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Ecologic

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Dedicated to my reasons for wanting to be green – Gillian, Chelsea and Rebecca

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Brian Clegg read Natural Sciences at Cambridge, specializing in experimental physics. He spent a year at Lancaster University gaining a second MA in operational research and then joined British Airways, where he worked for seventeen years on a wide range of projects. In 1994 he launched a new career providing creativity consultancy to corporations and writing for magazines and books. His clients have included BA, SmithKline Beecham, the BBC, the Treasury and the Met Office. He is a Fellow of the Royal Society of Arts. He is also the editor of the successful www.popularscience.co.uk book review site. Brian Clegg lives in a Wiltshire village with his wife and two children.

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Also by Brian Clegg

The Global Warming Survival Kit

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1
It’s Not Logical, Captain

A 727 jet taxies on to the runway at Munich’s Franz Josef Strauss airport on a beautiful June evening. The cabin is packed with delegates from Numismata, one of Germany’s biggest trade fairs. They are a jovial group, discussing successful deals, swapping lurid and mostly fictional stories of adventures in hotel bedrooms. A few grumble about the one that got away, the great prize they almost captured, but even they are smug underneath. No one has left the fair empty-handed. And no one realizes that they are seconds away from the threat of death.

On the flight deck the atmosphere is calmer, but there are still smiles. The crew members go off shift after this sector. Away from the distorting plastic windows of the main cabin, the captain takes a moment to survey the stunning herringbone red sky that stretches out over the runway. He hears a snort of irritation from the right-hand seat. He has already agreed that the co-pilot can handle the take-off, and his junior is frustrated that the control tower has vetoed a rolling start because the previous flight hasn’t had time to clear. They aren’t late, but the co-pilot enjoys the quick turn and take-off of a rolling start – it’s more macho.

The captain slips on his Ray-Bans to counter the low-lying sun. As the tower’s clearance crackles in his headphones, he nods to his colleague: ‘It’s all yours.’ The

young pilot in charge pushes forward the throttles and hears the muffled scream of the engines far behind him. Painfully slowly at first, the aircraft begins to rattle its way down the runway. While the co-pilot concentrates on the controls, the captain glances at the load sheet, then back to the air-speed indicator. He is waiting for V1. And that's where things start to go wrong.

There are two critical speeds in aircraft take-off – V1 and VR. The first is the speed of last resort, the take-off decision speed. After V1, the plane should still be able to get off the ground if an engine fails; before V1 it has to abort. After V1 there isn't enough runway left to stop the plane without crashing. Once V1 is reached, there's no going back. VR, a slightly higher speed, is the rotation velocity, the point at which the pilot will pull back on the stick and the plane should lift off.

Both these speeds are governed by a number of factors. The weather. The air pressure. And crucially, the weight of the aircraft.

On the 727, the captain frowns. He has taken off from this runway many times before. It seems to him that they have travelled too far, it has taken too long to reach V1. Perhaps, though, it's an effect of the light. The flight engineer mutters something from behind him, but the captain doesn't catch it. Finally, the air-speed dial matches the number. 'V1,' the captain calls out to the co-pilot, readying him for take-off. And then, 'Rotate.' The co-pilot nods at the crisp instruction and pulls gently back on the stick. The plane judders, but does not leave the runway.

Now the captain is worried. They are well past V1 – no chance of stopping – but it seems something is wrong with the calculation. His eyes flick between the runway lights and the instruments. They are running out of concrete. 'Give it a couple of seconds more,' he encourages his junior. 'Hold on, we need more, hold on . . .' The air-speed

indicator creeps up at a near invisible pace. ‘Rotate!’ This time the word is more than crisp – it is a barked command. Painfully slowly, the 727 noses into the sky, yards from the end of the runway, and lumbers off.

They had been within two seconds of disaster. In the cabin, the delegates noticed nothing. All that concerned them was the wait until the No Smoking sign went off and the drinks trolley arrived. Only the flight crew realized that they had faced death. But not why. They couldn’t know that their plane was nearly brought down by a very common inability to combine the predictions of mathematics with an understanding of human behaviour.

Weighing passengers

If that planeload of people had died on take-off, their murderer would have been a routine calculation, made by a computer. We’re all used to bags being weighed at check-in. This isn’t just so that the airline can charge infuriatingly high rates for excess baggage, or to make the whole business of checking in even more irritating. It’s to help calculate the overall weight of the aircraft – an essential component in knowing how it will perform and whether take-off will be safe.

