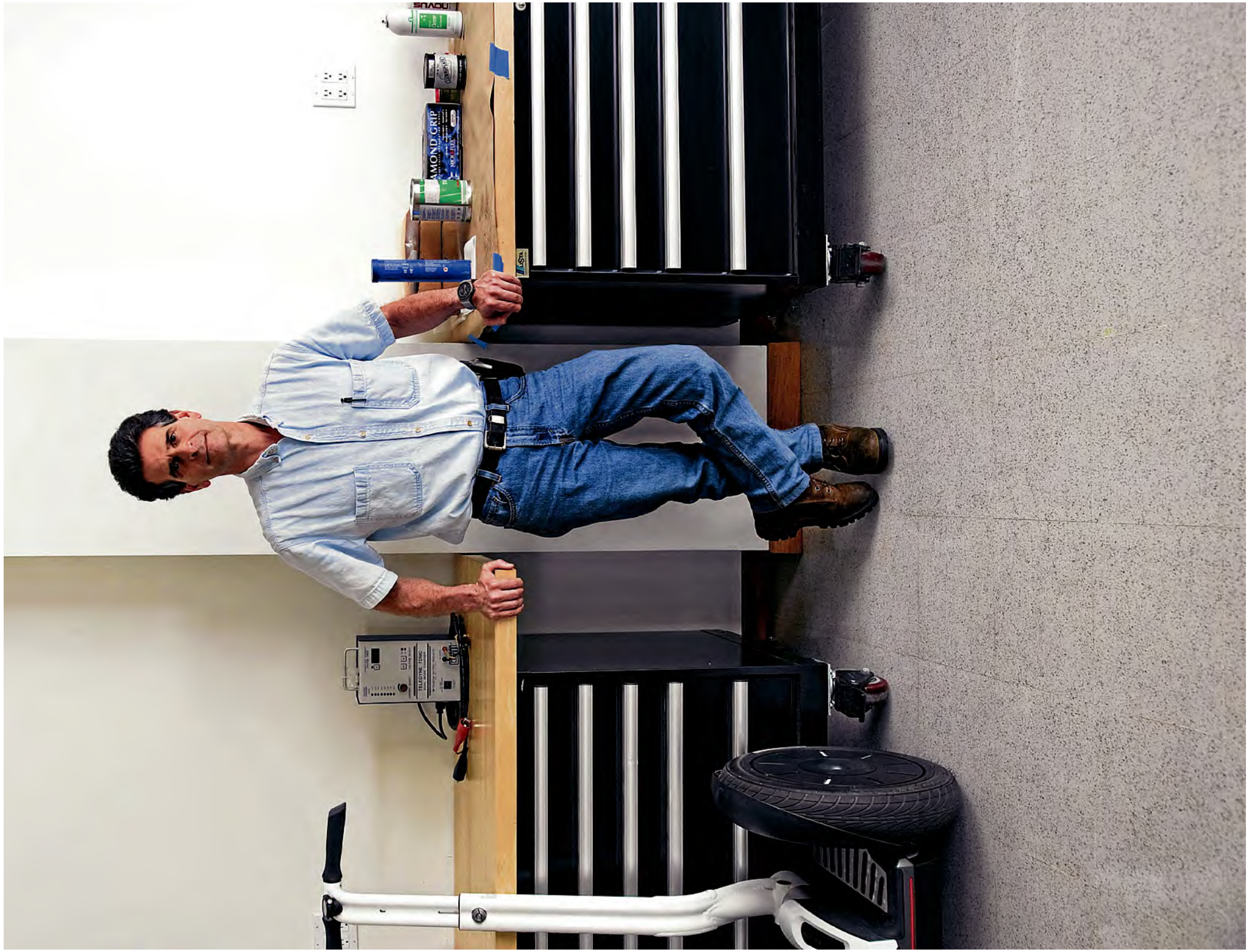

PART MAN, PART MACHINE

Some see Dean Kamen as a Willy Wonka character whose most famous invention – the Segway personal transporter – is still the butt of jokes. Others compare him to Henry Ford. His next project, after perfecting an electric car, is to 'to fix the world' – using a 200-year-old engine nobody else thinks can work. By Adam Higginbotham

