FAIL BETTER

A collection of inspirational failures

Curated by Jane ní Dhulchaointigh and Michael John Gorman

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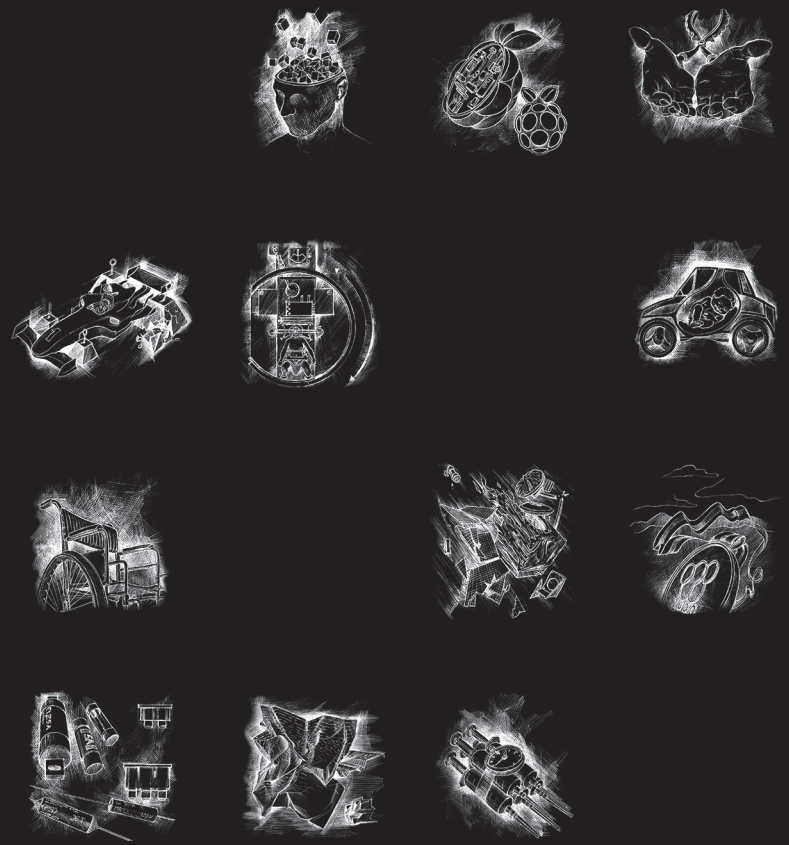


SCIENCE GALLERY

TRINITY COLLEGE DUBLIN

FAIL BETTER

Contents

Why FAIL BETTER?

Michael John Gorman
Director of Science Gallery and FAIL BETTER curator

Previously stigmatised, scorned or brushed under the carpet, in the last decade or so failure has been enjoying something of a Renaissance. It is frequently suggested that rather than bury our failures, we should wear them as a badge of honour. Silicon Valley venture capitalists apparently hesitate to invest in entrepreneurs who have notched up less than three major failures. "Fail early, fail fast, fail often" is a common phrase among start up companies.

The goal of FAIL BETTER is to open up a public conversation about failure, particularly the instructive role of failure, as it relates to very different areas of human endeavour. Rather than simply celebrating failure, which can come at great human, environmental and economic cost, we want to open up a debate on the role of failure in stimulating creativity: in learning, in science, engineering and design. Should we

"Rather than simply celebrating failure… we want to open up a debate on the role of failure in stimulating creativity: in learning, in science, engineering and design."

embrace failure in all its painful glory? Or should we instead seek to cultivate a culture of openness around failure, as a necessary ingredient of all experimentation and prototyping?

Serendipitous accidents have a powerful role in the stories we tell about scientific discoveries. Alexander Fleming accidentally contaminated a dish containing a bacterial culture with a blue green mould. He noticed to his surprise that the colonies of *Staphyloccus* bacteria adjacent to the mould were inhibited, leading to the discovery of the antibiotic properties of penicillin. Robert Wilson and Arno Penzias accidentally discovered cosmic background radiation when they were trying to eliminate background 'noise' on a radio antenna. Initially they suspected that pigeons or urban interference might be to blame before they suggested that they might be observing the leftover radiation from the Big Bang, earning them the Nobel Prize in Physics. In the medical arena, the current debate about the publication of negative clinical trials data reveals the

force of publication bias towards success, a challenge not only in medicine but in all scientific research where frank admission of failure is crucial.

In engineering and design, failure has an even more central role. The quote attributed to Thomas Edison about the light bulb, "I have not failed, I have just found 10,000 ways that don't work", is almost certainly apocryphal but it captures something important about the role of failure in the creative process. Engineers design systems with built-in redundancy, allowing them to fail 'gracefully'. However, from Deepwater Horizon to Fukoshima, we are all too frequently reminded that failure is often far from graceful, and those human and mechanical failures are inevitably intertwined. How can we all learn to, as Dubliner and Trinity graduate Samuel Beckett put it, "fail better"?

FAIL BETTER is intended to spark a fresh conversation about failure and its role in the creative process. We are delighted to be able to seed this

public conversation with some surprising and personal stories of failure from an extraordinary group of contributors from around the world, who have been incredibly generous in their participation. I would like to thank our curator Jane ní Dhulchaointigh, a designer and the inventor of Sugru, and our tireless researcher Tessa Delahanty for their work in hunting down spectacular failures from around the world. I would also like to thank the Science Gallery team and all of our wonderful supporters.

76,634 Fails and Counting

Jane ní Dhulchaointigh
FAIL BETTER Curator

I didn't mean to invent Sugru, it happened by mistake.

Art was too hard for me, and I failed at it pretty fast. From high hopes, it took me less than a year to give up. [Fail no. 0068532] Instead, I decided I'd reinvent myself by becoming a wildly successful product designer. I loved 'stuff'; so how cool would it be to design it? And how hard could it be? Well… quite hard too, I found out. Having dreamt, worked and achieved my way into the prestigious design department at the Royal College of Art, I realised after only a few weeks that although I did indeed love 'stuff', on reflection, I didn't actually like 'new stuff' all that much. In fact, I kind of hated it, and the consumerist system that churns out more and more of it every minute of every day. [Fail no. 0068545] And to boot, I could see I wasn't a very good designer. [Fail no. 0068562]

In all my enthusiasm, I could definitely conclude that, without a doubt, I'd signed up for the wrong course, and the wrong career. But it wasn't to turn out as clear-cut as that, because of what happened next. Tricky situation. What's a girl to do? The best this girl could do was hide away in the carpentry workshop and try to find some thinking space.

I think with my hands, by doing things, so I started playing with materials. It took me back to my sculpture days, my bread making days at home and even my mud-cake and sandcastle making days. I destroyed things like wood, foam and concrete and put them back together in different combinations to see if they would be interesting. [Fail no. 0068576 – 0068635] One day, I mixed together silicone with waste wood dust. It looked like wood, but I could shape it in my hands. I formed it into a ball and left it on the bench. After lunch, it felt hard. Something made me throw it on the ground. What happened next made me break out into laughter and run into

the studio next door to show anyone I could find. When it landed on the ground, it didn't just bounce a little, it bounced a lot! Right back up into the room like a ping-pong ball. My moment of delight led to an obsessive search to find the purpose of this odd stuff I'd made. For weeks I searched high and low for the one big problem or opportunity for it, until I ran out of steam. [Fail no. 0068701–0068853]

It was at the point of giving up that we found it, right under our noses. I'd used leftovers of my mixture around the house to fix my kitchen sink plug, and change the shape of an uncomfortable knife handle. Comforting my tears of frustration, my boyfriend James helped me see what I'd done, and what it could mean. The penny dropped. What if this material could turn anyone into a designer? What if everyone could improve, adapt and fix things so they worked better for longer?

A whole new world opened up in my mind where we didn't need to keep buying new stuff all the time, we

have enough stuff, we just need to make it work better. The idea for Sugru was born.