Much though airlines would like to do it, they don’t weigh the passengers. It’s thought that it would be too intrusive. Some airlines have given serious consideration to having secret weighing platforms as individuals pass through a pinch point on the air bridge that leads up to the aircraft door, collecting a realistic weight profile, but practicalities and a fear of bad publicity have stopped this idea being implemented. The airlines can’t just ignore the passengers’ weight, though – it makes a big contribution to the load the plane has to carry.

Instead, they resort to probability. Airline planners decide on the most likely weight for the average passenger and use that in their calculations. (This weight has crept up over the years as too many supersized fast-food meals take their toll.) It's not ideal, but it's good enough to calculate take-off speeds and safety factors. Usually. Even so, probability says that on some flights the approximation will be wrong – and that was what brought the 727 near to disaster on that summer evening in Munich.

Germany hosts the world's biggest coin collectors' festival, Numismata. Rotating around three centres – Berlin, Frankfurt and Munich – the event is a magnet for coin dealers. This particular flight out of Munich was timed precisely to catch dealers as they left the fair; almost all its passengers were coin dealers.

In themselves, dealers aren't particularly overweight. They are pretty average. But they are obsessive about their coins. They don't like to put their best buys in the luggage. They keep their acquisitions on their person, or in hand luggage. In those easy days before terrorist threats intensified airline security, the dealers had been able to go on board weighed down with coins, pushing up their average weight sufficiently to throw out the airline's take-off calculations. The 727 was nearly brought down by pockets full of cash.

All the information that was needed to prevent this incident existed. The planners understood how the passenger weight was calculated and the implications of getting it wrong, but they didn't know about the coin fair. Sales and check-in agents knew coin dealers and their habits, but weren't aware of the impact on the expected weight and safety. The scene was set for disaster.

This incident really happened, although some details have been changed. The airline has never publicly discussed it, but it was the talk of airline conferences for

years afterwards. It was my introduction to the distinction between what seems to make sense at first glance and the realities revealed by good logical analysis.

When I went to work for an airline, my first job was to construct a system that would enable planners to avoid the kind of disaster that nearly happened at Munich. Here, the essence was finding a way to spot unexpected connections, to modify the generally satisfactory average weights to reflect special events like the coin fair, combining the mathematical input of the weight calculation with the human experience of how passengers behave in different situations.

This is the essence of operational research, the mix of logic and an understanding of human behaviour, in which I was just beginning to work. Sometimes taking a more logical view of circumstances involves an exploration of the incentives and emotional factors that are involved in making a decision. At other times a logical view requires the comparison of very different options, or testing causality – whether we are mistaken in assuming one event causes another – a key factor in everything from airline incidents to carbon offsetting.

Emotion and logic

We tend to see logic and human reaction as two sides of a coin. In the original 1960s *Star Trek* series, logic was represented by Mr Spock, emotional human reaction by Dr McCoy. The message of the series was that you need both. Neither one, in isolation, is enough to cope with everything the universe can throw at you. This is true, but the balance between the two is often hard to manage. When we consider a subject as emotionally loaded as the environment, the Dr McCoy ‘feely’ side totally overwhelms

the Mr Spock logic. That's why, I suggest, we need some ecologic. Getting sensible answers about the environment requires both numbers and human reaction; it's not enough just to go with your feelings.

In principle, the environment should be a no-brainer. No one wants to destroy the world. We all – even the much-maligned heads of corporate giants – hope that our children will have a good life, not one that's blighted by an earlier generation's greed. Yet in practically every green area we are either failing to take the essential steps to prevent such blight, or we are being deceived – often by ourselves. By using the dissecting scalpel of ecologic, it's possible to open up the reality beneath the layers of confusion and deception.

Before exploring how this can happen, I want to tell another story that illustrates why such logical analysis is so necessary when understanding human behaviour. As in the opening example, I'm staying away from green issues for the moment. When I'm not writing books, I help organizations be more creative. Over the years I've discovered that it's important to start off with examples that aren't directly connected with the issue at hand, because otherwise participants concentrate on the details of the example, not the process. The purpose of what follows is to demonstrate how we humans deceive ourselves. These events haven't occurred yet, but there is no reason why they shouldn't.

The lottery deception

To celebrate the New Year, the National Lottery has decided to run a double event. Two draws on the same day. Two chances to become a millionaire. As usual, stacks of tickets have been sold. Millions of people are holding on to

the hope of having their lives transformed. Of course, they know it's unlikely. They probably won't win. But there's a tiny chance that they could soon be living the celebrity lifestyle, and that's what makes spending the money worthwhile.