PHOTOGRAPHS BLAKE FITCH

Hands-on
Kamen can't, or won't, say how much he is worth: 'In dollars? Because my mother thinks I'm irreplaceable'

Ten years ago, on the summit of a hill in the verdant New England countryside, at the highest point he could find between Boston and Manchester, New Hampshire, Dean Kamen designed and built the sprawling, hexagonal house he called Westwind. Filled with gadgets, tools and curios – including a 25 ton tugboat steam engine that once belonged to Henry Ford and an elevator featured in *The Sting* – and furnished with a 50,000 watt wind turbine to generate electricity and a floodlit baseball field to entertain his employees, it lies just seven miles from the headquarters of his research and development company, Deka.

Now 57, Kamen has a variety of ways of covering this distance: at the wheel of his gleaming black Humvee, or perhaps his Porsche coupé, the journey takes some 20 minutes; often, he chooses to pilot his helicopter, a two-seat, jet-powered Enstrom 480, which he keeps in a hangar beneath the house, and will put the inventor on the roof of his office in about three-and-a-half minutes.

But when I first meet him, Kamen takes me out to the car park at Deka to show off something new: a small blue plastic car he and a team of engineers have been working on for five months. He gives me a brief tour: 256 lb of lithium batteries, a false floor, the new number plate announcing it as the 'Revolt'.

'So here's my car,' he says finally, his voice rising in excitement. 'It's the only one in the world! Isn't that cool?'

He turns a key in the ignition: there is a click, and a barely audible hum; the car is entirely electric. 'Virtually silent,' he says. 'There aren't a lot in the world. A lot of people have hybrids, but a hybrid is nowhere near as interesting as a pure electric.'

As we gather speed down the highway towards Westwind, the whine of the electric motors rising to compete with the light classics wafting from the radio, Kamen explains the real secret of his new car.

Beneath the false floor in the boot he and the Deka engineers have mounted a Stirling engine. Conceived in Scotland almost 200 years ago, the Stirling is a marvel of thermodynamics that could help to replace the internal combustion engine – in theory it can turn any source of heat into electricity, in silence and with 100 per cent efficiency. But corporations including Phillips, Ford and Nasa have devoted decades of research, and millions of dollars, to developing the engine, and all retired defeated, having failed to find a way of turning the theoretical principles of the engine into a workable everyday application. Kamen, nevertheless, has spent the past 10 years and, he estimates, up to $40 million working on the problem.

'I think people assume that I'm some crazy frenetic guy… most of my life is hard, focused work at trying to do things that are difficult to do'

Now he and his engineers have built and tested a range of Stirling engines suitable for mass production that can be run on anything from jet fuel to cow dung. The one in the boot of the small blue car is designed to extend its range and constantly recharge its batteries to make a new kind of hybrid vehicle: one fit for the roads of the 21st century. A Stirling-electric hybrid, Kamen tells me, can travel farther and more efficiently than conventional electric cars; it generates enough power to run energy-hungry devices such as heaters and defrosters that are essential for drivers who, unlike those he calls the 'tofu heads' of California, must cope with a cold climate; and even using petrol, the engine runs far cleaner than petrol-electric hybrids such as Toyota's Prius.

However, Kamen confesses, his new creation isn't quite finished yet: 'The Stirling engine's not hooked up. Which really pisses me off.'

But it could work?

'It will work,' he says. 'Trust me.'