The journey to bring it to life took six years from this delightful moment of clarity [Fail no. 0068904–0075749], and it's taken me into the worlds of chemistry, materials science, intellectual property, business, fundraising, design, marketing and manufacturing. The process of creation has brought me through thousands of small and a few big victories and failures. The victories are sweet, although I've found it's the failures that not only drive you to do better and shoot higher, but that cause you to reflect. The times where we've failed have led to our thinking opening up and this is when most of our best ideas have emerged and best decisions have been made.

Failing better doesn't just mean that failure is ok. The start-up mantra to embrace failure can be an excuse to do average work and never really commit to your ideas. Failing better means that, if it happens,

failure can be more powerful than you've ever known, just as success can be. And for that to happen, it's all in the intent. For me, failing better means setting all of your heart on an idea, giving every ounce of your commitment to it, putting a stake in the ground, and shouting it from the rooftops. Failing better is what happens along the way when you really go for it.

A collection of inspirational failures

Curated by Jane ní Dhulchaointigh and Michael John Gorman

Samuel Beckett, *Worstward Ho*

"Ever tried. Ever failed.
No matter. Try again.
Fail again. Fail better."

The Wrong Boots

Selected by Ranulph Fiennes

I don't like heights and I don't like climbing but despite this, I decided to climb Mount Everest in 2005. In the preceding two years, my wife of 38 years, my mother, and two of my three sisters had died and I was in a bad state mentally. So I thought, 'I must get my mind off it'. One way of doing that was to do something I really didn't like: climbing. So in 2005, I decided to climb Everest with a friend, Sibusisu Villane, from the side he wanted to—Tibet. The trouble was, as I was 61 by then, I couldn't keep up with the 30 and 40 year old climbers in our group. Despite this, everything went pretty well and if I hadn't had an angina attack I would have probably succeeded on that attempt. But I didn't, and I decided my next attempt in 2008 would be from the Nepal side.

I was determined to succeed this time, and so, to give myself an edge on these young climbers, I decided

against properly insulated climbing boots which are heavy, in favour of light ones. I thought they would help me keep up. Unfortunately they had the opposite effect, which was to swell my feet up and give me bad blisters. It was too late when I discovered my mistake and I couldn't tell anybody that I'd been so stupid.

I did manage to get quite high on that attempt despite the state of my feet. But I didn't make it. It wasn't until

2009, using heavy, properly insulated boots, that I did actually get there. The lesson I learned was not to try to keep up with people. Just plod along in your own time. This time, instead of going with Europeans, I went with just one Sherpa. I knew that my highly competitive nature would not even try to compete with the Sherpa. They can climb like goats and I accepted that next to the Sherpa, I was a second-rate human.

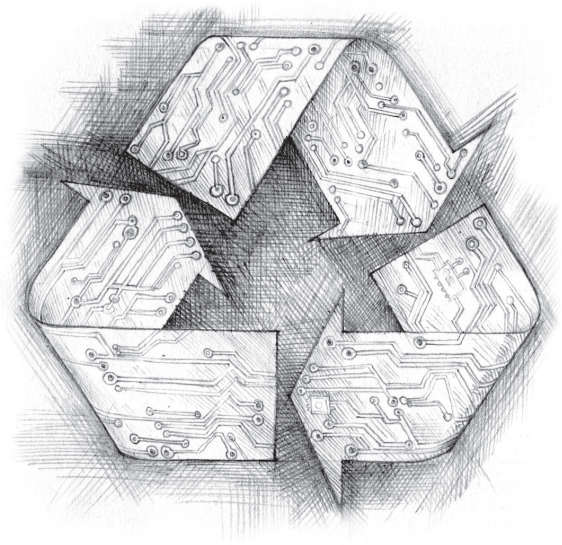
Ranulph Fiennes, also known as Sir Ranulph Twisleton-Wykeham-Fiennes, 3rd Baronet, OBE, is a British expedition leader and holder of several endurance records. After failing his A-levels at Eton, Ranulph served in the British Army for eight years. He later undertook numerous record-breaking expeditions and was the first person to visit both the North and South Poles by surface means during the Transglobe Expedition (1979–1982). He was the first person to completely cross the Antarctic continent on foot. In May 2009, at the age of 65, he climbed to the summit of Mount Everest. According to the *Guinness Book of Records* he is the world's greatest living explorer. Ranulph is also a prolific charity fundraiser, having raised over £14m for different UK charities. He has written numerous books about his army service and his expeditions, as well as a book defending Robert Falcon Scott from modern revisionists.

Soluble Circuit

Selected by Ellen MacArthur

Should electronics be designed to fail after a defined period of use? Although most people argue ‘no’, many will debate about the role of ‘designed obsolescence’ in many of today’s products. The majority of business models were built for a linear ‘take-make-dispose’ economy, so sometimes it’s in the manufacturer’s interest for a product to fail after a certain amount of use. However, there are signs that this business model won’t work long-term. Tweaking design to enable easier repair, upgrade and remanufacture could be appealing for businesses and the wider economy, especially in a world where technology advances so quickly.

We have assembly lines that are rapid, automated, and scalable. What would products, and the systems in which they fit, look like if we put as much thought into the disassembly process? We don’t want a



phone that will fall apart in use, but at some point it makes sense to access upgradable parts or to recover the valuable materials inside. There are amazing disassembly technologies that enable products to reach the end of a cycle when and how the manufacturer chooses—I’ve selected this soluble circuit board from the National Physical Laboratory.

Rather than shredding (the current route for most circuit boards), after submerging this circuit board in warm water the bonding ‘positively fails’ by disappearing, thus enabling the component parts to be easily removed to recover the resources into purer, more valuable materials streams.
A regenerative circular economy is a framework, powered by renewable energy, and in which biological and technical materials repeatedly cycle. It is catalysing innovation amongst businesses, governments, scientists and students around the world. Some of these innovations will fail, but those that succeed will be crucial in driving economic progress in the 21st century.

Ellen MacArthur made yachting history in 2005 when she became the fastest solo sailor to circumnavigate the globe, and remains the UK’s most successful offshore racer ever, having won the OSTAR, the Route du Rhum and finished second in the Vendée Globe at just 24 years of age. In 2010, having become acutely aware of the finite nature of the resources our linear economy relies upon, she stepped away from professional sailing to launch the Ellen MacArthur

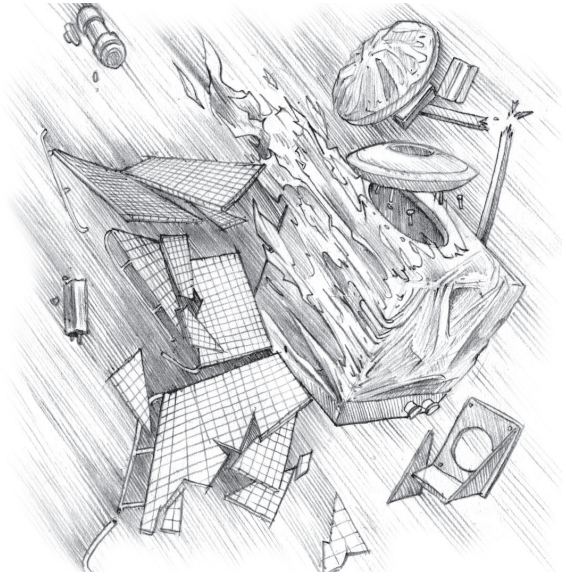
Foundation in 2010, which works with education and business to accelerate the transition to a regenerative circular economy. Ellen MacArthur sits on the European Commission’s Resource Efficiency Platform, and her foundation has published two seminal macro-economic reports. She regularly interacts with European governments and institutions, and received the French Legion of Honour from President Nicolas Sarkozy, three years after having been knighted by Queen Elizabeth II.

The Mars Climate Orbiter

Selected by Jocelyn Bell Burnell

The Mars Climate Orbiter was a robotic space probe launched by NASA on December 11th 1998 to study the climate, atmosphere and surface changes on Mars. On September 23rd 1999, NASA issued a press release stating that the Mars Climate Orbiter was believed to be lost. A day later they abandoned their search and it was logged as a failed mission. After a week of investigations, NASA finally revealed what happened to the 125 million dollar spacecraft. They announced in a statement that, “people sometimes make errors.”