The first draw goes much as any other week. Out come the numbers, one after another, a random string of possibilities and hopes. This particular lottery uses six numbers from a possible forty-nine. There's a bonus ball too, but that's for losers. Let's watch those six big numbers: 24 – 39 – 6 – 41 – 17 – 29. It's over for all but the lucky few. There's nothing exceptional. Although the announcer tries to inject wild excitement into his voice, it has been done a thousand times before. It's not news.

Then the second draw begins. Let's pick up the commentary. 'They're using the machine they call Delilah for the draw tonight, started by none other than a former member of Blondie. Here comes the first number and . . . what are the chances of that? The first number is one. Okay, next choice. Well, would you believe it? Two. That's incredible. And the third number's coming through now. Hey, is this a joke? The third number is three . . .'

And so it goes on until the draw is complete: 1 – 2 – 3 – 4 – 5 – 6. All neatly in sequence. There is uproar. The payout is suspended while the draw machine is overhauled and checked. A trickle of demands for a refund soon becomes a torrent. Questions are asked, all the way up to parliament. Yet no one can find anything wrong. How could this be? How could such an incredible result happen?

That simple lottery draw exposes a strange, disturbing reality. Our world has many random elements in it, where probability is the only guide. Whether you are running an environmental campaign or you are a quantum physicist, probability is an essential contributor to what's happening in your world. Yet human beings are incompetent when it

comes to handling the outcome of chance. We just don't get probability. It seems unnatural, and it fools us all the time. There really was no reason to be surprised by the lottery draw: 1 – 2 – 3 – 4 – 5 – 6 is just as likely to come up as 24 – 39 – 6 – 41 – 17 – 29. It has *exactly* the same chance. Yet to our probability-blind brains there is a huge difference between the two results.

It might seem strange that we can't cope with probability if it's so important, but evolution often produces a compromise, where one capability is sacrificed to make another strong. The ability that makes it impossible for us to handle probability well is pattern recognition. We depend on patterns. They provide our interface with the real world. So strong is our need for patterns that we frequently make them up where they don't exist. Where there is no pattern, where probability rules a sea of randomness, we are lost.

This is why the lottery result takes us by surprise – and why so many people bother to buy lottery tickets in the first place. When we see a draw like 24 – 39 – 6 – 41 – 17 – 29 our probability blindness conceals just how unlikely it is that a particular combination of numbers is going to be drawn. It is only when a pattern is imposed and we see 1 – 2 – 3 – 4 – 5 – 6 that we realize just how improbable the whole thing is.

Living a pattern

Why are patterns so important to us? Because they help us make sense of a complex world. If we didn't deal with patterns, we would collapse under the strain of information overload. I don't hold in my brain the exact instructions for flipping the light switch in the lounge. It would involve too much detail. Exactly where to stand, where to position my

finger, where to press and at what angle, how much pressure to use, how far the switch moves before I can stop pressing . . . It's too much, and it's too specific. Even if I could hold all this detail, then I'd have to learn all over again how to switch on the lights in the kitchen. Instead I have a broad pattern that says, 'This is what light switches are like, this is how to turn them on,' and until I get to America and find their switches are the wrong way up, I can get along pretty well.

We use patterns all the time without even realizing it. When I pass someone in the office corridor and recognize them, I'm using pattern-matching. If I had to collect every detail of a face and compare it with the data on everyone I knew, I'd be lost. What's more, I would only have a chance of recognizing a person if I saw them from exactly the same angle, with the same lighting as when I first stored their details away. As soon as they changed their hair or put on glasses or gained a wrinkle I would have to start all over again. This is why the biometric systems now being introduced to identify individuals at airports using fingerprint identification, retinal scans or face recognition are so hit and miss. It's a difficult job. The eye/brain combination that allows us to recognize people (and do a host of other things) doesn't work like a camera, breaking a picture down into a grid of pixels – it picks up patterns and shapes, which enable us to be much more flexible in recognizing what we see.

This is also why computers find it so difficult to come close to the human ability to recognize objects and text. We can see that **word**, *word* and **word** all say the same thing, because we are working with patterns, not using exact matching. We can even use patterns to see what isn't there.

In the example overleaf, it's very clear that the top word is 'bank' despite significant parts of the letters being missing. Even the second example, with a full half of each

letter missing, is readily identifiable. It’s only when we introduce ambiguity that our pattern skills fail – does the bottom word say ‘bank’ or ‘rank’? There’s no way of telling.

Figure 1 Breaking the bank.

Such is our dependence on pattern that it is frighteningly easy to jump to a whole set of false

conclusions based on an over-simplistic picture. We might just be starting from a single word, like that half-glimpsed BANK sign, but immediately our pattern-building brains begin to construct a whole network of links and associations that may not have as much validity as we believe. All through this book you will find examples of how we take the implications and linkages of words and other patterns to make incorrect deductions.

