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Thomas Midgley Jr.: Apex Criminal

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Abstract: Some criminals are more dangerous than others. Although killers capture the public imagination, corporations and state leaders are more dangerous in practice. Yet the crimes of the powerful are rarely punished as severely as street crimes. When George Trepal poisoned his Florida neighbours with thallium, killing one victim, he was sentenced to death. However, when Thomas Midgley Jr. employed a known poison (lead) as a fuel additive to prevent engine knock, there was no criminal inquiry, even when 15 production line workers died during initial production. Midgley, despite being poisoned himself, misrepresented tetraethyl as benign, and consequently, an estimated 147 million people died. Midgley also solved the problem of safe refrigerants, developing Freon-12, the first chlorofluorocarbon. This substance degraded the ozone layer, resulting in another 6 million estimated deaths, also accelerating climate change. The 153 million who died from tetraethyl and Freon-12 were victims of crime: negligent homicide, manslaughter, or, it is argued, murder. Therefore, Midgley, a serial killer and mad scientist, is the most dangerous criminal who has ever lived. However, because he is an apex criminal, an offender whose crimes are so immense that they cease to be recognised as criminal, his name remains unknown to most criminologists.

Keywords: Thomas Midgley Jr., George Trepal, lead, Freon, mad scientist, serial killer, climate change

When a crime is sufficiently large, it ceases to be understood as a crime. As Rostand observed, "Kill one man, and you are a murderer. Kill millions of men, and you are a conqueror. Kill them all, and you are a god" (1962, p. 68). This phenomenon of scaled culpability might help to explain why white-collar crime is so often viewed as something other than crime (e.g., Sutherland, 1944), why corporate crime is

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seen as something other than crime (e.g., Passas, 2005), why state crime is seen as something other than crime (Rothe & Kauzlarich, 2016), and why environmental crimes are understood as something other than crime (e.g., Potter, 2010). But offences of the powerful *are* crimes (Pearce, 1976), and in terms of their financial consequences, injuries, and deaths, they are far more dangerous than all street crime, combined (Coleman, 2006).

This article briefly examines the criminal culpability of the scientist, Thomas Midgley Jr. During his own lifetime, Midgley was lionised as a "hero" (Kuper, 2022), but today he is characterised as a "one-man environmental disaster" (Pearce, 2017)—although, importantly, he is not remembered as a criminal. This article argues that Midgley should be viewed as *the greatest criminal in human history*—an apex criminal. In part one, the article begins by describing a capital case from Florida (involving the use of thallium to kill a neighbour), paying particular attention to jurisprudential issues of culpability. It notes that the murder of even one victim by poison can be punished by death. In part two, the article outlines Midgley's career with attention to two principal scientific contributions—tetraethyl lead and chlorofluorocarbons—and evaluates their public health and criminal justice consequences. It has been estimated that Midgley's inventions killed more than 100 million (Klaas, 2023). In part three, Midgley's criminal culpability is explored. Although Midgley did not intentionally kill, he deliberately misrepresented the risks associated with his inventions. In fact, Midgley exhibited several of the characteristics of a mad scientist (Tudor, 1989) and (arguably) satisfied the definition of serial killer (Oleson, 2013). In part four, the article suggests that the immensity of many environmental crimes can help to explain why these crimes are often understood as an unfortunate collateral consequence of business or—at most—a matter for tort law. Although the deliberate killing of one victim by poisoning justifies the imposition of the death penalty, the indirect killing of 150+ million does not. This has implications for the contemporary climate crisis.

The Crimes of George Trepal

In March 1991, George Trepal was sentenced to death for the first-degree murder of his Florida neighbour, Peggy Carr (Trepal v. State, 1993). Prosecutors demonstrated that Trepal had broken into the Carr home, removed bottles of Coca-Cola, opened the bottles and poisoned them with thallium nitrate (a highly toxic heavy metal);

recapped the bottles, replaced them, and then waited for his neighbours to die. The *Poisoner's Handbook* describes the horrors of thallium poisoning:

> Along with diamond dust, thallium is the most heinous of all poisons. It is completely odourless and tasteless, and fatal in the amount of one gram. The symptoms begin one to three days after ingestion. They include extreme pain, nausea, paresthesia in the extremities, hematemesis (bloody vomiting), bloody diarrhoea, loss of hair, convulsions, lethargy, cyanosis, tremors, ataxia, psychological depression, fever, *bleeding from the pores*, skin swelling, brain damage, and death. All this takes place over a period of six weeks. Beyond immediate emesis, there is no cure. (Hutchkinson, 1988, p. 40, italics in original).

All five of the seven members of the Carr family who drank the adulterated bottles of Coca-Cola were poisoned; three of them experienced acute severe neuropathy with respiratory depression, and one (Peggy Carr) died (Desenclos et al., 1992). After evaluating the evidence, the sentencing judge identified three aggravating factors in the case (one or more aggravating factors are required to impose the sentence of death):

- previously convicted of another capital felony or of a felony involving the use or threat of violence (Trepal was also convicted of six contemporaneous attempted first-degree murders);
- great risk of death to many persons (Trepal introduced adulterated Coca-Cola into the extended Carr household, which included several children); and
- committed in a cold, calculated, and premeditated manner (deliberately poisoning Coca-Cola bottles with thallium and recapping them) without any pretence of moral or legal justification.

These factors increased the culpability of Peggy Carr's murder, and on the basis of those aggravating factors, balanced against several mitigating factors, the jury sentenced George Trepal to death (by a vote of nine to three). This punishment was upheld by state and federal courts as proportionate to the crime and constitutional. The Florida Supreme Court affirmed Trepal's conviction and sentence in June 1993 (Trepal v. State, 1993), the U.S. Supreme Court declined to hear his appeal in 1994 (Trepal v. Florida, 1994), and for the last 32 years, despite numerous unsuccessful appeals on various grounds, Trepal has remained confined in one of Florida's death row cells (Death Penalty Information Center, 2025).