The error was that one team used imperial units while the other used metric. The software being used calculated the force the thrusters needed to exert in pounds, then a separate piece of software took in the data assuming it was in metric units or newtons—a factor of four and a half difference!



Their planned approach of the planet, at an altitude of about 150 kilometres, was therefore off and it hit Mars’ atmosphere at an altitude of about 60 kilometres. As a result, the Mars Climate Orbiter likely disintegrated due to atmospheric pressure.

The world looked on, amazed that the NASA engineers didn't catch the mistake. Even at the highest level errors happen and can go unnoticed, proving that attention to detail is always paramount.

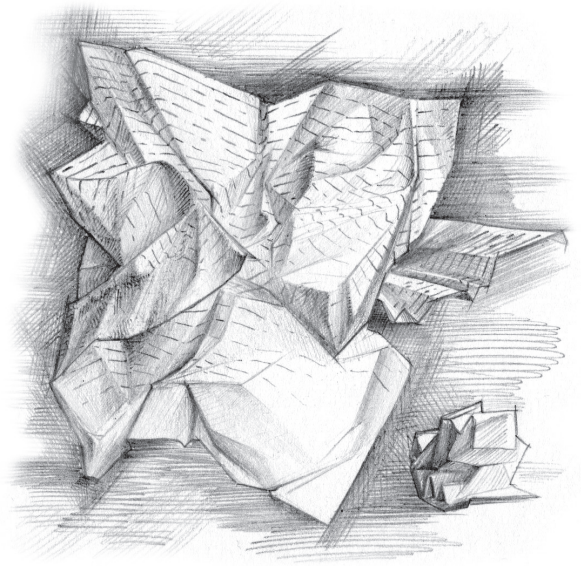
Jocelyn Bell Burnell was born in Belfast in 1943, at a time when science was not a subject commonly studied by girls. In 1965, Jocelyn earned a B.Sc. degree in physics from the University of Glasgow. Later that same year she began work on her Ph.D. at Cambridge University. It was while she was a graduate student at Cambridge, working under the direction of Antony Hewish, that Jocelyn discovered pulsars. This was one of the most significant astronomical developments of the twentieth century but in 1974, when her supervisor Antony Hewish was awarded the Nobel Prize, Jocelyn was not included in the award. Awarded her Ph.D. in radio astronomy from Cambridge University in 1968, Jocelyn has studied the sky in almost every region of the electromagnetic spectrum and has received many honours and awards for her contributions to science. She was the first female president of the Institute of Physics of the UK and Ireland, became Pro-Chancellor of Trinity College Dublin in 2013 and is a visiting Professor of Astrophysics at Oxford University.

Samuel Beckett—Original manuscript drafts of Worstward Ho

Selected by Michael John Gorman

For Beckett, failure was the ultimate goal of art. As he wrote in his *Three Dialogues*, "to be an artist is to fail, as no other dare fail, that failure is his world and the shrink from it desertion". His works play constantly with failure of narrative, dialogue and language itself. Beckett's most memorable formulation on failure was presented in his late novella *Worstward Ho*: "Ever tried. Ever failed. No matter. Try Again. Fail again. Fail better".

Beckett's vision of heroic failure as the vocation of the artist has a strange contemporary echo in the current Silicon Valley mantra, "Fail Fast, Fail Early, Fail Often". Beckett's idea of 'failing better' is seductive. What does it mean to fail better? When Beckett was awarded the Nobel Prize in Literature in 1969, he reportedly declared to his wife that the



news was “a disaster” as the publicity would undoubtedly distract him from his writing, and he did not travel to Stockholm to collect the award. Fame and conventional success were abhorrent to Beckett.

Years ago I happened to be living in an apartment building in Paris which Beckett used to walk past

every day at precisely the same time, as he traced an identical route past the Observatory and towards La Closerie des Lilas and the Place de l’Odéon. He used to disguise his lanky frame in different ways with assorted hats, scarves and sunglasses, but was as regular as clockwork so people would spot him and look at their watches and exclaim “*C’est Beckett!*”. Even in his quest for anonymity, he was a failure. For me, Beckett is the ultimate poster-boy of failure. As for Sisyphus, for both the artist and the scientist, failure is not an end point but an essential component of a cyclical process. What I especially love about this manuscript of *Worstward Ho* is that it shows that Beckett attempted multiple revisions of his text: even he couldn’t get it right first time around.

Michael John Gorman, one of the FAIL BETTER curators, is the Founding Director of Science Gallery and the CEO of Science Gallery International. Currently, through a gift of €1M from Google.org, he is developing an international Science Gallery network in partnership with leading universities in urban centres worldwide. Michael John is also Adjunct Professor of Creative Technologies at Trinity College Dublin,

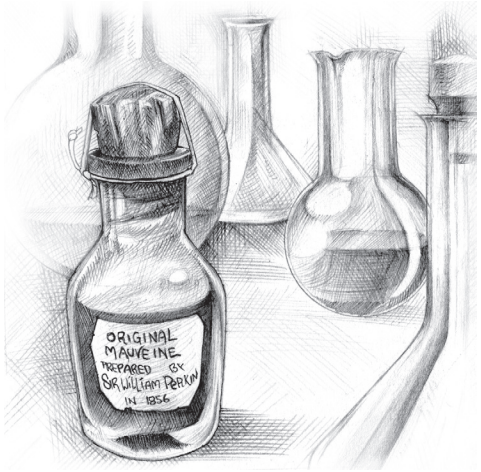
Director of the Idea Translation Lab (in partnership with Harvard University) and Coordinator of the European StudioLab project. Prior to coming to Trinity College Dublin, he worked at Stanford University where he lectured in science, technology and society, and has held postdoctoral fellowships in Harvard University and MIT. He has authored numerous publications and articles on aspects of the relationship between art and science and the history of science. He holds a Ph.D. in 17th century history of science from the European University in Florence.

Mauve

Selected by Ken Robinson

The accidental invention of the colour mauve was made in 1856 by William Perkin. William was trying to develop a synthetic version of quinine and had been experimenting with coal tar. He kept failing. One night, after another day of dead ends, he was about to leave the laboratory when the light from the gas lamp glanced off the edge of a beaker. The beaker was filled with a coal tar solution and shot out a brilliant purple light. He was curious, diluted the mixture and discovered a colour that isn't in nature at all. William, a painter and photographer, took a keen interest in his new discovery.

The colour became a sensation and William went on to found the synthetic dye industry, which in turn led to the development of the chemical industry at large, including the chemicals for the photographic industry. It also contributed to chemistry being taken



seriously as a commercial and academic discipline. All of this began with William Perkin failing to do what he set out to do, but seeing a different possibility in what he had done.

Ken Robinson is an expert in the field of creativity and innovation in business and education. His visionary consultancy skills are employed by governments, major corporations and cultural organisations worldwide. He holds a Ph.D. from the University of London for research into drama and theatre in education. He was the principal author of *The Arts in Schools: Principles, Practice and Provision*, Director of The Arts in Schools Project, and Chair of the National Advisory Committee on Creative and Cultural Education. He was Professor of Education at Warwick University in the U.K. and is now Professor Emeritus. Among other roles he is currently senior advisor to the J. Paul Getty Trust in Los Angeles. In June 2003, he was knighted by Queen Elizabeth II for his outstanding achievements as a writer, speaker and leader in creativity, the arts and education.

The NeoNurture

Selected by Timothy Prestero

Every year over 4 million infants in the developing world die within a month of birth. Half of these newborns would survive if given a warm, clean environment in which to grow stronger. In developing countries, not only is there limited access to modern, high-tech incubators, but a lack of infrastructure and replacement parts render such devices worthless. We decided to make an incubator that takes advantage of abundant local resources — car parts and mechanics.

In the NeoNurture, we used sealed-beam headlights as a heating element, a dashboard fan for convective heat circulation, signal lights and a door chime serve as alarms, and a motorcycle battery and car cigarette lighter provided backup power during incubator transport and power outages. The NeoNurture featured in exhibitions and publications worldwide and was listed as number 1 in *Time Magazine's* 2010

issue, 'The 50 Best Inventions of the Year'. Despite this recognition, it never got beyond a prototype. While awards are fantastic, they still felt like a booby prize.