The environment as comfort blanket

Here's an example. A recent edition of the *Ecologist* magazine featured an article entitled 'Age of Awakening', describing ancient spiritual wisdom provided by an ethnic wise man. Ecology is a science (the clue is in the 'ology') and this magazine carries a reasonable number of scientifically based stories, though admittedly with a particular message in mind. But at the same time, it also carries touchy-feely stories like this one with little or no scientific basis. The inclusion of such an article in a magazine with an apparently scientific theme demonstrates how easy it is to deceive ourselves, confusing the 'feeling' of being green (all natural, warm, hand-knitted and such) with the actual science of saving the planet.

To be effective in solving environmental issues we have to cut through the patterns and self-deception – that's the role of ecologic. Warm, cuddly feelings are great when we are trying to get people enthused, encouraging them to join in a campaign, but they are a tool of marketing, not a practical guide to making things happen.

That emotional response – which tells us that 'natural' is better than 'chemical', for example – is a common cause of misunderstanding. A pinch of the purely chemical substance sodium chloride (I'm using 'chemical' in the way

it is often misused to portray something unnatural) will do us much less harm than a pinch of the entirely natural deadly nightshade or the devastatingly poisonous castor bean plant containing the neurotoxin ricin. The things that frighten us are often not the greatest dangers we face. Many people fear flying, for instance, not because it is more dangerous than other modes of transport, but because it is more scary. We let emotion influence our weighting of what's important.

Take the word 'organic'. When we hear it, all sorts of associations spring into being, apparently fully-formed. Tasty food, perhaps. Healthier eating. Produce that is grown sustainably. Natural rather than artificial. No chemicals. Good animal welfare. A concern for the land. This could well all be true – but we can't assume that the pattern holds just because it's what we expect. We need to bring in ecologic to test that pattern.

Irrational acts

Although operational research, the basis behind my ecologic approach, is mathematically based, delving into ecologic doesn't require sophisticated calculations. The numbers will rarely get more complicated than $1 - 1 = 0$, and often it's more about gaining an understanding of why people take a particular action even when it doesn't make sense. We need the guidance of a logical viewpoint because as human beings we tend not to act rationally.

A good example of this can be seen in the Ultimatum game. Before I describe this, answer a simple question. If I were to offer you £1 – no strings attached, nothing to be done, all you have to do is say yes – would you accept? It's not a trick question. Be clear what you would answer.

Now imagine you were taking part in the Ultimatum game. You play with one other person. I offer the pair of you £100. The other person has to decide how the cash is split between you. Your part in the game is to decide whether or not you will accept the split. If you say ‘yes’, the cash is split between you the way the other person decides. If you say ‘no’, neither of you gets any money. There is no negotiating; it’s just a one-off, yes-or-no decision. The other person decides to keep £99 and give you £1. Would you accept?

Rationally, this is exactly the same choice as before. All you are really being asked is if you would accept £1 for doing nothing. However, the majority of people would say ‘yes’ to the first question and ‘no’ to the second. They feel hard done by if the other person takes almost all the money. It’s not fair.

Experiments have shown that unless the person splitting things makes it at least 70:30, the choice will tend to be rejected. There is more than one influence at play. We can afford to punish the other person if the amount is relatively insignificant. £1 is a small enough figure for most of us to ignore. If the amount being split were £100 million, I suspect far fewer would turn down the £1 million on offer just because the other person was getting £99 million. Even so, there’s something strange at work in this decision.

Rationally, taking the money is the only sensible thing to do, however small the portion you are awarded. But we have evolved to cooperate, and so strong is the need to feel fairness and reciprocal support that we flip into punitive mode, even though we suffer as well as the person dividing the cash. However, we can’t afford to take a similar, irrational, ‘cutting off your nose to spite your face’ attitude when making decisions about the environment. We have to overcome our social conditioning and emotional reactions

to take the logical, rational choices that will help save the planet.

Which caused what?

Another aspect of our natural make-up is our limited ability to think outside the here and now. Only in the last 50–100,000 years – a moment in the evolutionary timescale – have we had the ability to think about the future. Not only does this make us bad at long-term planning – we all put much too much weight on the present – it has also left us pathetically poor at getting to grips with why things happen in a particular way. We can find it surprisingly difficult to match up cause and effect. We are often tricked into assuming false causality simply because two events are close together in time or space.

For several years after the Second World War the rate of pregnancy in the UK closely followed the number of bananas imported into the country. More bananas, more babies. Fewer bananas, fewer births. Just looking at the numbers, it's easy to assume a link, but anyone who suggests that the bananas directly caused the pregnancies is imagining a false causality (and is due a few refresher lessons in biology).