The Inventions of Thomas Midgley Jr.

There are at least three noteworthy similarities between George Trepal and Thomas Midgley Jr. First, both men were intelligent, hailed as geniuses. Trepal was a member of the high-IQ society, Mensa (Good & Goreck, 1995; Oleson, 2016), and has been described as a "self-styled genius" (Martinez, 1991); similarly, Midgley was an accomplished inventor, lauded in the pages of *Science* as one of America's "most creative men" (Kettering, 1944, p. 562) and named a "genius engineer, chemist and inventor" (Phillips, 2019). Second, both men were identified as chemists despite the fact that they had trained in other fields. Trepal graduated in 1972 with a degree in psychology and worked as a computer programmer, but was identified as a "sophisticated chemist" by the U.S. Court of Appeals for the 11th Circuit (Trepal v. Secretary, Florida Department of Corrections, 2012). This might be due to Trepal's abiding interest in chemistry or his prior criminal record for operating a clandestine methamphetamine lab. Midgley trained as a mechanical engineer, but he, too, made his name in chemistry. Third, and most importantly, like Trepal, Midgley poisoned people. In fact, as a consequence of Midgley's development of tetraethyl lead (TEL) as a fuel additive, five workers at the Standard Oil Plant in Bayway, New Jersey, died of lead poisoning during the first two months of the facility's operation, leading to its closure for safety concerns (Flavell-While, 2010). However, it was not just the Bayway Plant where there were problems. DuPont's Chambers Works, described as a "museum of disastrous chemistry" (Lerner, 2018), was known during the 1920s as "the House of Butterflies" due to the cases of TEL poisoning there:

> The first cases of tetraethyl lead intoxication known to medical science developed in September 1923, at the du Pont plant, and baffled famous neurologists who were consulted. One of the early symptoms is a hallucination of winged insects. The victim pauses, perhaps while at work or in a rational conversation, gazes intently at space, and snatches at something not there. (Bent, 1925).

Bent also notes that approximately 300 people (80% of those who worked in the House of Butterflies or entered it to make repairs) were seriously poisoned, some repeatedly, and that eight people died in the first 18 months of the plant's operations. Flavell-While concludes, "Between 1923 and 1925, 15 workers on the TEL production lines died due to lead poisoning. Dozens more suffered incurable neurological damage and mental illness" (2010).

Thus, Midgley's indirect poisoning of TEL workers caused far more injuries (300+) and deaths (15+) than Trepal's intentional poisoning of the Carr family (1 death and 4 additional poisonings). However, these numbers are dwarfed by some 153 million deaths attributable to two of Midgley's inventions: tetraethyl lead and chlorofluorocarbons. It is these myriad deaths that have prompted commentators to identify Midgley as "the most environmentally disastrous person of all time" (Phillips, 2019) and the man who "had more impact on the atmosphere than any other single organism in Earth's history" (McNeill, 2001, p. 111).

Midgley's full biography (c.f. Boyd, 1953; Kauffman, 1989; Kettering, 1953) is beyond the scope of this article, but three key points are relevant. First, Midgley developed tetraethyl lead as the leading gasoline additive to prevent engine knock (as well as developing a process to extract bromine from seawater, facilitating the application of TEL). This made a few stakeholders exceptionally wealthy, but caused the deaths of millions (Larsen & Sánchez-Triana, 2023). Second, Midgley invented chlorofluorocarbons, which increased the safety of refrigeration but damaged the planet's ozone layer, causing millions of additional deaths (Takle, 2002). Third, despite the horrific body count associated with his inventions, Midgley enjoyed wealth, status, and fame during his lifetime; the unintended—but predictable—consequences of his creations became apparent only after his death.

Tetraethyl Lead

In late 1921, while working for General Motors, Midgley alighted upon a solution to the problem of automotive engine knock. Early car motors would hiccup because of early ignition of fuel in the cylinders, preventing the use of efficient, higher-octane fuel. Midgley and his boss, Thomas Kettering, surmised the cause of the knock and sought an additive to correct the problem. Midgley identified at least 143 fuel additives (Pearce, 2017), "from melted butter and camphor to ethyl acetate and aluminium chloride" (Kitman, 2000). One especially promising possibility was ethyl alcohol (ethanol), which is economical and can be produced at scale. Midgley boasted, "Alcohol has tremendous advantages…[including] clean burning and freedom from any carbon deposit…[and] tremendously high compression…. Because of the possible high compression, the available horsepower is much greater" (in Kitman, 2000). Ethanol was great chemistry, but bad business: "The trouble was that ethanol was simply too easy and cheap to produce. And, crucially, it wasn't

patentable" (Phillips, 2019). Therefore, Midgley kept looking. He speculated that dyeing the fuel red would cause the gasoline to absorb more radiant heat and fully evaporate. This theory was far-fetched, yet because the only oil-soluble dye available at the time was iodine, it *did* stop the knock. However, Midgley soon realised that it was chemistry, not colour, that mattered. Armed with the periodic table, he worked from right to left and down, moving from iodine to tetraethyl lead— "Ethyl"—a powerful (and patentable) anti-knock additive.

But experts cautioned Midgley against using lead. The health risks of the element had been understood for nearly 3000 years. The Greek physician, Nicander, described the symptoms of lead poisoning, as lead was used widely in the ancient world. Indeed, recent research suggests the smelting of lead inhibited cognitive abilities, precipitating the collapse of the Roman Empire (McConnell et al., 2025). Laws were in place in the Middle Ages to restrict the introduction of lead into wine (Green, 1985). The symptoms of lead poisoning in London's industrial workers were described by Charles Dickens (1868).

