

Disruptive technology: a blessing and a curse

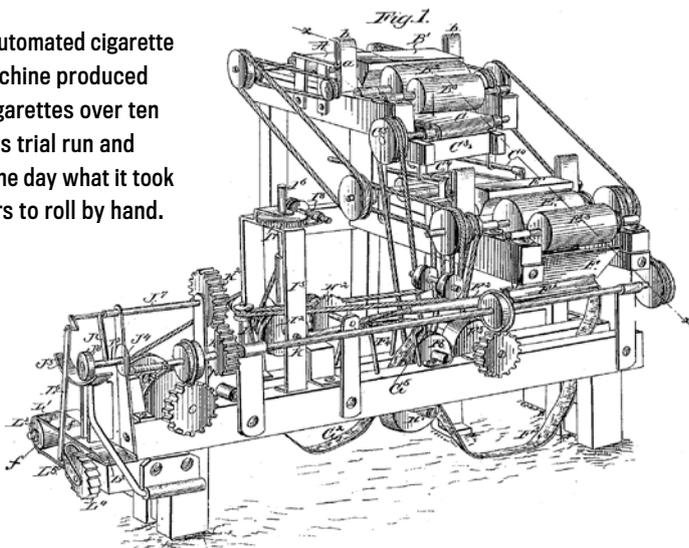
What do cigarette-rolling machines, refrigerators and e-cigarettes all have in common? The answer is: they are all disruptive technologies. But they also engineered (or could engineer) massive change in the rates of cancer and other diseases – a change of global societal proportion, within one generation. Such disruptive technologies can create massive profits, while at the same time having unintended positive or negative consequences for an entire society’s well-being, longevity and economic health.

By David Sweanor

In the 1880s, cigarettes were expensive, made by hand. The vast majority of tobacco was consumed in non-combusted forms (e.g. snuff or chewing tobacco). An automated cigarette rolling machine, invented by 18-year-old James Bonsack, revolutionized cigarette production. The machine produced 70,000 cigarettes over ten hours in its trial run and rolled in one

day what it took 48 workers to roll by hand. At first adoption was slow and companies were reluctant to invest in the machine, believing consumers preferred hand-rolled cigarettes. Volume in pre-machine days was 500 million, but that catapulted to ten billion by 1910. Retail price was halved. American Tobacco took advantage of the new technology so successfully that it was broken up in 1911 under US antitrust law. Today’s „big tobacco“ companies have, over the decades, masterfully re-engineered, optimized, innovated, adapted and brilliantly packaged, priced, and marketed cigarettes. They have survived 50 years of challenges: US Surgeon General’s Reports (1964-2014); bans on television advertising; restrictions on marketing to children; taxes, clean air laws; a U.S. Master Settlement Agreement of over \$250 billion; being adjudicated by U.S. federal court to have engaged in fraudulent behavior, and becoming a regulated product under the 2009 U.S. Tobacco Control Act. By the early 20th century articles addressing the health effects of smoking began to appear in medical journals. In 1930, researchers in Colo-

The first automated cigarette rolling machine produced 70,000 cigarettes over ten hours in its trial run and rolled in one day what it took 48 workers to roll by hand.





gne, Germany, made a statistical correlation between cancer and smoking. In 1938 Dr. Raymond Pearl of Johns Hopkins University reported that smokers do not live as long as non-smokers. By the 1950s the evidence mounted that smoking (i.e. inhaled smoke from the burning or combusting of tobacco) had caused an epidemic in lung cancer and led to the landmark 1964 US Surgeon General's report and a dramatic reversal in cigarette sales and smoking prevalence from over 50% of American males to less than 20% in 2012.

Death-promoting: the cigarette rolling machine

The cigarette rolling machine is therefore responsible for both extraordinary profits and the biggest impact of the „3 D's“ – disease, death, dollars – of all time. For example, in the U.S., lung cancer – the rarest cancer in 1900 – had exploded to overtake all other cancer death rates by 1955. By 1990 it was causing twice as many deaths as any other form of the disease – 30% of all deaths from cancer. The rolling machine holds the dubious honor of having spawned the long-lived retail profit-maker, „the cigarette century“. The success defies credulity – but can hardly be admired, unless one places pure profits over people's lives. The cigarette century has prematurely killed over 20 million Americans thus far

– more deaths than in all the U.S. wars ever fought since the country's founding. The resilience and sustained market share of cigarettes continues globally. If nothing disrupts the reign of the ubiquitous cigarette century, then by 2100 this mass-produced retail product will have prematurely killed one billion people worldwide. The cigarette has survived and thrived despite being clearly labeled for decades as lethal“ ... a defective product – unreasonably dangerous, killing half its users and addictive by design”.