Dean Kamen claims that he doesn't know how much he is worth – 'In dollars?' he asks in his puckish Long Island accent. 'Because my mother thinks I'm irreplaceable.' He's made his living as an inventor for 40 years, and in that time has patented

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more than 150 devices; but the one for which he remains best known is also his least successful, its name synonymous with failure and hype. When the Segway Personal Transporter was launched in December 2001, Kamen told *Time* magazine that it would 'be to the car what the car was to the horse and buggy'. But today the two-wheeled, gyroscopically controlled electric vehicle is renowned as an absurd novelty, banned from use on British streets, and endures as a comic prop, signifying bumptious nerds in a hurry.

Yet for almost a full year before it was revealed to the public, Kamen's invention was one of the most eagerly anticipated pieces of new technology in history. Shrouded in secrecy, known only by the codenames 'Ginger' or 'IT', the device was the subject of unprecedented speculation about what it might be, or do. Statements from business and technical luminaries who were among the privileged few to have actually seen Ginger – including Amazon boss Jeff Bezos and Apple CEO Steve Jobs (who said it was an invention as significant as the PC, and that cities would be designed around it) – fuelled wildly imaginative conjecture about a technological miracle from the pages of science fiction. It was a hydrogen-powered hovercraft; a magnetic anti-gravity device; a time-travel machine; a mind-reading robot.

When IT was finally revealed, before an audience of millions on *Good Morning America* and looking like a cross between a manual lawnmower and a child's scooter, it was a devastating anti-climax. Coupled with its high price and a handful of PR flubs – George W. Bush was memorably photographed falling off one (although, characteristically, it later turned out this was because he'd failed to switch it on) – the Segway never stood a chance.

Sitting beneath the portrait of Albert Einstein that hangs over the fireplace in the library at Westwind, Kamen patiently defends the device in which he invested 10 years of his life and several millions of his personal fortune; a slight, wiry man with a thick shock of black hair turning slowly grey, Kamen is articulate but often hopelessly verbose, and the subject of the Segway proves no exception. 'I don't know that we made any mistakes,' he says, 'I think that the hype it got was going to doom it… nothing in the world could ever meet the expectations that people had for it. And, you know, to this day there are people who think I planted the idea of making all that hype. I didn't.'

Far from being the result of a miscalculated marketing strategy born of the hubris of its inventor, the months of anticipation that preceded the launch of the Segway had almost nothing to do with Kamen himself. Renowned for his work on medical devices developed for major corporations including Johnson & Johnson, the inventor had long ensured that the R&D work at Deka was conducted under conditions of secrecy that verged on the paranoid, and the Ginger project was more closely guarded still.

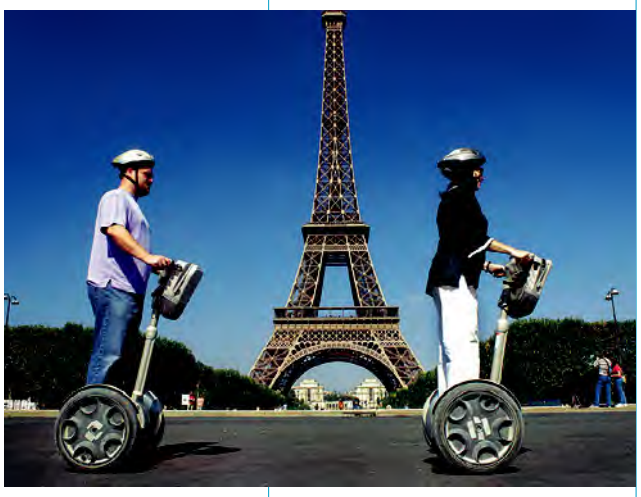
He had, however, agreed to allow a journalist regular access to the Ginger workshops – to gather material for a book to be published after the machine was launched. In the outline of the book sent out to publishers, the writer assiduously avoided providing any details of what the invention might be – indeed, his agent added to the mystery by adding references to the device as IT. But, somehow, the inside.com website received a leaked copy of the proposal and the tantalising details that it contained sparked 11 months of fevered conjecture.