Here's the problem: every doctor and hospital administrator in the world who has seen *ER* knows what a medical device should look like. They don't want effective technology that looks like it's made from car parts. It sounds crazy, but some hospitals would

rather have no equipment than something that looks cheap and crummy. They didn't want our incubator. And so it never got beyond a prototype.

I got to thinking, if I want to change the world, I have to actually pay attention to how people are going to use a device. Really, there's no excuse for failure. I have to accept that there are no dumb users, that there are only dumb products. I got into this business designing products. I've since learned that if you really want to make a difference in the world, you have to design outcomes. It's design that matters.

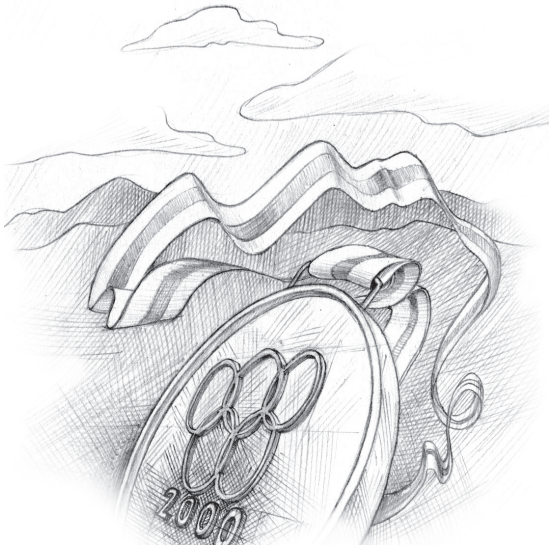
Timothy Prestero is the founder and CEO of Design that Matters, a nonprofit that collaborates with social entrepreneurs and volunteers to design products for the poor in developing countries. A former Peace Corps volunteer and MIT graduate, Tim has worked in West Africa, Latin America and Asia. He is a Martin Fellow at the MIT Laboratory for Energy and the Environment, a Draper Richards Kaplan Fellow, and was named an Ashoka Affiliate in 2004. His awards include the 2007 Social Venture Network Innovation Award, and the 2009 World Technology Award. This year, Design that Matters was named the winner of the National Design Award in Corporate and Institutional Achievement.

Olympian

Selected by Sonia O'Sullivan

My accreditation pass from the 1996 Olympics in Atlanta reminds me of when I failed to live up to all expectations based on my achievements up to that point, including being the reigning world champion over 5000m.

The following year, I tried to erase the failure at the World Championships but once again came up short because I was trying too hard to overcome the failure and prove that I was still a great athlete. It was only after this disappointment in 1997 that I accepted the failure that occurred in Atlanta the year before and took the decision to walk away from everything in my past, whether good or bad. This was when I was able to shut the door and start all over again and realise that failure may be the end of one chapter in your life but it doesn't mean that you will never be successful again.



(Three years later, in 2000, Sonia O'Sullivan took home the silver medal in the Sydney Olympics in the 5000m, becoming the first Irish woman to win an Olympic medal in athletics).

Sonia O'Sullivan was born in Cobh, County Cork, where she spent many years running around the hills before embarking on an athletics scholarship at Villanova University, in Pennsylvania, USA. She graduated in 1992 with a

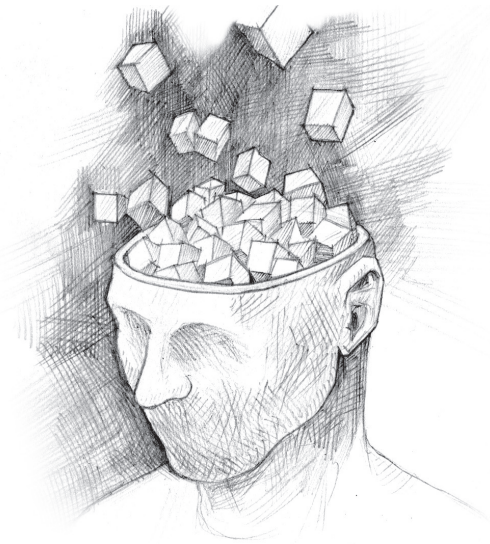
degree in accountancy ahead of her first Olympic Games in Barcelona. In Barcelona Sonia established herself on the athletics scene, finishing in 4th place over 3000m. This was the launch pad of a very successful athletics career that saw her compete in four Olympic Games, including a silver medal winning performance in Sydney over 5000m in 2000. The Olympic silver medal capped a string of successes by Sonia, which includes three World Championship gold medals, three European Championship gold medals, and four world records. Sonia still holds the world record over 2000m, along with every Irish record in the books over distances ranging from 800m to half marathon. She lives in Melbourne, Australia with her daughters Ciara and Sophie.

The Ice Pick Lobotomy

Selected by Shane O'Mara

Would an ice pick driven through the eggshell thin bone above your eye into your brain cure your 'maladies', your 'melancholy', your 'madness'? During the middle decades of the 20th century transorbital lobotomy, or 'ice pick' lobotomy, a radically invasive form of brain surgery, was used extensively for patients with psychiatric illnesses. It was a rapidly executed procedure, taking perhaps a few tens of minutes in total, requiring no more than a local anaesthetic, conducted for the purposes of 'psychosurgery'.

This was the era before effective pharmacotherapies or psychotherapies for psychiatric illnesses; an era before there was an outline understanding of the psychological functions supported by the frontal lobes. We now know much about the frontal lobes: they support 'executive functions' within the brain such as planning, intending, imagining alternatives, initiating actions, directed remembering, and deferring



gratification. In short, what makes us human.

In the unfortunate patient, the frontal lobes would be cut away from the rest of the brain by a simple and quick side-to-side motion, leaving the person with irreversible and enduring consequences. There were good intentions behind the procedure —curing the 'incurable' by radically intervening in

the brain. However, transorbital lobotomy rendered many of its victims docile, mute and compliant. This therapeutic surgical strategy was a terrible but instructive failure of medical ethics, of patient treatment, and of neurological understanding of brain function and dysfunction. The legacy is what can go wrong. Medical ethics, safeguards and precautions have evolved so that similarly reckless experiments can never be conducted again.

Shane O'Mara is Professor of Experimental Brain Research at the School of Psychology in Trinity College Dublin, and the Director of the Trinity College Institute of Neuroscience. Shane's research centres on examining how the brain makes memories. He explores what life would be like without memory, our enduring personal record of our hopes, experiences, desires, wishes, needs, loves and hatreds. He is particularly interested in how memories are encoded by neurons in the brain, and how this encoding is affected by psychiatric or other conditions. Shane is also interested in public policy applications and counterfactual interpretations of neuroscience, and has published over 100 papers in these areas.

The Third Policeman

Selected by Anne Enright

Flann O'Brien's first book, *At Swim-Two-Birds*, sold very few copies before Longman's warehouse, and with it all remaining stock of the book, was burnt down by the Luftwaffe in 1940. It had been, however, published in London, and this was enough to alert the lags of the Palace Bar to the idea that O'Brien was a 'coming man' of the literary scene over which they presided. Many of these drinkers worked for *The Irish Times*: Bertie Smyllie was editor, Austin Clarke chief poetry reviewer, and Pussy O'Mahony ruled the advertising section. Their conversation, according to Patrick Kavanagh, was on such significant matters as George Moore's use of the semi-colon and what English journals paid for book reviews.

When O'Brien's second novel, *The Third Policeman*, was turned down by Longman for being more fantastical than his first, he could not face Dublin

opinion and put it about that the manuscript had been blown out of the boot of his car, page by page, on a long trip to Donegal. The book, published a year after his death, was not only hailed as important in some way or other, even described as “the first post-modernist text”, it also makes people laugh out loud on public transport and on beaches and in their beds. In the literary world, a book is a failure if you say it is a

failure, and some books are a success because they are declared a success, and time is a great wind, that blows our words into a future we cannot know.