In practice there are many ways in which this apparent relationship could have been caused. There could have been a reverse causality (more pregnancies caused an increased demand for bananas), a mutual causality (both the pregnancies and the urge to buy bananas were caused by the same surge of post-war enthusiasm) or a total lack of causality (coincidences happen).

Such misunderstandings of causality are easy to make. We see apparent linkages ('correlations', in maths-speak) and assume that the environmental equivalent of the

bananas was the driving force behind the green ‘pregnancies’. We are not helped by the way the media present information to catch our attention rather than making sure we really understand what is going on. As we will see, we need to be constantly on our guard against misinterpretation.

2
Balance and the Bogeyman

So dependent are we on patterns that we find it easy to see them when they aren't really there. This is the bogeyman effect. The world seems a dangerous place, particularly in the dark. Our senses are ready to spot and identify a predator. So we imagine a strange shape under the bed or in the corner of the room. It's caused by something quite ordinary, but our pattern recognition goes into overdrive and we are scared out of our wits.

It becomes harder to be scared by shadows as we get older, but we don't lose that frisson of fear – and we have a whole new set of environmental bogeymen, thanks to the media. Writers for newspapers and TV journalists are always looking for a hook – something that will catch the audience's attention. Broadcaster Andrew Marr wasn't far from the truth when he called journalism 'industrialized gossip'. Few hooks are more effective and visceral than fear, so the media regularly pick up on dangers and magnify them in order to achieve ratings. It's a bit like the way children exaggerate to get attention.

Biased 'balance'

This doesn't mean that every media scare story is wrong, or even biased towards the scary side. Sometimes, thanks to

another dangerous media word, ‘balance’, the media will play down a story that really needs bringing out. For several years, for instance, the BBC attempted to give balance by putting up both sides of the argument when it came to man-made causes for climate change. Unfortunately, it continued to do so long after there was any significant scientific doubt about the existence or the causes of global warming. As environmental campaigner Jonathon Porritt put it at an event in 2007 organized by the Royal Society of Arts, ‘As the science gets harder, the politics gets softer . . . flakier.’ While the scientific results on climate change were firming up, politicians and the politically minded broadcasters were becoming less effective. With its tendency to bring in someone to speak against climate change to ‘balance’ the scientific consensus, it was as if the BBC were reporting on one of Richard Branson’s publicity stunts and, after announcing that he intended to fly round the world, then brought on a representative from the Flat Earth Society to say that it’s not possible because the world isn’t round.

This is not saying that balance is a bad thing. It’s perfectly reasonable to bring in two opposing views if both are held by appropriate people in the relevant fields of knowledge, and if the two viewpoints hold similar degrees of substance. But the attempt to provide balance at all times, particularly when dealing with a piece of science, is a guaranteed way to confuse the audience.

The MMR madness

When a bogeyman comes along, balance both good and bad goes out of the window. Perhaps the strongest bogeyman card the media can play is danger to children. When children are put at risk, our sense of balance and fairness is

abandoned. Sadly, the media quite often raise the public's awareness of a bogeyman with insufficient evidence – and because we don't wait for detailed evidence in dealing with a bogeyman, we go straight into panic mode.

This was all too obvious in the MMR scare, started in 1998 by Dr Andrew Wakefield. For nearly ten years the suggestion that the measles, mumps and rubella vaccine could cause autism in children resulted in worry and confusion in the public. Yet the fuss was largely based on a study of twelve individuals by one semi-amateur. Rather than listen to the many different experts who had undertaken vastly larger, more conclusive studies, the media sparked fear by picking up on the scare stories of one man, based on little more than anecdote. And once a bogeyman has been raised, it is very difficult to put down. In 2007, even after Dr Wakefield's claims had been conclusively discredited, there were still occasional bursts of MMR panic in the media, despite outbreaks of measles among those not inoculated, including at least one death.

Part of the problem is that the news media are very unwilling to reveal their mistakes. Science often advances by learning from error. But when contrary results show that a scare story was based on false evidence, as happened with the MMR panic, this is not usually reported by the media in anywhere near as much depth as the original story – if it's covered at all. What typically happens is that someone pre-announces some research before a peer-reviewed paper comes out. The media pick up on this and make a big splash, terrifying everyone. Then either the paper isn't published, or later work shows that it was an error. And the media respond with silence. We don't get to hear of the new research. We certainly don't hear, 'Sorry, we scared you unnecessarily – we got it wrong.' The reality is just ignored.