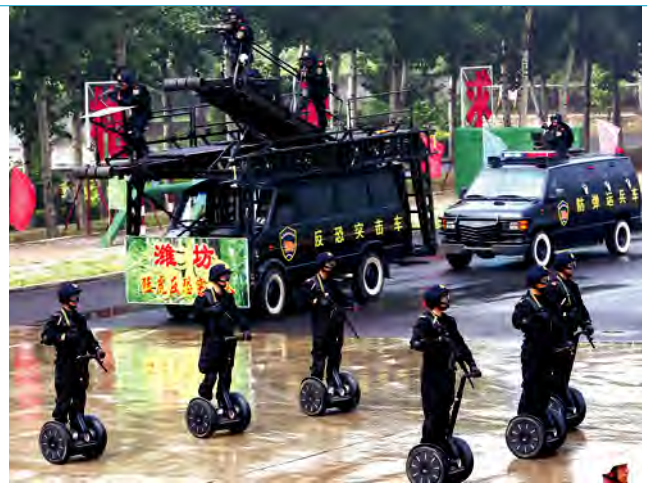
Kamen later described the IT leak as 'the single worst thing that has ever happened to me in business'. Marketing studies conducted for Segway before the launch estimated that the device would sell 31 million units during its first 10 to 15 years; six years later, just 23,500 machines had been sold worldwide.

Kamen says that he does not consider the Segway a failure. 'I think it's a technical success,' he tells me. 'And I think over time, personal, small, nimble transportation will be a huge success in what's becoming a highly pedestrian, city environment. I don't know how the mega-cities in the next 10 or 20 years will bring efficient transportation to people… I know they won't be using cars. I think the Segway is a pretty good shot.'

And, he says, he doesn't mind seeing something into which he poured so much money become the subject of so many jokes. 'If I'm the butt of the joke,' he says tightly, 'I'm the butt of the joke. But, you know, I guess I'm more than happy to let history answer the question of whether my ideas are stupid, or important.'

It's not hard to get the impression that Kamen is a whimsical man. There's the adolescent fantasy of a home, of course, where a hexagonal theme encompasses many fixtures from the built-in furniture to the sinks, there are darkened corridors cut from ragged black rock to resemble tunnels in a mine, and a secret passageway – entered by tugging on the spine of a copy of *Ingenious Mechanisms for Designs and Inventions, Volume 4* – which leads from the library to the kitchen. But there's also North Dumpling Island, three acres of gravel and sand in Long Island Sound, home to a lighthouse with a library and wine cellar that





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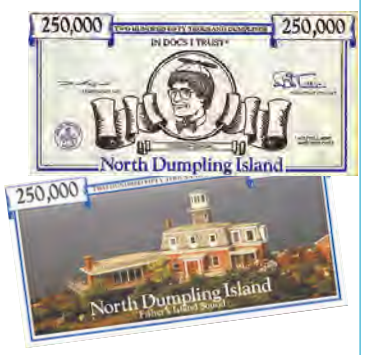
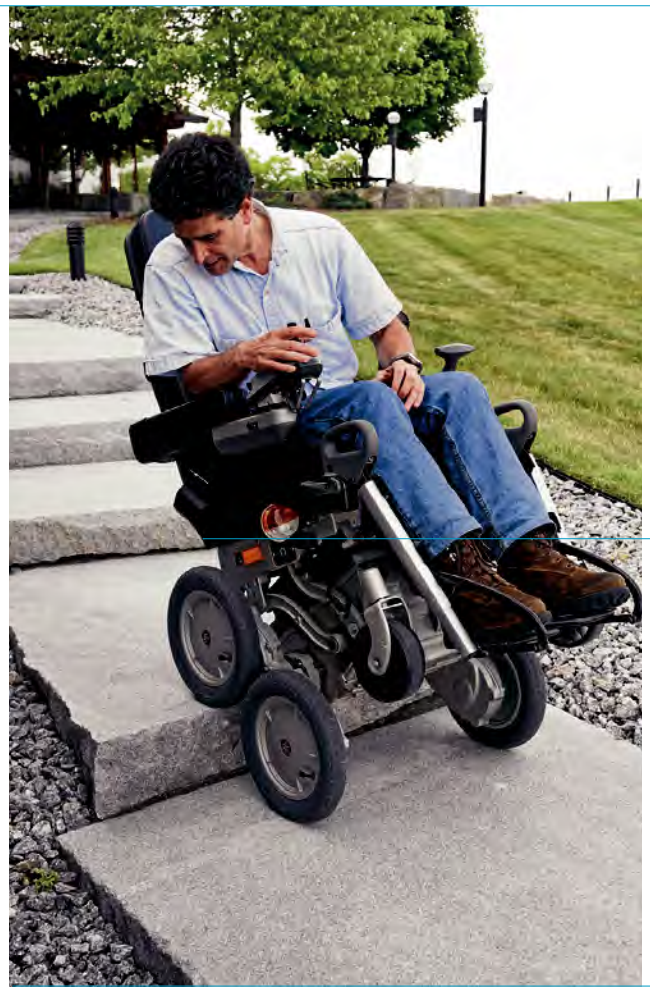
Transport gets personal Clockwise from right: Segway-equipped Chinese police on an anti-terrorism exercise; George Bush takes a tumble; a Segway tour of Paris. Below, currency notes for Kamen's 'independent nation', North Dumpling Island



