# CREATING AN AUTOMOBILE REVOLUTION

Amnon Shashua and Ziv Aviram discuss how they built Mobileye into a market-leading global company and how in the not too distant future driving will be nothing like it is today



AFP

**LAST MAY** 10, the memorial day for those killed in 68 years of conflict, Israel mourned 23,447 deaths.

No such national day of remembrance exists for traffic deaths. Since the founding of the state, 35,000 people have been killed in car crashes, or 50 percent more than those who fell in war and by terrorism. This year alone, 351 persons were killed on the roads, up from 341 in 2015, when there were 12,122 accidents that involved personal injury.

The American writer Shirley Jackson once wrote a provocative short story, "The Lottery," about an American farm village that kills Tessie, a townsperson chosen at random as a human sacrifice, to ensure a bountiful crop of corn. It seems that deaths on our roads are perceived with equal fatalism. Very little action is being taken.

Meanwhile, our roads are becoming ever more clogged and dangerous. From January through November, 279,698 new vehicles were sold, up 14 percent from last year. Over the past four years, a million new vehicles have hit the roads.

Other countries have acted decisively. In 1997, Sweden adopted "Vision Zero," a road traffic safety project that aspires to a highway system with no deaths or serious injuries. It has spread to many other countries. "Vision Zero" slashed traffic deaths in Sweden by one third between 1997 and 2009, through speed limits, crash barriers, road design, stringent enforcement and other measures. According to the World Health Organization, Sweden now has significantly fewer road deaths than Israel, by every measure, including road deaths per

billion vehicle km (3.5, compared to Israel's 5.3).

If 93 percent of road accidents are caused by drivers, according to Bryant Smith, a Stanford Law School expert, there have to be ways to help drivers avoid crashes. The problem is a global one. Worldwide, there are 1.5 million road deaths and 15 million injuries annually as a result of car accidents.

What if Israel, the Start-up Nation, put hi-tech to work to tackle the traffic-accident crisis? Mobileye Vision Technologies, a Je-

rusalem-based company, has done just that.

Mobileye uses visual systems and software to warn drivers of impending collisions. The device warns drivers if their vehicles are about to stray into another lane, and if they are dangerously close to a vehicle ahead. It has been installed in 12 million vehicles around the world, including Israel, the US, Japan and Korea.

And it works. Insurance company data audited by an actuary show the device cuts accidents by half. A Transportation Ministry regulation requires all heavy vehicles

(Opposite page) Mobileye co-founder Amnon Shashua speaks at a press event at CES in Las Vegas, January 5, 2016; (above) Ziv Aviram, who founded Mobileye together with Shashua, demonstrates the company's vision technology at The Jerusalem Post Diplomatic Conference, November 2016

over 3.5 tons to install this device as of November 1.

I spoke with Prof. Amnon Shashua and Ziv Aviram, co-founders of Mobileye and

longtime friends, to learn how their device works, how they got the idea and how they built a market-leading global company whose revenues in 2016 will total about $350 million, generating some $200m. in profit, and employing 700. Shashua is the company's chairman, and Aviram its president and CEO.

***First to Imagine***: Former Teva Pharmaceutical Industries CEO Israel Makov once defined successful innovation as involving three stages – first to imagine, first to move, first to scale. Shashua, a Hebrew University computer science professor, recalls being asked at a conference in late 1998 by a car maker whether two cameras could identify the location of a vehicle. Humans, animals and insects use two eyes to gain perception of depth.

Shashua answered, "Why two? It can be done with one." He knew this from his computer science research having published, the year before, a seminal article titled "3D Visual Recognition from a Single 2D Image." The fact that there is only one "eye" in Mobileye was an iconoclastic idea initially rejected by all. Today, however, it is standard.

***First to Move***: "We [Shashua and Aviram] decided to develop a company," he told me. The decision was taken when the two were on a motorbike trip in the Negev. The company was launched in mid-1999. The idea was to use a single camera along with advanced software to warn drivers. At the time, no one thought this monocular device was possible. It was unique.

***First to Scale***: Shashua has continued to serve as a professor, and for a time department head, while growing Mobileye, a rather astonishing feat. Aviram's background is in retail – he was CEO of Keter (books), Gali (shoes) and Attrakzia (clothing). In all three cases, he took the company from losses to profitability.

"We absolutely complement one another," Shashua says, "and it is good there are two of us, but not more. We strategize together; we enjoy that we are different people, with different skills, but support each other.

"It is hard to interact with someone above you, or below you," Aviram noted. "If you are at the same level, the interaction balances. You do not fear to admit you don't know what to do. Amnon and I come from different disciplines; he goes in one direction, I, in a different one, and most of the time we converge. If you tackle a problem from different directions, it is a big advantage."

## We are in the midst of the largest revolution that the automotive industry has ever seen in the last 100 years, and Mobileye is in the center

Shashua is especially proud of Mobileye's profits, not just its revenues. "The key is profit, not revenues," he said. People don't realize how hard it is to build a company that is profitable. Many companies make big revenues. A few make big profits."

***Quality Management***: Aviram thinks the fact that his background is retail, not technology, is an advantage. "It lets me think differently about things," he notes. "Management is management. In the end, it is about motivation, motivating workers."

"We save lives," Aviram says. "We are creating a revolution in the automobile industry. So people love to join us. This is part of creating true motivation. Our people work out of internal belief.

***Raising Money***: Start-ups usually have innovative technology. But the way they do business is usually conventional. Aviram, coming from outside hi-tech, decided they would raise initial investment funds outside the box.

The year 1999 was the height of the dot.

com bubble. Venture funding was plentiful. But Shashua and Aviram knew it would take eight years to develop the product – too long for impatient venture funds.

