story of a movie or book in one or two sentences. It should describe your main character, his or her goal, and the situation he or she faces. For example, the premise of Jurassic Park is that a team of researchers working on an island with de-extinct dinosaurs are, after the fences were sabotaged to steal dinosaur eggs, faced with the escape of the biggest predators that have ever lived. Will they get to safety? In Inferno, an attack draws semiotics professor Robert Langdon into the search for Bertrand Zobrist's genetically modified technology intended to halve the population of the earth. Will Langdon be able to decipher the clues left by Zobrist before his work is activated and spreads across the globe?

Second, outline a premise that includes your main character, his or her goal, and the situation he or she faces. Make sure that the science and technology is a part of your SciFi story premise.

Finally, which questions came up that would be useful to ask about your own, present-day research and innovation and its impact?



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