'If I'm the butt of the joke, then I'm the butt of the joke. But I guess I'm more than happy to let history answer the question of whether my ideas are stupid or important'



When officials objected to his building a wind turbine on his three-acre island, he declared it an independent nation, with a territorial limit of 200 inches

'This thing lets you look people in the eye — it's a really big deal' Kamen with the iBot electric wheelchair, which can 'stand up'

Kamen bought for $2.5 million in 1986. Soon afterwards, he announced his intention to erect a wind turbine there – and when New York State authorities objected, he declared that North Dumpling would become an independent nation, with a territorial limit of 200 inches. He now likes to refer to himself as Lord Dumpling, and will tell anyone who will listen about his fiefdom's currency (the 250,000 Dumpling note features a pen-and-ink portrait of Kamen himself, wearing a bow tie and a cap with a propeller on it), newspaper (*The North Dumpling Times*) and customs regulations (a printed visa form includes spaces to provide distinguishing marks of both the applicant's face and buttocks). Kamen appointed friends and family to positions in the Dumpling cabinet, including Ministers of Brunch and Nepotism, and now keeps a copy of the artificially yellowed North Dumpling Constitution behind glass on an upstairs wall at Westwind.

This image of the Peter Pan of physics is one Kamen does little to dispel – indeed, when at one point he hints that he might not genuinely think that North Dumpling Island is a sovereign nation with plans to join Nato, he quickly adds, 'you can't put that in', like a man keen to preserve a child's belief in Father Christmas. But he also explains that the hexagon provided the best possible engineering solution to building a house on the top of a hill; he visits his private island only once or twice a year, and then only for a day or so at a time. For all his geeky indulgences, the fanciful affectations of the crackpot inventor belie a lifetime earnestly dedicated to changing the world. 'I think people assume that the accountant or the lawyer or even the engineers get up every day and plod along in some career, but I'm some crazy frenetic guy that runs from one silly…' he trails off. 'That it really is The Life and Times of Willy Wonka. And while we all have those moments, most of my life is hard, focused work at trying to do things that are difficult to do.'

Kamen is now regarded as one of the most accomplished electro-mechanical engineers in the world – 'He's extraordinary,' says Bob Tuttle, who has worked with him since 1976 and is now executive vice-president of Deka, 'the ultimate systems engineer.'

'He's often compared to Thomas Edison or Henry Ford,' says Bill Doyle, who met Kamen while working at Johnson & Johnson in the mid-1990s. 'The comparisons are not without merit.'

