IT IS STRANGE WHAT CLINGS to your mind from the flotsam and jetsam of the everyday. For Helmut Schmidt it was an article in, of all places, *Reader's Digest*. He'd read it as a 20-year-old student in 1948, at the University of Cologne, after Germany had just emerged from the Second World War. It lodged in his memory for nearly twenty years, surviving through two emigrations, from Germany to America and from academia to industry – from a professorship at the University of Cologne to a position as a research physicist at Boeing Scientific Research Laboratories in Seattle, Washington.

Through all his changes of country and career, Schmidt pondered the meaning of the article, as though something in him knew that it was central to his life's direction even before he was consciously aware of it. Every so often he would engage in a bit more reflection, take out the article in his mind's eye and examine it in the light, turning it this way and that, before filing it away again, a bit of unfinished business he wasn't yet sure how to tend to.[1]

The article had been nothing more than an abridged version of some writing by the biologist and parapsychologist J. B. Rhine. It concerned his famous experiments on precognition and extrasensory perception, including the card tests which would later be used by Edgar Mitchell in outer space. Rhine had conducted all of his experiments under carefully controlled conditions and they had yielded interesting results.[2] The studies had shown that it was possible for a person to transmit information about card symbols to another or increase the odds of a certain number being rolled with a set of dice.

Schmidt had been drawn to Rhine's work for its implications in physics. Even as a student, Schmidt had had a contrary streak, which rather liked testing the limits of science. In his private moments, he regarded physics and many of the sciences, with their claim to have explained many of the mysteries of the universe, as exceedingly presumptuous. He'd been most interested in quantum physics, but he found himself perversely drawn to those aspects of quantum theory which presented the most potential problems.

What held the most fascination of all for Schmidt was the role of the observer.[3] One of the most mysterious aspects of quantum physics is the so-called Copenhagen interpretation (so named because Niels Bohr, one of the founding fathers of quantum physics, resided there). Bohr, who forcefully pushed through a variety of interpretations in quantum physics without the benefit of a unified underlying theory, set out various dictums about the behavior of electrons as a result of the mathematical equations which are now followed by workaday physicists all over the world. Bohr (and Werner Heisenberg) noted that, according to experiment, an electron is not a precise entity, but exists as a potential, a superposition, or sum, of all probabilities until we observe or measure it, at which point the electron freezes into a particular state. Once we are through looking or measuring, the electron dissolves back into the ether of all possibilities.

Part of this interpretation is the notion of 'complementarity' – that you can never know everything about a quantum entity such as an electron at the same time. The classic example is position and velocity; if you discover information about one aspect of it – where it is, for instance – you cannot also determine exactly where it's going or at what speed.

Many of the architects of quantum theory had grappled with the larger meaning of the results of their calculations and experiments, making comparisons with metaphysical and Eastern philosophical texts.[4] But the rank and file of physicists in their wake complained that the laws of the quantum world, while undoubtedly correct from a mathematical point of view, beggared ordinary common sense. French physicist and Nobel prize winner Louis de Broglie devised an ingenious thought experiment, which carried quantum theory to its logical conclusion. On the basis of current quantum theory, you could place an electron in a container in Paris, divide the container in half, ship one half to Tokyo and the other to New York, and, theoretically, the electron should still occupy either side unless you peer inside, at which point a definite position in one half or the other would finally be determined.[5]

What the Copenhagen interpretation suggested was that randomness is a basic feature of nature. Physicists believe this is demonstrated by another famous experiment involving light falling on a semi-transparent mirror. When light falls on such a mirror, half of it is reflected and the other half is transmitted through it. However, when a single photon arrives at the mirror, it must go one way or the other, but the way it will go – reflected or transmitted – cannot be predicted. As with any such binary

process, we have a 50–50 chance of guessing the eventual route of the photon.[6] On the subatomic level, there is no causal mechanism in the universe.