Krause warned that organic lead is a "malicious and creeping poison" which – after a long latent period - leads to "a slow weakening and enfeebling of the whole body, … ultimately result[ing] in death" (Seyferth, 2003a, p. 2352). Clark warned that "on busy thoroughfares it is highly probable that the lead oxide dust will remain in the lower stratum" (Markowitz & Rosner, 2002, p. 18). And Henderson warned (presciently):

> [C]onditions will grow worse so gradually, and the development of lead poisoning will come on so insidiously (for this is the nature of the disease) that leaded gasoline will be in nearly universal use and large numbers of cars will have been sold that can run only on that fuel before the public and the Government awaken to the situation. (Kitman, 2000).

Midgley refuted the suggestion that tetraethyl lead might so accumulate. Although no experimental data had been collected on the question, Midgley predicted, "[T]he average street will probably be so free from lead that it will be impossible to detect it or its absorption" (Kitman, 2000). This, of course, was wrong: Patterson (1965) reported that human lead levels were 600 times higher than pre-industrial levels and that nearly all modern environments were contaminated by lead, well above normal levels.

The automobile and petroleum industry resisted challenge by trafficking in disinformation and doubt, employing the same strategies as cigarette producers

(Proctor, 2012) and global warming sceptics (Dunlap & McCright, 2015). Midgley, despite having been seriously poisoned by lead himself (Seyferth, 2003b, p. 5162), and despite publishing on the neurological problems associated with tetraethyl lead (Midgley, 1925), assured audiences that ethyl presented no risk to public safety: "After mixing tetraethyl lead with gasoline, no great precaution need be exercised … no health hazards actually exist unless the gasoline is used very abnormally for purposes for which it was not intended" (Midgley, 1925, p. 827). Having been named as the Vice President of the General Motors Chemical Corporation (Kitman, 2000; Robert, 1983), Midgley even made a show of pouring tetraethyl over his hands and inhaling its vapors, assuring the reporters who asked about the danger of skin contact that there was no risk, even if one washed in ethyl every day (Markowitz & Rosner, 2002, p. 27).

Tetraethyl lead was widely consumed between 1923 and 2021 (when leaded gasoline was finally banned for passenger cars in all countries). During the early 1970s, some 100,000 tons were dispersed into the atmosphere in the USA annually (Lean, 2018). This imposed profound public health burdens, including high blood pressure, cardiovascular disease, cognitive impairment, kidney problems, and fertility issues. Health problems have long been associated with high blood-lead concentrations (e.g., the 80 μg/dl "danger point" of the 1960s (Markowitz & Rosner, 2002, p. 111)). The Lancet's Global Burden of Disease study (GBD, 2016) estimated 500,000 annual premature deaths due to blood lead effects; the World Health Organisation (Prüss-Üstün et al., 2006) estimated 700,000 deaths. Other research has shown lead-based reduction of 824 million IQ points in the USA (Bellinger, 2012; Vahaba, 2022), and lead has been suggested as a causal variable for increases in crime rates (Nevin, 2016; Reyes, 2015; Zaalberg, 2019). Fraser (2025) suggests that lead might explain the rapid rise and fall of serial murder in the United States. Lead has also been traced to 151 million additional mental health disorders (McFarland, Reuben, & Hauer, 2024). More recent research has demonstrated that "[t]here is no known safe blood lead concentration" (World Health Organisation, 2024) and that even modest concentrations of lead produce illness, impairment, and death on a staggering scale.

For example, Landrigan (2018) described a body of research estimating 412,000 US deaths per year attributable to lead exposure—18% of all-cause mortality. He writes, "calculation that lead accounts for more than 400,000 deaths annually

in the USA represents a tenfold increase over the number of deaths currently ascribed to lead…. previous estimates have produced lower numbers because those analyses assumed that lead has no effect on mortality at amounts of lead in blood below 5 μg/dL and, thus, did not consider the effects of lower exposures" (e157). Matthews (2023) laments, "However bad you think lead poisoning is for the world, it's worse." The World Health Organisation (2024) estimates that "1.5 million deaths globally were attributed to lead exposure in 2021, primarily due to cardiovascular effects." Another recent study (Larsen & Sánchez-Triana, 2023) suggests that lead does even more damage: 5.5 million deaths globally per year (90% of them in low and middle-income countries), imposing annual costs of $6 trillion dollars. If this is correct, lead contamination is responsible for more deaths than car accidents. tuberculosis, malaria, HIV/AIDS, and suicide, *combined* (Matthew, 2023).

Chlorofluorocarbons

Midgley's development of tetraethyl lead shaped the course of history, but ethyl was not his only breakthrough. He also developed "an altogether new series of refrigerating gases, based upon the unpromising element, fluorine, which are at once nontoxic and noninflammable" (Kettering, 1944, p. 562).

Early refrigerants—including ammonia, chloromethane, propane, butane, and sulfur dioxide—were dangerous: both toxic and inflammable. Exposure could result in injury or death. Therefore, to expand its markets, General Motors' Frigidaire Division tasked Midgley with identifying a safer refrigerant (Leslie, 1980). Armed with his periodic table, Midgley identified a promising set of elements, finally settling upon Fluorine (nontoxic, noninflammable, and with a low boiling point). It took time to synthesise the compound: dichlorodifluoromethane (better known by its trade name, Freon-12), but the public was delighted when Midgley revealed the world's first CFC by breathing in Freon-12 and gently exhaling it to extinguish a candle flame (Leslie, 1980). For this pioneering work on CFCs, Midgley received the Society of Chemical Industry's 1937 Perkin Medal. The commercial applications included aerosol propellants as well as refrigerants. "By the early 1970s, CFCs were in widespread use, and worldwide production of the compounds had reached nearly one million tons per year, representing roughly a $500 million slice of the chemical industry" (American Chemical Society, 2017).