But Kamen is almost entirely self-taught, and technically never even graduated from high school. As a boy in the New York suburb of Rockville Centre, Long Island, he disliked being told what to do by teachers, and challenged them over their teaching of the principles of maths and physics. His results were often poor – partly because he refused to co-operate with educational conventions. At first, he would only answer test questions when he knew for certain what the answers were; then he gave up answering questions altogether: 'I decided taking a test is a fool's errand. Because the ones you know the answer to, don't waste your time writing down. And the ones you don't know the answer to, why shine a bright light on how stupid you are?'

But at home in his parents' basement, Kamen was tinkering with transistorised electronics. At 16, he produced a redesigned audiovisual system for the Hayden Planetarium in Manhattan, and afterwards went into business, making automated lightshows and presentations. Before he left high school, he was earning $60,000 a year; every penny he made, he spent on new equipment; when all his friends went to Woodstock in 1969, he spent the weekend alone in the basement, finishing an order. But Kamen wanted to do something more, something that would change people's lives for the better: 'I knew that I didn't want to make stupid, superfluous things,' he says. 'I wanted to make important things.'

He had his chance when his elder brother, a medical student at Harvard, complained of the need to administer automatically measured doses of intravenous drugs to hospital patients. As a result, Kamen experimented with off-the-shelf components, devised the world's first drug-infusion pump – and formed a company to manufacture it. To meet demand, he needed more equipment, and a bigger workshop, so he hired an architect and a bulldozer, and surprised his parents by sending them on a Caribbean cruise. In their absence he had the house jacked up, the basement expanded into the backyard, filled with machinery so heavy it had to be lowered in by crane, and then covered with a new patio in time for his parents' return. He carried on paying college tuition for five years, but in the end dropped out without graduating. In the years that followed, he continued to work on advances in medical technology, and produced a portable insulin pump for diabetics. In 1982, he sold the company he had developed, Autosyringe, for about $30 million; he was 30 years old. Shortly afterwards, he created Deka, named for the first letters of 'Dean Kamen', and offered the company's services as inventors for hire.

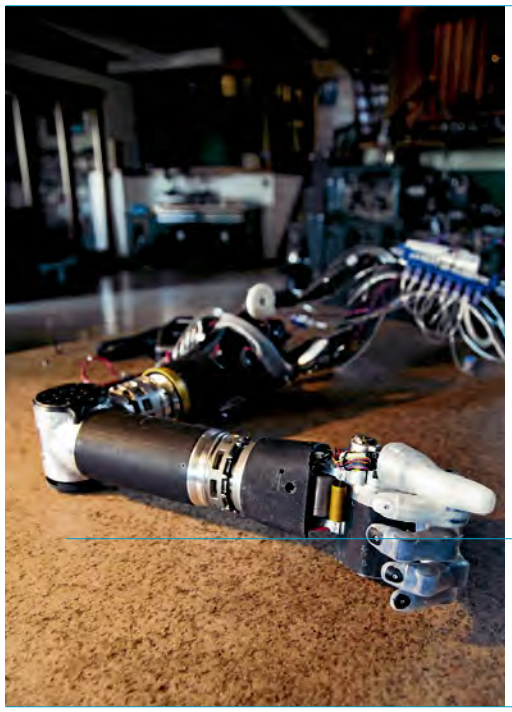
In the corner of his office at Deka headquarters in Manchester, between the giant cardboard cut-out of Darth Vader and the chair painted with another vivid image of Einstein, Kamen and one of the 350 engineers he employs are proudly explaining the thinking that went into one of the company's most successful creations.

'So you get guys like Chris,' Kamen says, looking up from the seat of a cumbersome-looking electric wheelchair, 'who are pretty good at mechanical stuff, systems stuff, control stuff. You put 'em all in a room…' he flicks a few switches and toggles a black plastic joystick on the arm of the chair, '… and you say, "Why shouldn't I be able to do what everybody else does when they've finished sitting around, which is – stand up?"'