If that were so, Schmidt wondered, how was it that some of Rhine's subjects were able to correctly guess cards and dice – implements, like a photon, of random processes? If Rhine's studies were correct, something fundamental about quantum physics was wrong. So-called random binary processes could be predicted, even influenced.

What appeared to put a halt to randomness was a living observer. One of the fundamental laws of quantum physics says that an event in the subatomic world exists in all possible states until the act of observing or measuring it 'freezes' it, or pins it down, to a single state. This process is technically known as the collapse of the wave function, where 'wave function' means the state of all possibilities. In Schmidt's mind, and the minds of many others, this was where quantum theory, for all its mathematical perfection, fell down. Although nothing existed in a single state independently of an observer, you could describe what the observer sees, but not the observer himself. You included the moment of observation in the mathematics, but not the consciousness doing the observing. There was no equation for an observer.[7]

There was also the ephemeral nature of it all. Physicists couldn't offer any real information about any given quantum particle. All they could say with certainty was that when you took a certain measurement at a certain point, this is what you would find. It was like catching a butterfly on the wing. Classical physics didn't have to talk about an observer; according to Newton's version of reality, a chair or even a planet was sitting there, whether or not we were looking at it. The world existed out there independently of us.

But in the strange twilight of the quantum world, you could only determine incomplete aspects of subatomic reality with an observer pinning down a single facet of the nature of an electron only at that moment of observation, not for all time. According to the mathematics, the quantum world was a perfect hermetic world of pure potential, only made real – and, in a sense, less perfect – when interrupted by an intruder.

It seems to be a truism of important shifts in thinking that many minds begin to ask the same question at roughly the same time. In the early 1960s, nearly twenty years after he'd first read Rhine's article, Schmidt, like Edgar Mitchell, Karl Pribram and the others, was one of a growing number of scientists trying to get some measure of the nature of human consciousness in the wake of the questions posed by quantum physics and the observer effect. If the human observer settled an electron into a set state, to what extent did he or she influence reality on a large scale? The observer effect suggested that reality only emerged from a primordial soup like the Zero Point Field with the involvement of living consciousness. The logical conclusion was that the physical world only existed in its concrete state while we were involved in it. Indeed, Schmidt wondered, was it true that nothing existed independently of our perception of it?

A few years after Schmidt was pondering all this, Mitchell would head off to Stanford on the West Coast of the USA, gathering funding for his own consciousness experiments with a number of gifted psychics. For Mitchell, like Schmidt, the importance of Rhine's findings would be what they appeared to show about the nature of reality. Both scientists wondered to what extent order in the universe was related to the actions and intentions of human beings.

If consciousness itself created order – or indeed in some way created the world – this suggested much more capacity in the human being than was currently understood. It also suggested some revolutionary notions about humans in relation to their world and the relation between all living things. What Schmidt was also asking was how far our bodies extended. Did they end with what we always thought of as our own isolated persona, or 'extend out' so that the demarcation between us and our world was less clear-cut? Did living consciousness possess some quantum-field-like properties, enabling it to extend its influence out into the world? If so, was it possible to do more than simply observe? How strong was our influence? It was only a small step in logic to conclude that in our act of participation as an observer in the quantum world, we might also be an influencer, a creator.[8] Did we not only stop the butterfly at a certain point in its flight, but also influence the path it will take – nudging it in a particular direction?

A related quantum effect suggested by Rhine's work was the possibility of nonlocality, or action at a distance: the theory that two subatomic particles once in close proximity seemingly communicate over any distance after they are separated. If Rhine's ESP experiments were to be believed, action at a distance might also be present in the world at large.

Schmidt was 37 before he finally got the opportunity to test out his ideas, in 1965, during his tenure at Boeing. A tall, thin presence with a

pronounced, angular intensity, his hair heavily receded on either side of an exaggerated widow's peak, Schmidt was in the happy circumstance of being employed to pursue pure research in the Boeing laboratory, whether or not it was connected to aerospace development. Boeing was in a lull in its fortunes. The aerospace giant had come up with the supersonic but had shelved it, and hadn't yet invented the 747, so Schmidt had time on his hands.