However, when scientists determined that CFCs could break down when exposed to UV light in the Earth's stratosphere, with each CFC molecule destroying thousands of ozone molecules (Molina & Rowland, 1974), public opinion began to turn. And confirmation of the effects of CFCs (in the form of a massive hole in the Antarctic ozone layer) (Farman et al., 1985) was enough to catalyse an international ban on CFCs in 1987—the Montreal Protocol. But CFCs are long-enduring chemicals: "The chemicals may last 100 years or more" (Cohn, 1987, p. 687). Nevertheless, it is believed that if the signatory states of the Montreal Protocol uphold their promises, the ozone layer should be restored by 2065.

For several reasons, it is difficult to calculate the public health consequences of CFCs. They represent a "double danger" (Takle, 2002) because they both degrade the stratospheric ozone layer and, as greenhouse gases, contribute to climate change. Degradation of the ozone layer is associated with increased cases of skin cancer: "[D]epletion of 2% total ozone is expected to lead to about one-half million additional cases of skin cancer and an additional 9,300 deaths. Measured values of ozone in the latitude range of the United States currently are about 6-7% below the natural levels" (Takle, 2002). The National Oceanic and Atmospheric Administration (2024) estimates that passage of the Montreal Protocol will prevent "443 million cases of skin cancer, approximately 2.3 million skin cancer deaths, and more than 63 million cases of cataracts in the United States alone, with even greater benefits worldwide." The Montreal Protocol also played a key role in mitigating anthropogenic global warming. New Zealand's National Institute of Water and Atmospheric Research (NIWA, 2021) modelled an alternative, avoided future in which CFC use increased by 3% each year, finding that—without the Montreal Protocol—the ozone layer would have collapsed by the 2040s; by 2050, UV intensity in mid-latitudes (e.g., US, UK, and Central Asia) would have been greater than in the tropics today; and by 2100, there would have been 60% less ozone over the tropics. They calculate that CFCs' greenhouse gas effect would have increased global warming by +1.7°C above baseline, while increased UV would have reduced the capacity for vegetation to absorb CO_2, increasing warming by an additional +0.8°C (for a total of +2.5°C). Combined with the +1.5°C levels already observed during 2024 (Copernicus, 2025), we would already be facing +4.0°C "scorched earth" scenarios. As it is, climate change is likely to produce unprecedented human misery (Oleson, 2024). And it was Midgley's dichlorodifluoromethane that put humanity on this dangerous path.

Accolades

Perhaps because Thomas Midgley Jr. trained as a mechanical engineer, not as a chemist, he was unconstrained by conventional orthodoxies. Flavell-While (2010) explains, "Midgley had, by all accounts, a brilliantly inventive mind, untroubled by received wisdom. Undaunted by even the most apparently complex tasks, he was a hands-on pragmatist and eternal optimist." Indeed, armed with the periodic table and a can-do attitude, Midgley grasped his way to the solutions for industry's most pressing problems of the day. He was venerated for his inventions, receiving "an unusual number of honours and awards" (Kettering, 1944, p. 563), including the Perkins and Priestley awards. In fact, hailed as a "national hero" (Edelman, 2016, p. 48; Kuper, 2022), Midgley was selected as President of the American Chemical Society in 1944. At the time of his death, he was the "most decorated chemist in the United States" (McGrayne, 2001, p. 104). But in the same way that great conquerors and colonisers, once praised as heroes, are now reviled as genocidal murderers (e.g., Simonton, 1994), Midgley has been reappraised. Kauffman (1989) questions whether Midgley was a saint or a serpent. Kuper (2022) names him "as the most disastrous peaceable human being who ever lived." Johnson (2023) identifies him as "the man who broke the world."

The still-emerging unintended public health consequences of Midgley's inventions, apparent only after his death, have prompted scholars to temper contemporary paeans (e.g., Pearson, 2014) with critique. But such criticism usually characterises Midgley's inventions as regrettable accidents—for example, Pearce's (2017) reference to a "one-man environmental disaster"—not as deliberate, criminal actions. But Midgely's inventions were not accidents, and those who died were victims of crime.

Midgley's Criminal Culpability

Two of Midgley's inventions—tetraethyl lead and Freon-12—produced millions of deaths (e.g., Larsen & Sánchez-Triana, 2023; NIWA, 2021; Takle, 2002; World Health Organisation, 2024), mostly through cardiovascular problems. Yet it is difficult to quantify the effects of these inventions on public health. Leaded gasoline was used in different intensities in different countries at different times; its effects, therefore, likely vary across time and place. The destructive effect of CFCs on the ozone layer is more pronounced at the poles, especially Antarctica, and continues to abate after the Montreal Protocol. If we simply multiply the World Health

Organisation's (2024) estimated 1.5 million lead-related casualties for 2021 by 98 (the number of years between the introduction of tetraethyl lead and its last use in passenger cars), this suggests *147 million deaths*. But this is a conservative estimate: Larsen and Sánchez-Triana's (2023) model would suggest many more deaths. Similarly, if we simply multiply Parker's (2021) count of 126,000 skin cancer deaths in 2018 by 95 (the number of years between the introduction of Freon-12 and the present) and attribute half of these to the lingering effects of CFCs, this suggests approximately 6 million additional deaths. This, too, is a conservative estimate and does not count deaths related to global warming, which can manifest in many forms. Therefore, employing conservative estimates, Midgley's inventions were responsible for *153 million* deaths. This figure dwarfs the 3.3 million deaths associated with Stalin's gulags (Wheatcroft, 1999), the 6 million Jews who died in the Holocaust (United States Holocaust Memorial Museum, 2023), or even the 26 million who died in the African slave trade of 1500-1900 (Manning, 1990). Yet, at least in the case of the Nazi's extermination of Jewish persons, those deaths were deliberate murder, while Midgley's inventions, although harmful, seem like something else.