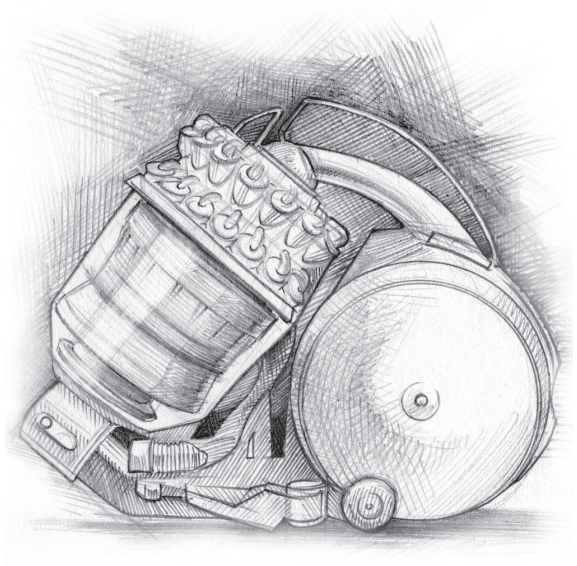
Anne Enright has written five novels and two collections of short stories. She is also an essayist and critic. Never rejected by a publisher, her fiction has won various prizes, and she has two children of whom she is inordinately proud. What might be called a fruitful life, however, is experienced as an endless series of small failures. If you get nothing done all day, every day, she says, at the end of two years, you will have written your book.

2,000 Dysons Later

Selected by James Dyson

The design process depends on new ideas, failed experiments, and incremental improvements. Collectively these little failures let engineers make big leaps. It's the approach I took when I ripped my hoover apart back in 1978 to create the first cyclonic vacuum cleaner. I was frustrated with vacuum cleaner bags losing suction and thought, there must be a better way. Ripping the bag off the machine was just the start. It then took me 5,127 prototypes to develop the final machine, each failed prototype informing the next one. There is always room for improvement and we have been iteratively improving the machine ever since.

Today Dyson has more than 1,500 engineers and scientists developing new technology by testing, breaking, and tweaking across hundreds of prototypes before we launch a new machine.



DC54 is the result of over 2,000 prototypes. We've achieved a machine that, in its lifetime, will never lose suction. It means that it will suck up just as much dust and dirt ten years from now as it did on day one.

Bagged vacuums lose suction as pores clog. And other cyclonic vacuum cleaners often rely on filters to capture dust, which also clog, causing loss of suction.

By using small, tightly packed cyclones to generate high centrifugal forces, we've got to a stage where we can banish replacement vacuum filters as well as vacuum bags. Instead, the cyclones inside DC54 contain flexible tips that oscillate at extremely high frequencies. It took 50 iterations of the technology and plenty of failure just to find the right material.

James Dyson is an industrial designer, inventor and the founder of Dyson Appliances. He invented the Dual Cyclone, the UK's best-selling vacuum cleaner. He is also a board member of the Design Council and was appointed a CBE in the 1996 New Year Honours. He lives in Malmesbury, Wiltshire.

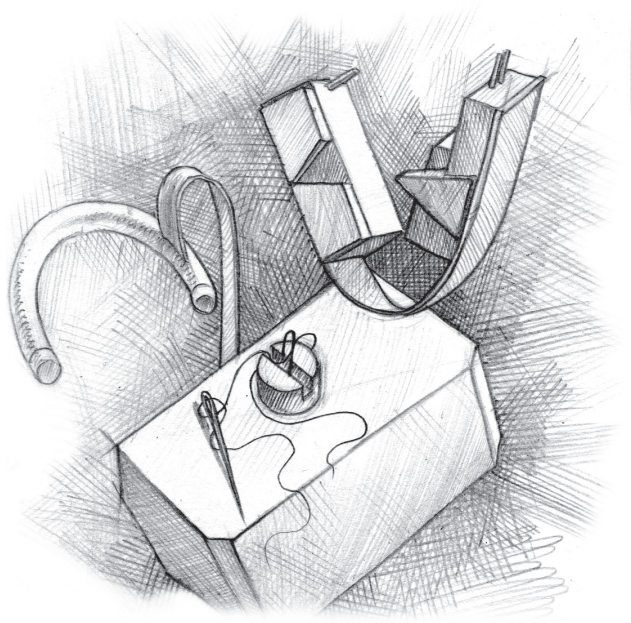
Fixperts

Selected by Jane ní Dhulchaointigh

As well as the more obviously inspiring examples of failure, I was really keen that FAIL BETTER should also include everyday failures—those on the scale we all experience every day, and often learn not to see anymore. There's so much beauty and potential to be found here if we just slow down enough to see it.

I'm a passionate believer in the power of making and fixing in order to change our relationship with the 'stuff' of the world, and create a more laterally thinking, skilled society while we're at it. It's for these reasons that I'm a huge fan of Fixperts.

Like a lot of successful collaborations, it all started with an open conversation. James Carrigan, a designer and my co-founder at Sugru, couldn't forget about how amazing it felt to help a local school kid by fixing a broken joystick on her electric wheelchair.



Daniel Charny (curator of the V&A's blockbuster show *The Power of Making*) couldn't shake the thought that fixing could be seen as a form of design, that it might have the potential to open up design thinking to a whole new set of people, and bring more meaningful projects to design education.

They hit on a big idea. Life is full of endless, small failures, which most people can't fix, or think they can't fix. Designers and makers are full of potential —they have skills, confidence and they often love to make a difference. What if the people with needs could be paired up with a designer or maker? A fixpert of sorts? And so, Fixperts was born!

In the eighteen months since that conversation, design schools in ten countries have paired up with local community groups to work together on fixes. Many more individuals have been connected, and seemingly small problems have been solved simply, with incredible spirit, and often to life-changing effect.

There are now almost 100 fix films on Fixperts.org explore what others have done, and if you like the stories, become a Fixpert yourself!

Jane ní Dhulchaointigh, one of the FAIL BETTER curators, is the inventor of Sugru (inspired by the Irish word for play), an innovative product that has been described as "21st century duct tape" by *Forbes* and was named alongside

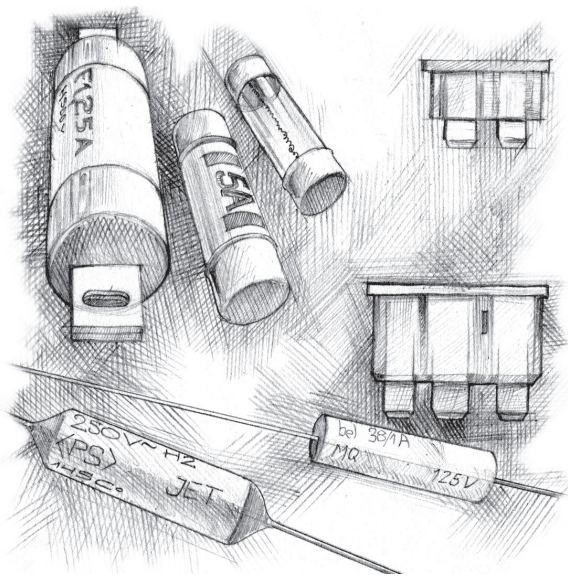
the iPad by *TIME Magazine* as one of the Top 50 Inventions of 2010. Jane was studying product design at the Royal College of Art in London in 2003 when she had her big idea. From that initial spark, she led a long and dedicated scientific development process to develop a brand new silicone that the user can form into whatever shape they like before it air cures into a tough, flexible, colorful silicone rubber. Used in this way, it can make all kinds of products safer, more comfortable or simply better. Jane is passionate about promoting a culture of fixing, creativity and resourcefulness, and sees it as an antidote to the throwaway mindset.

The Humble Fuse

Selected by Tim Harford

The humble fuse is a simple idea. When too much electric current surges through a circuit, it brings the risk of damaging expensive equipment, or people for that matter. The fuse is designed to melt and break the circuit before that happens. The first to suggest such an idea was Louis-François-Clement Breguet in 1847—he wanted to protect electrical telegraph equipment from lightning strikes.