So Aviram asked, who has money? Well, rich people. So, with the help of a broker, he approached 100 persons with money. In two weeks, they raised $1million.

These investors "lived the business with us," he recounted, and their money was very patient. The number of investors grew; some invested more than once.

The pinnacle came in August 2014 when Mobileye raised an unprecedented $890m. in its initial public offering (IPO) of stock in the US, the biggest such sum ever raised by an Israeli company in the US.

The company's market value at the time was $5.3 billion. The timing was less than auspicious; during the IPO, Operation Protective Edge, a battle with Hamas in Gaza, was raging.

***Strategic Inflection Points***: Andy Grove, the legendary former CEO of Intel, stressed the importance of key decision points, where a wrong move can sink a company, while a right one can grow it. Shashua and Aviram believe they faced at least nine such key decisions. One of the most important was to develop their own chip (microprocessor).

Aviram recounts, "We looked for an existing chip. The supplier did not meet the timetable. And we were dependent on them. So, we said, let's do it ourselves. We will make our own chip. At the time, we were only 20 people. Experts told us, get off this stupidity of making your own chip. Continue doing what you're good at. But we decided, no chip, no business. It was the right decision."

Shashua adds, "Building a system on a chip enabled us to build an efficient and inexpensive platform. Our competitors developed software and used standard chips. We knew we couldn't build a business based on licensing others' technology. If we had a hardware asset, we felt we could sustain a business. And we were right."

***The Israeli Market***: Most Israeli start-ups

think globally from the start and ignore the tiny Israeli market. Mobileye, in contrast, markets aggressively in Israel. You can hear their radio ads throughout the day.

I asked Shashua why Mobileye worked hard to sell its product at home.

"Sandbox," he replied. Israel provides an ideal test bed, close at hand, and Israeli Mobileye users provide valuable feedback and information.

**Government Regulators – Friends Not Foes**: Many businesses regard government regulators as enemies, troublemakers or annoying pests. For Mobileye, regulators are strategic allies.

Shashua says, "We had a product with advanced features that the car industry did not want to adopt. We had to convince the regulators. We showed them our data for forward-looking cameras that prevent collisions. And the regulators embraced our standard. When you set the standard, you own the industry. You do not just sustain a competitive edge, you expand it. Our competitors thought the monocular approach [single camera] was temporary. It was not. They lost many years, and the gap between them and us grew and is hard to close. We are now in 90 percent of the new vehicles in the world. It is not the driver or the end customer deciding he wants the accident-prevention technology. It is the regulator who dictates these systems' penetration by setting rules whereby every new vehicle must be equipped with them."

**Strategic Partners**: Pioneer entrepreneur Dan Vilenski had a single mantra, as head of the Israel-US Binational R&D Fund: Every start-up needs a strategic partner. But those matchups are very tough to create.

Earlier this year, Mobileye, Intel and the BMW Group announced a partnership to create an open system, based on standards, for autonomous (self-driven) vehicles.

"Intel and BMW, they've declared Mobileye to be not a supplier, but a full partner," Shashua notes. "Since our IPO, we took several steps that were critical. We are now working on road experience management

(R.E.M.). This requires highly accurate maps for navigation, more accurate than exist today. We saw that this is the Achilles heel of autonomous vehicles. With our cameras already in cars, we can integrate and create these maps. This is a 'sweet spot' for the industry, and we offer a major advantage."

Aviram has been driving to work on the Tel Aviv-Jerusalem highway for two years, with a self-driven car. He told the recent Jerusalem Post Diplomatic Conference, "We are in the midst of the largest revolution that the automotive industry has ever seen in the last 100 years, and Mobileye is in the center."

**The Car of the Future**: "Robot cars do not drive like humans," Shashua observes. "They are too slow, too conservative. Cities won't agree to this. How can we teach self-driving cars to drive safely, but like humans? We are proposing a solution. And our future includes this solution. This will be much bigger than the existing car industry. This is 'wow' squared!"

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People will not own cars. Sales of cars will fall by half. The brand of your car will be of no importance. You will summon a car when needed and it will drive you to where you're going

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Aviram adds, "Eighteen years ago, we started a company that had vision-based technology to prevent car accidents. Today, our vision is much wider. We are a provider of infrastructure to enable autonomous driving systems. It will be very hard to produce

such systems without Mobileye."

"There will be a total change in how and what we drive. There will be no parking lots. People will not own cars. Sales of cars will fall by half. The brand of your car will be of no importance. You will summon a car when needed and it will drive you to where you're going."

As a retired professor, I know how hard it is to endure and prevail in the world of publish-or-perish, especially in competitive Israeli universities. Shashua continues to live in two demanding worlds, business and academe, and thrives in both. I asked him for his secret.

First, he sleeps very little, perhaps three and a half hours a night. Second, he observed, very busy people are more efficient than less busy ones.

And, if teaching, research, running a lab with doctoral candidates and Mobileye were not enough, there is more. On the bottom floor of Mobileye's building, in Jerusalem's Har Hotzvim, there is a start-up, Orcam, founded in 2010 by Shashua and Aviram. Orcam has a portable artificial-vision device that enables the visually impaired to understand text and identify objects. Intel Capital is a main investor.

I don't know how many deaths and injuries Mobileye has prevented. The number must be huge, since the data prove Mobileye cuts road accidents in half. It is inspiring to know that when self-driving cars become common and numerous, and crashes diminish, a part of Israel will be inside those cars.

**Postscript**: At the huge annual Consumer Electronics Show in Las Vegas, held every January, Mobileye, BMW and Intel announced they would together put 40 self-driven cars on US and European roads later this year. This is a step toward introducing BMW's iNEXT in 2021, BMW's first fully autonomous car. ∎

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