Criminal homicide, defined at common law as "the killing of a human being by another human being" (Dressler, 1995, p. 463), consists of three types: murder, manslaughter, or negligent homicide (American Law Institute [ALI], 1985, § 210.1). These are distinguished by the mental state (*mens rea*) of the offender. For negligent homicide (§ 210.4), all that is required is that the offender

> be aware of a substantial and unjustifiable risk that. . . [death] exists or will result from his conduct. The risk must be of such a nature and degree that the actor's failure to perceive it, considering the nature and purpose of his conduct and the circumstances known to him, involves a great deviation from the standard of care that a reasonable person would observe in the actor's situation. (§ 2.02(2)(d)).

It constitutes manslaughter if the homicide is committed recklessly (§ 210.3), which means "he consciously disregards a substantial and unjustifiable risk that . . . [death] exists or will result from his conduct" (§ 2.02(2)(c)). Similar to negligent homicide, in manslaughter

> [t]he risk must be of such a nature and degree that the actor's failure to perceive it, considering the nature and purpose of his conduct and the circumstances known to him, its disregard involves a gross deviation from the standard of conduct that a law-abiding person would observe in the actor's situation. (§ 2.02(2)(c)).

But to satisfy the Model Penal Code's definition of murder (§210.2), homicide must be "committed purposely or knowingly" (§ 210.2(1)(a)) or "committed recklessly under circumstances manifesting extreme indifference to the value of human life" (§ 210.2(1)(b)).

Midgley did not purposely set out to kill people, "his conscious object to … cause such a result" (§ 2.02(c)), but he didn't need to do so. Even under the jurisprudence of his time, intent signified intentional commission of the act that caused the death (for example, inadvertently killing a rape victim with chloroform):

> Salter, in order to perpetrate rape, administered a known poison from a bottle so labelled, which caused the death of Barbara Dunn; but he contends that all he intended was to produce a state of anaesthesia that he might accomplish his assault, and that he did not intend to kill. Can he be said not to have had the intent to kill Barbara when he knowingly and purposely used chloroform, knowing as he did that it was poison and that death might ensue from its use? We do not think so. (State v. Salter, 1948, pp. 268-269).

Midgley also employed a known poison to generate profit, and did not intend to kill. But, as in *Salter*, Midgley knew that tetraethyl was poison and knew that death might ensue from its use.

Even if Midgley's actions were not purposeful, he acted knowingly— "aware that it is practically certain that his conduct will cause such a result" (§ 210.2(1)(b)(ii)). After all, many prominent scientists had warned Midgley directly about the insidious dangers of tetraethyl lead (e.g., Kitman, 2000; Markowitz & Rosner, 2002; Seyferth, 2003a). Midgley had published on the health effects of lead (Midgley, 1925), and he knew that 15 men had died on the tetraethyl production lines between 1923 and 1925 (Flavell-While, 2010). Midgley had, himself, been poisoned by lead, forced to take a leave of absence to recuperate in Florida. Yet just one year later, at a press conference, Midgley washed his hands thoroughly in tetraethyl lead and assured his audience that in doing so, he was taking no chance whatsoever, *nor would he be taking any chance if he washed in tetraethyl every day* (Markowitz & Rosner, 2002, p. 27). Under the then-existing state of knowledge, Midgley *knew* that producing tetraethyl would cause manufacturing deaths (it already had), and he knew (or should have known) that using tetraethyl would cause consumer deaths. This was virtually certain. But the allure of progress (and money) was simply too great. And at a hearing in 1925, a Standard Oil representative said the quiet part out

loud, calling tetraethyl a "gift of God" and asking if industry should forego profit and progress simply because a few unfortunates might die:

> Now, as a result of some 10 years' [sic] research on the part of The General Motors Corporation and 5 years' research by the Standard Oil Co., or a little bit more, we have this apparent gift of God—of 3 cubic centimetres of tetraethyl lead—which will permit that gallon of gasoline…to go perhaps 50 per cent further… What is our duty under the circumstances? Should we throw this thing aside? Should we say, 'No, we will not use it,' in spite of the efforts of the government and the General Motors Corporation and the Standard Oil Co. toward developing this very thing, which is a certain means of saving petroleum? Because some animals die and some do not die in some experiments, shall we give this thing up entirely? (Kitman, 2000).

The situation is analogous to the sale of counterfeit pharmaceuticals, such as in *The Third Man* (Greene, 1949), in which an ineffective substance was misrepresented as life-saving medication. People die so that someone else can make money. Some experts equate the crime with murder: "You're killing people. It's premeditated, cold-blooded murder. And yet we don't think of it like that" (Marshall, 2009).

Even if Midgley did not pour tetraethyl over his hands and lie, certain in the knowledge that people would die, he nevertheless misrepresented tetraethyl as safe, "consciously disregard[ing] a substantial and unjustifiable risk that … [death would] result from his conduct" (ALI, 1985,§ 2.02(2)(c)), "under circumstances manifesting extreme indifference to the value of human life" (ALI, 1985, § 210.2(1)(b)). In common law, this is sometimes referenced as "depraved heart" murder (Oleson, 2013).

In summary, Midgley's invention (tetraethyl lead) caused the premature deaths of perhaps 153 million people. And while he did not *will* the death of TEL's manufacturers or consumers, his knowledge about the risks associated with lead, combined with his willful misrepresentation about the risks of lead, creates criminal culpability for causally related deaths. Kitman (2000) writes, "The merchants of tetraethyl lead—or any other unnecessary additive known to be dangerous—are no better than criminals. They should be dealt with accordingly." Midgley was not the sole perpetrator, and the petroleum industry writ large bears responsibility for the public health consequences of leaded gasoline (and for CFCs). But Midgley did play a key role in events, as inventor, advocate, and apologist. Certainly, there is evidence that supports an interpretation of negligent homicide. But Midgley's

press conference misrepresentation was more than negligent: the facts also support an interpretation of recklessness (therefore constituting manslaughter) or extreme, depraved heart recklessness (therefore constituting murder). And, given Midgley's experience with early deaths on the TEL production line, warnings from concerned experts, and his own bout of poisoning, culpability for murder can be inferred on the basis of knowledge or intent (following *Salter*). Knowledge or depraved heart recklessness—both states of *mens rea* sufficient for murder—neatly fit the recorded facts. If that is correct, Thomas Midgley murdered more than 100 million people.