The fuse concept isn't unique to electrical engineering. The mechanical equivalent is the shear pin, a part which is designed to break in emergency situations before something more expensive does. Engineers understand that in a complex world, sometimes things go wrong, and there is value in making sure that the failure occurs early and in a convenient place. Fuses are cheap. Human beings are not.



Where are the fuses and shear pins in our social and economic systems? Democratic elections can be seen as a kind of fuse—less about voting in competent governments, more about throwing out terrible ones. But our financial system lacked a fuse. The first failures were not small, and they did not protect the rest of the economy from catastrophic damage.

In 2005, the then Chief Economist of the International Monetary Fund, Raghuram Rajan, paraphrased St. Augustine, saying "Lord, if there be shocks, let them first be small ones. The danger is that the economy will be hit unexpectedly by a perfect storm before it has been stress-tested." Rajan was hoping that the financial system had a fuse that would fail before something more serious happened. It didn't.

Tim Harford is an economist, journalist and broadcaster. He is the author of *The Undercover Economist Strikes Back* and the million-selling *The Undercover Economist*. He is a senior columnist at *The Financial Times*, and the presenter of Radio 4's *More or Less* and *Pop Up Ideas*. Tim has spoken at TED, PopTech and the Sydney Opera House and is a visiting fellow of Nuffield College, Oxford.

Radioactive Moonshine

Selected by Holly Morris

On April 16th 1986, the Chernobyl Nuclear Power Plant's reactor number 4 blew up after a cooling capability test. The resulting nuclear fire lasted ten days, spewing 400 times more radiation than the bomb dropped on Hiroshima. To date, it's the world's worst nuclear accident.

But nearly 28 years after the disaster—amidst a quagmire of politics and science around nuclear energy—the human parable of Chernobyl is often lost.

This is best embodied in approximately 130 'self-settlers' who live inside the Chernobyl 'Exclusion Zone'. Almost all of them are women. We first encountered this community while filming in the exclusion zone, just a few miles from a mass of radioactive lava that even now simmers beneath a crumbling reactor. We saw a bizarre sight—a small cottage straight out of an ancient folk tale, surrounded

by lush vegetable gardens and farmyard animals. Then we saw Hanna, a striking woman in a colourful print skirt, headscarf and rubber boots, making her rounds. At her cottage, Hanna offered us homemade moonshine and thick slices of raw pig fat. "Starvation is what scares me, not radiation", Hanna said. Their moonshine is to drink and share but also to barter with.

Like the wolves, moose, wild boar and other wildlife not seen for decades that have come back to the abandoned forests around Chernobyl, the women of the exclusion zone tell an extraordinary story of survival. They offer a dark yet strangely affirming portrait of life post-apocalypse.

Holly Morris is an award-winning author, director, producer and writer. She was Editorial Director of Seal Press, and is an alumni and board member of the Hedgebrook Writers in Residence program. Her book, *Adventure Divas: Searching the Globe for a New Kind of Heroine*, was listed in both Editors Choice and Notable Book of the Year by *The New York Times*. Holly is also a documentary producer and correspondent. She is the executive producer/writer/director of the award-winning prime-time PBS documentary series, *Adventure Divas*, and host of the series *Globe Trekkers* (PBS), *Treks in a Wild World* (PBS), and *Outdoor Investigations* (OLN). She has travelled and filmed in dozens of countries including Zambia, Malawi, Niger, India, Paraguay, Gabon, Turkmenistan, Turkey, Norway, Azerbaijan, Borneo, and Georgia. Her current project, *The Babushkas of Chernobyl*, is a documentary about the women living in Chernobyl's Exclusion Zone.

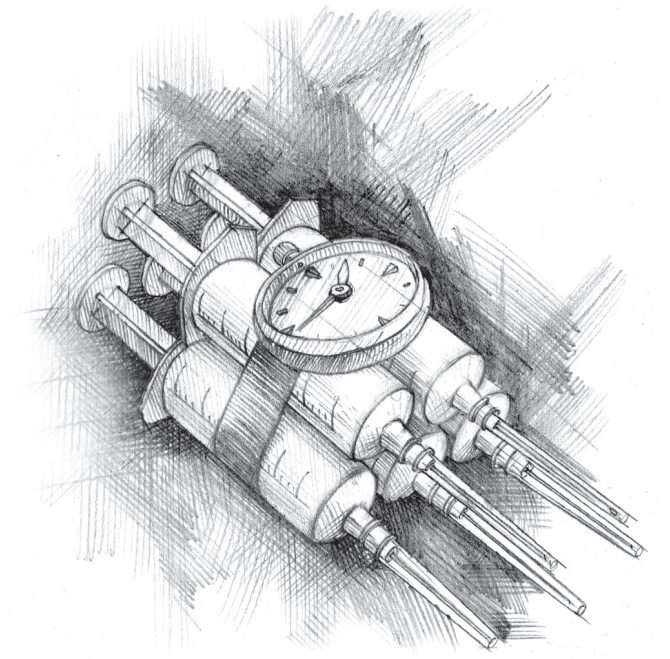
The K1 Syringe

Selected by Marc Koska

The alarm bells first rang back in '84. The article predicted—accurately, as it turned out—that HIV would spread via unsafe injections like a bush fire. Appalled at the prospect of such an avoidable catastrophe, I decided there and then to try and do something about it. I'd never had a sense of purpose before. At 23, after drifting through school and various jobs, my sense of direction didn't go far beyond crewing yachts around the Caribbean.

My ignorance of healthcare systems and syringes was complete—and the only thing I'd ever manufactured was excuses. But at least I realised it. So I set about learning. I read everything I could on the transmission of viruses like HIV. I found out how UK drug addicts used syringes. I went to Geneva to learn about public health policy.

An inexpensive, non-reusable syringe seemed to be



the answer, so I mugged up on every relevant patent and syringe design. I went to see lots of syringe factories, and I studied plastic injection moulding technologies.

The quest was to develop a syringe that could be made of the same materials on existing assembly equipment and used in exactly the same way as a conventional syringe—but with one minor, negligible cost modification that would make re-use impossible. A syringe that would work once, and then fail. The K1 Syringe was the result. And today, 27 years later, millions are used every week.

So far so good, then. But safe syringes aren't a solution to ignorance or indifference to unsafe practice. That takes education. Patients and healthcare professionals alike have to be made aware of the life-threatening consequences of reusing any instrument that comes into contact with blood. That's why I formed the SafePoint charity in 2006. Parenthood only reinforces your determination to protect other families from what is, after all, an entirely preventable human tragedy. Preventable tragedy makes me angry—as I'm sure it does you. It's a terrible waste. And there's still so much more to be done…

Marc Koska is a designer, inventor and social entrepreneur. His invention, the K1 Syringe, saves millions of lives every year. His syringe, made by Star Syringe Ltd, can only be used once, preventing the reuse of unclean syringes. He is also the founder of SafePoint, a charity dedicated to educating those in the developing world about the dangers of unsafe injections. Marc has won many awards for his work including British Invention of the Year in 2004 and The Economist Innovation Award for Social and Economic Innovation in 2011. Marc received an OBE in 2006.

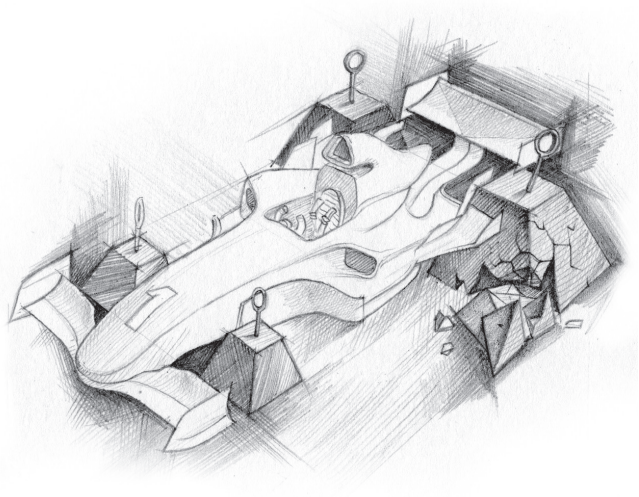
When The Wheels Come Off

Selected by Ross Brawn

During the Hungarian Grand Prix, the carbon fibre left rear suspension of the 2003 Ferrari Formula One car failed while braking.