At this, there is a whining of servomotors, and the chair abruptly rises into the air on one of its three pairs of wheels, bringing the inventor eye-to-eye with me. Balanced in space, Kamen grabs my hands and challenges me to push him over; I can't; he turns on the spot, the machine remaining perfectly upright on two wheels. This, he explains, is only one of the ways in which the chair, known as the iBot, can transform the lives of the disabled. 'People don't understand,' he says, 'when you lose the ability to walk, mobility is only a piece of what you're missing. You lose dignity, you lose respect, you lose access, because of stairs and curbs. Well, this thing will walk up and down stairs, up and down kerbs, it lets you look people in the eye – it's a really big deal.'

Kamen began work on what would become the iBot in 1990 and eventually sold the medical rights to the technology to Johnson & Johnson, which spent $100 million developing it. Before the iBot finally went on sale in 2003, Kamen told the disabled journalist John Hockenberry that when those testing the chair first experienced the feeling of it balancing in 'standing mode', every one of them burst into tears.

Today, work on new medical technology for such



companies as Johnson & Johnson remains the chief source of revenue for Deka – what Kamen refers to as his 'day job'. But the company has also been responsible for several innovations commissioned by Darpa, the Pentagon's Defence Advanced Research Projects Agency. Among these is the PowerSwim, fins that allow combat divers to swim underwater at up to two knots, and a 'controllable launcher', for fighting in urban environments, which uses compressed air to shoot a man onto the roof of a building in 1.2 seconds: 'That's a fun thing,' Kamen says. 'He goes firing up at high speed, slows down, and just as he reaches the top of the parabolic arc, he's standing there and will just walk onto the building… it's simple physics.'

When he first suggested this solution to the men from Darpa, Kamen says they sat in his conference room and laughed at him. 'And a few months later, I delivered one. And it works beautifully.'

The unexpected success of the launcher led indirectly to the Pentagon bringing an even more taxing problem before Deka in 2006: updating prosthetic technology for the 21st century, to help the increasing numbers of American veterans returning from foreign wars without their arms.

Kamen initially thought the task was impossible; but almost exactly a year later, he unveiled Deka's 'Luke' arm, named after the *Star Wars* character Luke Skywalker, who is given a robotic arm after losing his to Darth Vader. The lightweight prosthesis grants users almost the full range of motion of their original limb – and, with 14 sensors to detect temperature and pressure, enables them to complete tasks as delicate as picking up a raisin or a grape, and be able to tell the difference between the two without looking. 'My guys are very smart,' Kamen says. 'It worked almost the first time. We put it on the first patients and everybody loved it.'

Kamen explains that this is far from his usual experience: the progress of most Deka projects is filled with surprises, almost none of which are pleasant – everything takes longer and is usually more problematic than expected; solutions are not easy; failure is the norm. Most of the problems the engineers seek to solve require years, sometimes decades, of trial and error.

'You know, you have to be optimistic. If you weren't, you'd never start a really difficult project. That's why other people didn't start it – they're rational. So I start these big projects. And in my heart of hearts, I know, boy, a lot's going to go wrong. You just have to be willing to fail a lot and somehow keep your optimism. Well, in the case of the arm, we didn't do a lot of the failing. It went together beautifully.'

Is it true that Kamen has worn exactly the same outfit for 30 years? 'No. I have long sleeves for the winter'

'My guys are very smart. It worked almost the first time'
Kamen's 'Luke arm', named after Luke Skywalker in 'Star Wars'

One of the more unlikely legends about Kamen is that he has worn exactly the same outfit every day for more than 30 years: his wardrobe is filled with sets of identical work boots, Levi's jeans and matching shirts. When I ask him if this is really true, Kamen tugs at the short sleeve of his blue denim shirt and replies, 'No – I have long sleeves for the winter.' The clothes are bought by Kamen's assistants, once a year, in batches of a dozen: he's fond of saying that this is simply practical, because he needs sensible outfits to work in. 'I always wear work clothes when I'm working. But if I'm awake, I'm working,' he tells me.