Serial Killer

Assuming that Midgley does bear criminal responsibility for the deaths of those who died from tetraethyl exposure, he might (arguably) also satisfy the definition of a serial killer. Serial killers are defined by their murder of multiple victims—a common minimum is three or four—across three or more homicidal events, separated by cooling-off periods (Oleson, 2013). The FBI (2010) defines serial killing as "The unlawful killing of two or more victims by the same offender(s), in separate events." These definitions distinguish the serial killer from a single or double murder, a mass killing (involving many victims in a single event) or a spree killing (involving multiple victims and events, but with no cooling-off period to interrupt them).

There are, however, two challenges in framing Midgley as a serial killer. The first relates to the number of homicidal events. Large-scale murder involving industrial toxins is very different in form from the murders of Ted Bundy or Jack the Ripper (who killed individual victims with his hands). If we understand Midgley's invention of TEL as the thing that ultimately killed 153 million people, then what were the specific actions that constituted murder? Midgley's press conference misrepresentation is one obvious possibility. Another might be the decision to continue manufacturing TEL after 15 production workers were killed and hundreds more were incapacitated. Another might be the decision to discount numerous warnings about lead contamination from experts. If each of these constitutes an act that culpably caused the death of victims of lead, then Midgley might be a serial killer—acting in reckless, knowing, or intentional ways and causing foreseeable deaths, with punctuated intervals between these moments (Oleson, 2013). The second hurdle involves the association between serial murder

and sexual motives (Toates & Coschug-Toates, 2022). While Billy the Kid and Al Capone might satisfy the FBI (2010) definition of serial killers, most scholars who write about serial killers ascribe their motives to sexualized violence and lust. And sex, almost certainly, is not what motivated Midgley to develop tetraethyl. But fame did motivate him, and money did motivate him, and power did motivate him; and lust for fame or money or power is another kind of lust (c.f., Oleson, 2004). So perhaps this aspect is not as ill-fitting as it initially appears.

Mad Scientist

De mortuis nil nisi bonum, but it is also reasonable to ask whether Midgley was a mad scientist. Solving mechanical problems with chemicals, Midgley alighted upon tetraethyl through trial-and-error and luck. He invented CFCs by charting chemical properties with a cheat sheet periodic table of elements. But fundamentally, he remained an engineer, an enthusiastic problem-solver, rather than a careful scientist. Tudor (1989, p. 29) has provided a checklist of the six core characteristics of the mad scientist, and Midgley fits them surprisingly well:

- *The scientist who is obsessed with, and consumed by, his work, and who seeks and seems to have mastered the "secret of life itself"*: Midgley was a hard worker and a dedicated researcher who, although a married father, straddled industry and university work (Leslie, 1980), and served the American Chemical Society for years, eventually acting as its President (Boyd, 1953). Kettering says that Midgley was "blessed with initiative and drive" (1944, p. 563) and Boyd notes, "For years Midgley ate chemistry and slept it" (1953, p. 2791). His breakthroughs in refrigeration and improved transportation, although not the secret of life itself, remade the shape of society in profound ways.
- *His creation, which, by accident or design, turns out to be monstrous and malevolent*: Midgley's two notable creations are, of course, tetraethyl lead and dichlorodifluoromethane. Although they initially appeared benign—a "gift of God" (Kitman, 2000)—they have caused the premature deaths of perhaps 153 million people or more, thinned the ozone layer, and accelerated anthropogenic climate change toward irreversible tipping points.
- *A visibly crippled assistant or aged retainer who is often instrumental in initiating the creature's rampage*: There is no account of Midgley having

a crippled retainer, but this function was fulfilled by Charles "Boss" Kettering—Midgley's colleague and supervisor, an industry executive and inventor himself (Leslie, 1980).

- *The younger male and female characters who constitute the film's "threatened innocents" often paid only desultory attention in the actual realisation of the film*: Because the effects of lead poisoning are particularly pronounced in young people (World Health Organisation, 2024), there were millions of "threatened innocents" implicated in the widespread consumption of tetraethyl. They were long overlooked:

> In the fifties and sixties, blood-lead levels of less than 60 micrograms (a microgram is a millionth of a gram) per deciliter (one-tenth of a liter) of blood (mcg/dl) were considered acceptable by America's medical establishment, not requiring intervention, because overt symptoms of lead poisoning, such as convulsions, do not typically occur below this level. (Kitman, 2000).

Indeed, many of the victims of tetraethyl never even got as far as having a birth certificate. Lead exposure is associated with greater rates of miscarriage and fetal death, even in concentrations once deemed safe (Edwards, 2014).

- *The laboratory setting, frequently contained within an isolated castle or mansion, and filled with elaborate pseudo-scientific apparatus*: Midgley worked in a laboratory—not in a castle or mansion, but first in Kettering's Delco laboratories and then in the laboratories of General Motors (Leslie, 1980). He was surrounded by engines, chemicals and other relevant apparatus.
- *A surrounding environment, which provides both representatives of existing bourgeois authority (police chiefs, judges, physicians) and a population of potential victims who finally rise, en masse, against the threat*. Midgley dealt with many representatives of bourgeois authority, including senior industry management, chemists, health experts, and public regulators (Markowitz & Rosner, 2002). For decades, millions of Americans were exposed to concentrations of environmental lead that had detrimental effects on mental and physical health as well as mortality. In 1975, the phaseout of leaded gasoline began in the USA and it was mostly complete in 1986 (Kitman, 2000). It was fully banned in 1996. But, outside the US, lead was used in passenger car fuel until 2021. Freon was widely used from

1930 until the 1987 Montreal Protocol (Cohn, 1987). Thus, for both lead and CFCs, potential victims *did* eventually rise against these creations, but doing so took years. In summation, Midgley ticked the boxes surprisingly well for each of Tudor's (1989) criteria.