The established approach at that time was to calculate suspension loads using G-force sensors in the chassis and on the suspension, and then resolve all the forces to determine the required strength of suspension. It wasn't common practice to measure the specific loads in the suspension links whilst the car was on the circuit. This was done in the lab, but not on the circuit. It also wasn't common practice to check the strength and integrity of the suspension as a complete assembly; the suspension was only tested as a set of separate components.

How did this failure change Formula One? Ferrari introduced real-time measurement of the entire suspension link forces whilst the car was on the



circuit. This was conducted at each track to build a library of load cases to design the suspension to. New techniques were also implemented for load and fatigue testing of suspension systems in the lab using the complete suspension assembly. This was common practice in road car applications but not in racing car design. Using these rigs, fully simulated load cases could be applied to the suspension systems. These

measures gave a step change in the reliability and safety of the suspension systems.

Ross Brawn was educated at Reading School. In the 1970s he completed an apprenticeship in Engineering at the UK Atomic Energy Authority in Harwell and became a trainee engineer. He got his first taste of motor racing as a machinist at Williams before joining March Engineering in 1977 as a mechanic. Ross returned to the Williams team and rose to the position of R&D Manager and Senior Aerodynamicist in 1979. Since then, Ross has had a hugely successful career with roles at Arrows, Jaguar, Benetton, Ferrari, Honda and Mercedes. Until December 2013, Ross Brawn was Team Principal at Mercedes.

Forceps

Selected by Robert Winston

In 1976 I undertook the world's first fallopian tube transplant. The procedure was under a microscope and in the middle of the operation I dropped the forceps on the floor. I had to make do with another instrument to finish the procedure. I drop things all the time, so it wasn't all that surprising.

That fallopian tube transplant didn't take and even many years later, when the transplant was eventually successful, the patient didn't manage to conceive as a result. As with many experiences of failure (and success), this proved that not to try for fear of failing would potentially mean missing the chance to succeed.

Robert Winston is Professor of Science and Society at Imperial College London. In the 1970s, he developed techniques that improved fertility treatments and later pioneered improvements in *in vitro* fertilisation (IVF) and subsequently developed pre-implantation diagnosis. He runs research projects at the Institute of Reproductive

and Developmental Biology at Imperial, aiming to improve human transplantation. He has published over 300 scientific publications in peer reviewed journals. Robert is committed to science communication and has presented numerous award-winning TV and radio programmes and written 20 books. Made a peer in 1995, he speaks regularly at the House of Lords on education, science, medicine and the arts. He was Chairman of the Lords Select Committee on Science and Technology from 1999–2002.

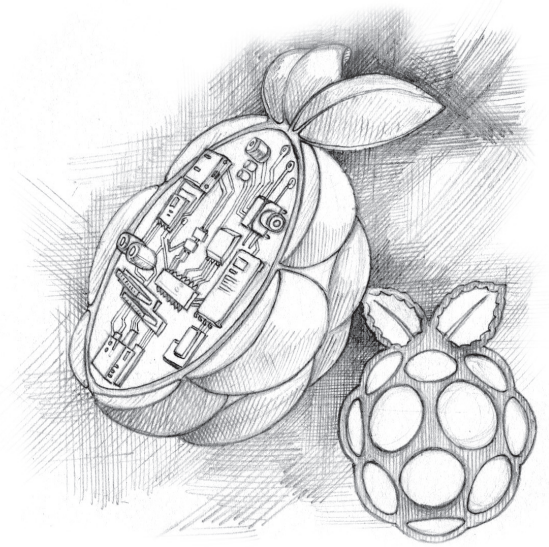
The First Raspberry Pi

Selected by Eben Upton

Back in 2006, a group of us at the University of Cambridge's Computer Laboratory became worried that we were failing to attract a sufficient number of candidates to study Computer Science. Between 1995 and 2005 the number of applicants to the course had halved, and, of those who had applied, there was a steep decline in the level of knowledge about computers. Our hypothesis (and to this day it's still a hypothesis) was that the disappearance of programmable computers in the home, and the associated 'bedroom programming' culture at the end of the 1980s, had left children with no easy way into computing as a hobby.

We asked ourselves whether we might be able to build a machine to fill this niche—something that was cheap, fun, rugged and programmable.

The exhibit represents my first attempt that year to



build what would eventually be called a Raspberry Pi. It uses decidedly low-tech off-the-shelf parts, can be assembled by hand, and provides roughly the same level of performance and programmability as a 1980s 16-bit microcomputer. Unfortunately, while it's cheap and programmable, it just wasn't fun enough for children raised in an era of

PlayStations and iPads to relate to. The eventual Raspberry Pi product is roughly 1,000 times as powerful as this one, and allows children to surf the web, play computer games and HD videos; these features are the vital hooks that get children interested in the device, starting them down the road to becoming computer programmers.

We've sold over two million Raspberry Pis since we launched last year, but I keep this board on my desk to remind me we didn't get it right the first time.

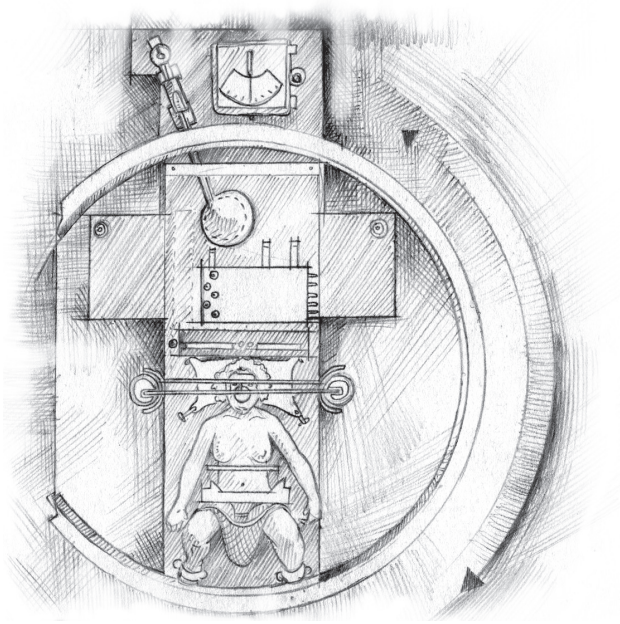
Eben is a founder of the Raspberry Pi Foundation, and serves as CEO of Raspberry Pi (Trading) Ltd, which is responsible for the foundation's commercial and technical activities. In an earlier life, he founded two successful mobile games and middleware companies, Ideaworks 3d Ltd and Podfun Ltd, held the post of Director of Studies for Computer Science at St John's College, Cambridge, and, along with his father, co-wrote *The Oxford Rhyming Dictionary*. He holds a B.A. in Physics and Engineering, a Ph.D. in Computer Science, and an Executive M.B.A. from the University of Cambridge.

Apparatus for Facilitating the Birth of a Child by Centrifugal Force

Selected by Marc Abrahams

In 1965, George and Charlotte Blonsky, a married couple living in New York City, were granted US patent #3216423 for an "Apparatus for Facilitating the Birth of a Child by Centrifugal Force". When a woman is ready to deliver her child, she lies on her back on a circular table. She is strapped down. The table is then rotated at high speed. The baby comes flying out. This is intended to "assist the under-equipped woman by creating a gentle, evenly distributed, properly directed, precision-controlled force, that acts in unison with and supplements her own efforts".

Though meticulously and lovingly engineered with safety features to protect both mother and child, the device never made it into general use. Few people other than the Blonskys perceived the need for it.



Their method stands rather outside most birthing traditions. Their mechanism is expensive and complex. Also, the tiny net designed to catch the child may be inadequate to the task. The Blonskys, though childless, loved children. Their idea was conceived during a visit to the Bronx Zoo. They

noticed an elephant that was slowly spinning in place. A zookeeper (wrongly) told them that's what elephants do prior to giving birth.