Life-saving: the refrigerator

Carl von Linde was first to patent a practical compact refrigerator using an improved method of liquefying gases in 1876 at the Technological University Munich in Germany. The first refrigerator to see widespread use was the General Electric „Monitor-Top“ refrigerator introduced in 1927, with over a million units produced. Early refrigerators were not without risk – they used dangerous and explosive gases (sulfur dioxide or methyl formate) and had doors that could not be unlocked from the inside – which caused some cases of preventable deaths of children who had used them as hiding places. However, the technology evolved and consumer safety and environmental protections have been optimized.

General Electric's „Monitor-Top“ refrigerator: its adoption had the exact opposite effect on cancer deaths as the cigarette rolling machine.

In the U.S. the rapid adoption of the refrigerator – from less than 10% of households in 1930 to over 90% in 1970 – had the exact opposite effect on cancer deaths as the cigarette rolling machine. Stomach cancer was initially by far the leading cause of cancer-related deaths. But from 1930 to 1990, the death rate from stomach cancer in the U.S. plummeted to the low level previously occupied by lung cancer in 1900. During the same time frame, cigarettes rocketed in uptake to lead the „3 D’s“ in the U.S. – causing almost half a million premature deaths and costing the US economy over \$380 billion a year. Thus, two disruptive technologies were prime drivers of a startling crossover in trend lines that occurred from 1900-1955: one death-promoting and the other life-saving. Independent of the medical and public health establishments, disruptive technology changed the course of two devastating forms of cancer in opposite directions, impacting dramatically, at the whole population level, on the „3 D’s“.

The rise of the e-cigarette

The idea that nicotine can be effectively delivered without smoke is not new. A Glasgow doctor, Lennox Johnston, showed in the 1930s that intravenous delivery could effectively replace cigarettes. The earliest prototype of an e-cigarette was a patent granted to Herbert A. Gilbert in 1963. This device was designed to heat the nicotine solution and deliver it via steam. But the technological developments necessary to make a commercially successful product were lacking. As electronics advanced, Hon Lik, a Chinese pharmacist, made a further breakthrough in 2003 with the invention of the first generation of what could be viewed as the modern e-cigarette. He used a piezoelectric ultrasound-emitting element to vaporize a liquid containing nicotine diluted in a propylene glycol solution. This allowed a user to attain a smoke-like vapor that could be inhaled, and thus a method to at least theoretically deliver nicotine into the bloodstream via the lungs albeit at slower absorption levels and with a lower amount of nicotine than with conventional cigarettes.

The design of e-cigarettes evolved with technological innovation. The company that Hon Lik worked for, Ruyan, started exporting its products in 2005–2006 and received its first international patent in 2007. The electronic cigarette has continued to rapidly evolve with most signi-



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ficant e-cigarette companies being actively involved in research and development of ever better technology.

Massively lower disease risk

Tobacco companies had long recognized the potential of innovative technology to disrupt the cigarette market. In filings with the US Securities and Exchange Commission they have listed any inability to match reduced-risk products from a competitor as being one of the key risks they face. As electronic cigarettes gained traction with consumers, these companies have sought to avoid being left behind by innovative technology and entered into the market themselves. There will invariably be winners and losers, and the companies that are currently the biggest winners from the „cigarette century“ have by far the most to lose. They are also typically burdened with risk-averse cultures and the threat new technology presents to their existing highly-profitable cigarette businesses. They fear a „Kodak moment“.

It has long been known that „smokers smoke for the nicotine but die from the tar“, that non-combustion products such as Swedish snus have massively lower disease risks compared to cigarettes, and major bodies such as the British Royal College of Physicians have urged a harm-reduction orientation to nicotine/tobacco use. Combusting (i.e. burning) of tobacco is the culprit in the vast majority of tobacco deaths, with inhaled toxic smoke and carbon monoxide projected to kill 5.8 million US children alive today and 480,000 adults annually. As stated in the January 2014 50th-anniversary re-release of the first Surgeon General’s report on the link between smoking and lung cancer: „Death (...) is overwhelmingly caused by cigarettes and other combustibles (...) promotion of e-cigarettes and other innovative products is (...) likely to be beneficial where the appeal, accessibility (...) and use of cigarettes are (...) rapidly reduced“.