Too Big to Fail

Midgley's two principal inventions were responsible for an estimated 153 million deaths, but other research (e.g., Larsen & Sánchez-Triana, 2023) suggests a figure perhaps 3.5x greater, imposing annual costs of $6 trillion. There is evidence (e.g., early casualties on the tetraethyl production line, warnings from scholars and experts, internal correspondence, and Midgley's own experience with lead poisoning) that the developers of tetraethyl lead clearly understood the health risks of environmental contamination but produced it anyway (Kitman, 2000). There is evidence that deferential regulators permitted ethyl to be marketed, despite the risk to public health that it represented (Markowitz & Rosner, 2002). General Motors and Standard Oil pursued the introduction of TEL so enthusiastically because tetraethyl promised to geometrically expand the market for passenger cars. And it did. When the Model T was first produced in 1908, US consumers owned just 2.24 automobiles per 1000 people; by the time leaded gasoline was fully banned in the USA in 1996, there were 781.16 automobiles per 1000 (Oak Ridge National Laboratory, 2014). Tetraethyl made many people rich. Accordingly, the companies involved in its production and distribution were not treated criminally, even when TEL workers suffered irreversible neurological problems and died. Big oil was too big to fail (c.f., Sorkin, 2010). As Glasbeek (2018) observes, profiteering corporations regularly engage in criminal acts with impunity that, if committed by an individual citizen (e.g., George Trepal), would trigger a criminal justice response and draconian punishments.

It must be noted that Midgley was not some lone wolf actor who deliberately killed victims. Rather, Midgley was one cog within a massive criminal apparatus, similar to the Holocaust (Arendt, 1963) or to the Global Financial Crisis (Financial Crisis Inquiry Commission, 2011). This apparatus was complex: many of the victims of tetraethyl lead and Freon-12 themselves drove cars and used refrigerators and air conditioners, de facto accessories to a network of crime. But Midgley was not just a car owner. Although his minimisation of the risks of TEL did not kill 153

million people, it legitimised others in bringing ethyl to market. Society pities—not blames—Oppenheimer for the atomic bomb, but it does hold accountable political leaders deemed responsible for mass deaths, even though they, themselves, might have killed no one directly: Hitler, Stalin, Pol Pot, and Charles Manson. Unfortunately, since its establishment in 2002, the International Criminal Court has convicted only 11 defendants (only 6, all African militia leaders, have been convicted of core ICC offences such as war crimes or crimes against humanity, with prison terms ranging between 9 and 30 years—the other convictions have been for crimes such as witness tampering) (van den Berg, 2025). For example, the Ugandan warlord Dominic Ongwen was convicted by the ICC in 2021 on 61 crimes, including murder, attempted murder, rape, torture, slavery, sexual slavery, forced marriage, outrage upon personal dignity, conscription and use of child soldiers under the age of 15, pillaging, destruction of property, and persecution. It is estimated that Ongwen had 49,772 direct and indirect victims, and his punishment was 25 years (Holligan, 2024). This works out to 4.4 hours of incarceration per victim, and represents a fraction of sentences imposed by other courts for non-violent crimes. For example, Ongwen's 25-year sentence is one-sixth the 150-year prison term imposed on Bernie Madoff for an $18 billion USD fraud (Trevelyan, 2009) and is one-eighth the 200-year prison term imposed on Morton Berger for possession of 20 images of child pornography (Vicini, 2007). It suggests that when crimes are big enough, they cease to be understood as crimes. It vindicates the view of Daniel Drew, who observed, "Law is like a cobweb; it's made for flies and the smaller kinds of insects, so to speak, but lets the big bumblebees break through" (Sutherland, 1940, pp. 8-9).

Discussion

Thomas Midgley Jr. was, by most accounts, a cheerful and optimistic man, famous for asking his supervisor, Kettering, "What do you want me to do next, boss?" (Kuper, 2022). He was an outstanding engineer: systematic, indefatigable, and curious (although not *too* curious)—Flavell-While (2010) says that he had "a brilliantly inventive mind, untroubled by received wisdom." He was, in the words of the Dead Kennedys, a "well-paid scientist" (Biafra, 1982) and, at the time of his death by suicide in 1944, the "most decorated chemist in the United States" (McGrayne, 2001, p. 104). Two of his inventions literally changed the world: tetraethyl lead and

dichlorodifluoromethane. Tetraethyl leads suppressed engine knock and improved fuel efficiency, thereby establishing the hegemony of the passenger car both in the USA (Oak Ridge National Laboratory, 2014) and abroad, conscripting modern life into the service of the automobile (Standage, 2021). His second invention, chlorofluorocarbons, provided a safer medium for refrigeration, expanding the global market for refrigerators and air conditioners (as well as serving as a common propellant for insecticides and inhalers). At least during his lifetime, Midgley's two inventions appeared to improve the quality of life for people. "Midgley was captivated by the thought that, in his lifetime, life expectancy of men in America had risen by more than 50%. He observed that this had never before happened in a single generation in the history of mankind and would likely never happen again" (Pearson, 2014, p. 60). But after Midgley's death in 1944, the public health consequences of tetraethyl and CFCs became increasingly apparent. And as our information got better, the news got worse: blood lead concentrations once deemed safe were revealed to be dangerous (World Health Organization, 2024), reducing IQ (Vahaba, 2022), increasing crime rates (Fraser, 2025; Nevin, 2016; Reyes, 2015), causing mental health disorders (McFarland, Reuben, & Hauer, 2024), illness (World Health Organization, 2024), and millions of deaths every year (Landrigan, 2018; Larsen & Sánchez-Triana, 2023); CFCs formed a hole in the ozone layer (Farman et al., 1985), increased cancer rates (Parker, 2021), and contributed to climate change (NIWA, 2021; Takle, 2002). If governments had not prohibited leaded gasoline for passenger cars and if governments had not eliminated CFCs in the stratosphere, NIWA (2021) estimates that global warming would have increased by another +2.5 °C, beyond the +1.5 °C already observed in 2024 (Copernicus, 2025), approximating the "scorched earth" worst-case conditions modelled in the IPCC's Sixth Assessment (2023).