The Blonskys were posthumously awarded an Ig Nobel Prize for their invention in 1999. They and the invention inspired an opera, *The Blonsky Device*, that premiered in 2013.

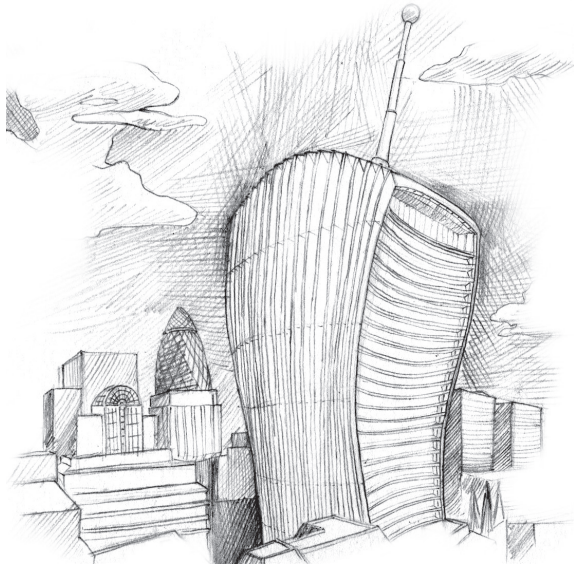
Marc Abrahams is the founder and master of ceremonies of the Ig Nobel Prize Ceremony, honoring achievements that make people laugh, and then think. The prizes are handed out by genuine Nobel Laureates at a gala ceremony held in autumn at Harvard University and broadcast on National Public Radio and on the Internet. He co-founded the science humor magazine *Annals of Improbable Research*, which he still edits. Marc has a degree in Applied Mathematics from Harvard College, spent several years developing optical character recognition computer systems (including a reading machine for the blind) at Kurzweil Computer Products, and founded Wisdom Simulators. He writes columns for many international newspapers and magazines including *The Guardian*, discusses improbable research on NPR's *Science Friday* and has written the librettos for sixteen science mini-operas that premiered as part of the Ig Nobel Prize ceremonies.

The Walkie Talkie Building

Selected by Oliver Wainwright

It was trumpeted as “the building with more up top”, a swollen pint glass of a tower that bulges out as it rises to pack in more offices at the lucrative higher levels—all topped with a Babylonian sky-garden. What the developer of 20 Fenchurch Street in the City of London had not bargained for was, that like every Bond baddie lair, the Walkie-Talkie building would also come with its own lethal death ray.

In the summer of 2013, the concave south-facing facade of the 34-storey tower was found to channel the rays of the sun into a concentrated beam down on to the street below, so hot it melted the bumper of a car, scorched shop carpets and bubbled their paintwork. One passer-by even managed to fry an egg in its heat. But it was not the first time that its architect, the Uruguayan-born Rafael Viñoly, had encountered this problem. His 57-storey Vdara hotel



in Las Vegas had exactly the same issue. Also designed with a concave glass facade, it focused the intense Nevada sun down on to the pool terrace below, singeing people’s hair and causing sun-loungers to melt. The facade has since been covered with a non-reflective film, which is also being applied to the Walkie-Talkie building.

It is something of a surprise that Viñoly should make this mistake twice, particularly given he has designed a building in China (as yet unbuilt) that exploits this technique to harvest the sun's energy—where a concave facade would direct the sun's rays to a thermal store at the top of an obelisk at its focal point. So there may be productive uses in this failure yet.

Oliver Wainwright is *The Guardian*'s architecture and design critic. Trained as an architect, he has worked for a number of practices, both in the UK and overseas, and written extensively on architecture and design for a wide variety of international publications. He is also a visiting critic at several architecture schools.

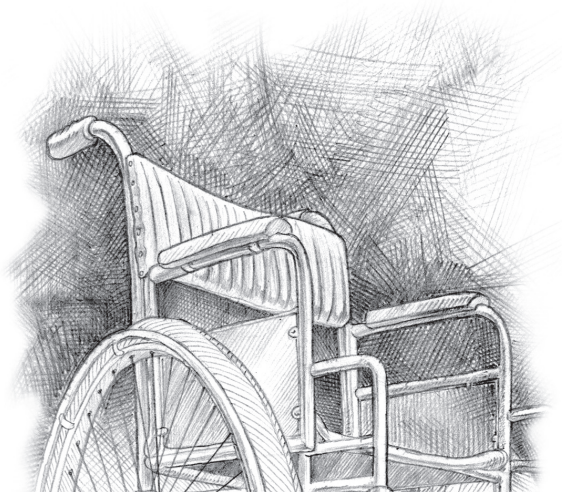
Superman's Wheelchair

Selected by Mark Pollock

In preparation for the South Pole Race, I learnt a lot about Shackleton, Scott and Amundsen; the explorers who carved those first trails into the Antarctic ice. They were the pioneers—it was their privilege, their courage, their risk. They charted the unknown world, showing the way for the rest of us. 100 years on, I followed in their tracks as I became the first blind person to race to the South Pole.

Eighteen months after the race, a fall from a second story window nearly killed me. I broke my back and the damage to my spinal cord left me paralysed. Now I am inspired by the vision of another explorer, Christopher Reeve. I am travelling in his tracks.

Christopher Reeve dreamed of empty wheelchairs. He and his wife Dana were the hub around which new global collaborations formed with the aim of curing paralysis and they forged ahead with intelligence



and ambition. Sadly Christopher died in 2004 from complications related to his paralysis before their ambition was realised; Dana died almost two years later from cancer. But the legacy they left us is strong. In a world that has failed to discover the cure for spinal cord injury, Christopher has shown me the way.

So now I roll to the gym every day in my wheelchair to explore the possibility of spinal cord injury

recovery, using aggressive physical therapy and high-dose electrical stimulation. I strap my paralysed limbs into my Ekso Bionics robotic legs and I walk. I walk miles and miles of uncharted steps towards the frontier of recovery. I believe a cure for spinal cord injury is possible. Success is our objective. And we know that in our pursuit of a wildly ambitious goal, the potential for failure travels with us. If there is no risk of failure, it's probably not worth pursuing.

Unbroken by blindness in 1998, Mark went on to compete in ultra-endurance races across deserts, mountains, and the polar ice caps including a race to the South Pole. He also won medals for rowing at the Commonwealth Games and set up an international motivational speaking business. In 2010, Mark was left paralysed after falling from a second story window. He is now exploring the frontiers of spinal injury recovery using aggressive physical therapy, robotic legs and by connecting those working in science and medicine. Selected by the World Economic Forum as a Young Global Leader and appointed to the Board of the Christopher & Dana Reeve Foundation, Mark is an ambassador for Wings for Life, co-Founder of the global running series called Run in the Dark (runinthedark.org) and is author of the book *Making It Happen*.

Ranulph Fiennes / Ellen MacArthur / Jocelyn Bell Burnell / Michael John Gorman / Ken Robinson / Timothy Prestero / Sonia O'Sullivan / Shane O'Mara / Anne Enright / James Dyson / Jane ní Dhulchaointigh / Tim Harford / Holly Morris / Marc Koska / Ross Brawn / Robert Winston / Eben Upton / Marc Abrahams / Oliver Wainwright / Mark Pollock

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Installation by artist Rosie O'Reilly.

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Soluble Circuit
The circuit board exhibited is on loan from The National Physical Laboratory.

Superman's Wheelchair
The wheelchair exhibited is on loan from the Christopher and Dana Reeve Foundation.

The Humble Fuse
The high voltage fuse exhibited was donated by Dublin City Council Public Lighting and Electrical Services Division, from the Main Lift Pumping Station in Ringsend.

The Third Policeman
The hat exhibited is on loan from The John J. Burns Library at Boston College.

The Ice Pick Lobotomy
The lobotomy instruments exhibited are on loan from the Wellcome Library, London.

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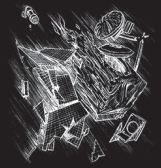









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