Kamen hasn't taken a holiday – 'You mean, like, say, "Oh! Let's fly someplace without an agenda and sit around doing nothing," or whatever people do on vacation?' – since he was 14 years old, and remains remarkably out-of-touch with popular culture. Although he does admit to having seen *Star Wars* several times on television, and he watches television late at night when it helps him to sleep, Kamen hasn't been to the cinema since he was a child. Now, he has little idea how to go about seeing a film: 'I guess you'd have to figure out when they start and buy a… right?' he asks tentatively. 'You walk up, buy a ticket… but do they go all day? Or do you have to go at night?'

He once returned from dinner at the White House and asked friends if they could identify the people he'd been seated with, Warren Beatty and Shirley MacLaine. He suffers from dyslexia, and says he has read only one novel in his adult life – a copy of *Cold Mountain* given to him one Christmas by an executive from Johnson & Johnson, which he embarked upon largely because he thought the story of an injured veteran had a healthcare angle the executive was keen on sharing with him. He prefers to relax by reading old academic textbooks from the 1940s and 1950s. 'I read physics. I read math. Everybody has to read those slow. And I'm not as dyslexic with numbers and equations.'

Although Kamen included seven bedrooms in his plans for Westwind, those, too, were intended to help with his work: 'I'm always talking to people. And typically, it goes late,' he explains early one morning, after I've watched Craig Venter, the geneticist renowned for mapping the human genome, wander past on his way to use Kamen's swimming pool.

'So if I just build a house with an easy, convenient place to keep people, we can get more done every day.'

Kamen did spend nearly eight years sharing his home with a girlfriend he met in 1994, but now lives alone. He's decided that he doesn't want to have a family: 'I would rather not be married than ever risk failing at that. It's not like failing at a project: pick yourself up, do another project. But if you have kids and you fail as a father… that's an unrecoverable failure in my mind. I wouldn't want that to happen.'

Kamen's latest project may well be his most ambitious yet: he wants to bring electricity and clean water to the Third World. His plan is not the creation of centralised infrastructure for power grids and sewage treatment, but a small-scale and, relatively, cheap solution. 'Like, how about a device that a couple of people can haul into a village that can turn any source of water – which is typically toxic these days, that kills two million kids a year – into a thousand litres of water a day. How about if we could carry something into a village that could give people a way to make electricity?'

After 12 years working on these two problems, the engineers at Deka now have their solutions on show at the workshops in Manchester. The first is the 'Slingshot', a large box about the size of an office photocopier, sheathed in black protective foam, that can cleanse water of any contaminant from radionuclides to sewage, and run for years at a time without maintenance. The second is another metal box, five feet square, connected to a bottle of compressed gas, which emits a low murmur of humming energy. This is a Stirling engine, similar to the one installed in his electric car, but large and efficient enough to electrify an entire village, which can be driven by any locally available source of heat. Both devices have already been proved amazingly effective: one six-month test has used a Stirling engine to provide electric light to a village in Bangladesh, powered by burning the methane from a pit filled with cow dung; Slingshot has undergone similar tests in a settlement in rural Guatemala. But Kamen has yet to find a commercial partner to manufacture either of the devices for the customers that need them most. 'The big companies,' he says, 'long ago figured out – the people in the world that have no water and have no electricity have no money.' He's tried the United Nations, too, but discovered a Catch-22: non-governmental organisations won't buy the devices until they're in full production.

Nevertheless, he maintains that the project is close to fruition, and there's too much at stake – in every sense – to give up now. 'If you include all the money we've spent on Stirling, and all the money we've spent on the water project, it probably is in the area of $50 million. And I'm a little company, and that's a lot of money. But I believe in it. I just believe in it. It might fail, but you've got to try. Look at the state of the world,' he says. 'It's a mess. What if we can fix it?'