Together, tetraethyl lead and CFCs caused the death of 153 million people, mostly due to lead exposure. This is a conservative estimate (World Health Organisation, 2024); other models would suggest a much higher figure (Larsen & Sánchez-Triana, 2023). One hundred and fifty-three million people is an inconceivably large number. It is slightly more than the current 145 million population of Russia (United Nations, 2024). It is more people than the estimated 65-75 million who died in World War II, and approximately the estimated number (136.5-148.5 million) who died throughout all of the wars and conflicts of the

twentieth century (Leitenberg, 2006). And Thomas Midgley Jr. is responsible for their deaths, not because he developed a fuel additive from a known poison, but because he ignored the warnings of subject-matter experts, ignored the deaths of TEL production workers, and intentionally misrepresented the risks of lead (despite having been poisoned himself).

Described as "an eternal optimist" (Flavell-While, 2010), Midgley likely believed, or at least hoped, that the experts were wrong and that wide-scale consumption of tetraethyl lead would be safe. It had to be, if ethyl was to succeed as a product. And Midgley was not the only person who prioritised progress (and corporate profit) over public well-being (Glasbeek, 2018). Far from it. Many others in the industry were also culpable in bringing TEL to market. And, in practice, tetraethyl and freon produced a recursive network of culpability, in which most of the victims of the chemicals were also accessories to the offence, consumers of leaded gasoline and refrigerants whose individual consumption contributed to the collective poisoning of the environment. But Midgley, although he did not act alone in this tangle of culpability, played a critical role—as inventor, advocate and stakeholder—in the introduction of both TEL and Freon-12. Because Midgley developed TEL as an anti-knock additive, and because he assured the public that "no lead health hazards actually exist" (Midgley, 1925, p. 827), and because he misrepresented poison as benign, as a "gift of God" (Kitman, 2000), some 153 million people died. The world of the automobile that Midgley bequeathed to us has enslaved as well as liberated (Kaczynski, 1995; Verkade & Te Brömmelstroet, 2024), and its potential climate consequences are apocalyptic (McGuire, 2022; Wallace-Wells, 2019).

Most of the illnesses and deaths associated with ethyl and Freon occurred after Midgley's 1944 suicide, which means that he eluded the hands of justice in this world. This is a recurring problem in environmental criminology: because of the 10-year lag between CO_2 release and its effects on global warming (Ricke & Caldeira, 2014), many of the (often mature or elderly) leaders and consumers who contribute most dramatically to global warming will already be dead before the temperatures increase and sea levels rise. But some of those who got sick or died due to tetraethyl lead exposure (Bent, 1925; Flavell-While, 2010) were poisoned while Midgley was very much alive. And while one intentional murder and four attempted murders by thallium poisoning were sufficient for a Florida court to sentence George Trepal to death (Trepal v. State, 1993), no one even

thought to charge Thomas Midgley Jr. with murder, nor manslaughter, nor even negligent homicide, when 15-line workers died producing his invention and when hundreds more went mad in the "house of butterflies." This never occurred to anyone because it looked like business, not wrongdoing; because people wanted cars that ran smoothly and because the motor industry wanted to get rich; because the employers blamed those who got sick and died. This is the difference between crimes of passion (like resentment) and crimes of the powerful (Pearce, 1976). Business is permitted to engage in crime (even very serious crime) with relative impunity, while an individual engaging in analogous behavior is punished, often severely (Glasbeek, 2018). George Trepal was a spiteful weirdo who tried to kill seven neighbours, so he was condemned to die and put on Florida's death row; but Midgley, a happy-go-lucky engineer who decided that putting poison into gas tanks and CFCs into refrigerator coils were clever solutions to wicked problems, killing some 153 million, was made vice president of his company. Instead of going to the gas chamber, Midgley received "an unusual number of honors and awards" (Kettering, 1944, p. 563), was identified as a national hero, and was elected as President of the American Chemical Society.

Today, the Pandora's box of Midgley's inventions is better understood. Midgley is still praised (e.g., Pearson, 2014), but the tone is more measured: Flavell-While (2010) describes Midgley's "troubled legacy", and Pearce (2017) calls him a "one-man environmental disaster", while Phillips (2019) identifies him as "the most environmentally disastrous person of all time." But this language absolves Midgley of blame. It describes 145 million foreseeable lead deaths in the terms we use for forest fires. Midgley is the greatest criminal that the world has ever seen. If Midgley qualifies as a serial killer (Oleson, 2004, 2013), he was the single greatest killer the world has ever known. More than Ted Bundy, Jeffrey Dahmer, or John Wayne Gacy; more than Pol Pot, Hitler, or Stalin. The 5700 historic serial killers in Radford/FGCU's expansive serial killer database account for an estimated 37,000 victims (Aadmodt, 2022), averaging 7 victims per offender. Midgley—not appearing on the list—is responsible for *4000 times* as many deaths as all the killers listed in the database. But, with few exceptions, the people who study serial killers have never heard of Midgley. Like the Devil, whose cleverest ruse is to persuade you he does not exist (Baudelaire, 1864), Midgley was an apex criminal, an offender whose crimes are so vast that they cease to be recognised as criminal.

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