Can the rise of the e-cigarette, as a class of products that is still in the early phase of innovation and improvement, do what the refrigerator did for stomach cancer – by making the cigarette and perhaps all forms of combusting of tobacco obsolete? Will combusting of tobacco simply become a curious behavioral relic of the 20th century? Or will e-cigarettes become another choice in a wide array of emerging products that will maintain smoking as a habit, delay quitting



and attract another generation of young smokers? This depends on a complex array of factors. The answer will be decided by time, by what happens in the marketplace, any by future regulation and consumer information.

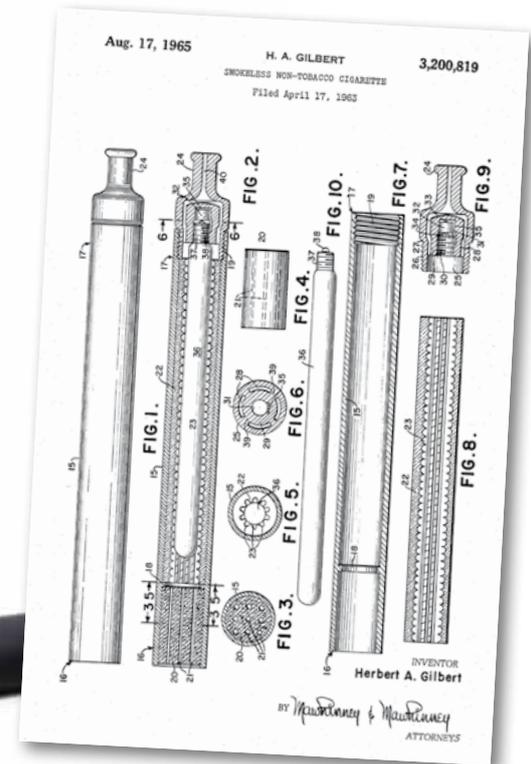
A „refrigerator scenario“

Innovative e-cigarettes might well become the most viable disruptive technology for preventing a „second cigarette century“. Could e-cigarettes finally dethrone the defective cigarette and in so doing prevent the one billion projected smoking-related deaths by the end of the 21st century? This is a possible „back to the future scenario“, with nicotine users returning to the use of a type of non-combusted and less addictive tobacco product much like the use of chewing tobacco in the US in 1880 – prior to invention of the cigarette rolling machine. This has the potential to be a „refrigerator scenario“.

While it might be hard to envision a nicotine market that is not dominated by cigarettes, it is really no different than, pre-Bonsack, envisioning a market that is. Or, indeed, a world where phones are not attached to wires, books don't necessarily involve paper, messages are sent without the need for postage stamps, taking pictures does not require film and automobiles can run without burning petroleum.

Making billions of dollars while saving millions of lives

In the case of cigarettes alone (there are other combustion-based delivery systems) smokers around the world are now paying the equivalent of roughly US\$ 800 billion a year on a product many are aware is likely to kill them, and for which they would welcome alternatives. A non-combustion product that could capture an increasing fraction of that enormous market would be a huge business opportunity; the ability to make billions of dollars while saving millions of lives by simply meeting an already-existing consumer demand. So entrepreneurs have long been busy developing alternative products, just as governments have (often inadvertently) prevented these products from being effective competition for cigarettes. Perhaps the best example is Swedish snus, a product that has resulted in Swedish men having by far the lowest rates of tobacco caused disease in Europe, despite high levels of tobacco use. It is bre-



akthrough technology, and it had (and has) huge potential to reduce the death toll from smoking. The EU's response to this breakthrough technology? It banned it everywhere but in Sweden. We clearly need clearer thinking.

E-Cigarettes are a classic example of disruptive technology that could deliver enormous gains for public health if governments would work with rather than against entrepreneurs, science and markets, and instead take a prudent and scientifically-informed approach that embraces pragmatic harm reduction. The e-cigarette products that exist now could be rendered obsolete – like early computers and mobile telephones – even while the category as a whole is making cigarettes obsolete. The private sector could very well change the course of the „3 D's“ if governments were to focus on the very real threats from cigarettes rather than reserving their risk aversion for the products that could replace them. We've seen it before, with refrigeration. Technology could finally end the cigarette century and wipe out the epidemic of smoking-related disease by making the product that causes it obsolete.

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