An idea slowly began taking shape. The simplest way to test all these ideas was to see if human consciousness could affect some sort of probabilistic system, as Rhine had done. Rhine had used his special cards for the ESP 'forced choice' guessing, or 'precognition', exercises and dice for 'psychokinesis' – tests of whether mind could influence matter. There were certain limitations with both media. You could never truly show that a toss of the dice had been a random process affected by human consciousness, or that a correct guess of the face of a card hadn't been purely down to chance. Cards might not be shuffled perfectly, a die might be shaped or weighted to favor a certain number. The other problem was that Rhine had recorded the results by hand, a process that could be prone to human error. And finally, because they were done manually, the experiments took a long time.

Schmidt believed he could contribute to Rhine's work by mechanizing the testing process. Because he was considering a quantum effect, it made sense to build a machine whose randomness would be determined by a quantum process. Schmidt had read about two Frenchmen, named Remy Chauvin and Jean-Pierre Genthon, who'd conducted studies to see if their test subjects could in some way change the decay rate of radioactive materials, which would be recorded by a Geiger counter.[9]

Nothing much is more random than radioactive atomic decay. One of the axioms of quantum physics is that no one can predict exactly when an atom will decay and an electron consequently be released. If Schmidt made use of radioactive decay in the machine's design, he could produce what was almost a contradiction in terms: a precision instrument built upon quantum mechanical uncertainty.

With machines using a quantum decay process, you're dealing in the realm of probability and fluidity – a machine governed by atomic particles, in turn governed by the probabilistic universe of quantum mechanics. This would be a machine whose output consisted of perfectly random activity, which in physics is viewed as a state of 'disorder'. The Rhine studies in which participants had apparently affected the roll of the dice suggested that some information transfer or ordering mechanism was going on – what physicists like to term 'negative entropy', or 'negentropy' for short – the move away from randomness, or disarray, to order. If it could be shown that participants in a study had altered some element of the machine's output, they'd have changed the probabilities of events – that is, shifted the odds of something happening or altered the tendency of a system to behave in a certain way.[10] It was like persuading a person at a crossroads, momentarily undecided about taking a walk, to head down one road rather than another. They would, in other words, have created order.

As most of his work had consisted of theoretical physics, Schmidt needed to brush up on his electronics in order to construct his machine. With the help of a technician, he produced a small, rectangular box, slightly larger than a fat hardback book, with four colored lights and buttons and a thick cable attached to another machine punching coding holes in a stream of paper tape. Schmidt dubbed the machine a 'random number generator', which he came to refer to as RNG. The RNG had the four colored lights on top of it – red, yellow, green and blue – which would flash on randomly.

In the experiment, a participant would press a button under one of the lights, which registered a prediction that the light above it would light up.[11] If you were correct, you'd score a hit. On top of the device were two counters. One would count the number of 'hits' – the times the participant could correctly guess which lamp would light – and the other would count the number of trials. Your success rate would be staring at you as you continued with the experiment.

Schmidt had employed a small amount of the isotope strontium-90, placed near an electron counter so that any electrons ejected from the unstable, decaying molecules would be registered inside a Geiger–Müller tube. At the point where an electron was flung into the tube – at a rate, on average, of 10 a second – it stopped a high-speed counter breathlessly racing through numbers between one and four at a million per second, and the number stopped at would light the correspondingly numbered lamp. If his participants were successful, it meant that they had somehow intuited the arrival time of the next electron, resulting in the lighting of their designated lamp.

If someone was just guessing, he'd have a 25 per cent chance of getting the right results. Most of Schmidt's first test subjects scored no better than this, until he contacted a group of professional psychics in

Seattle and collected subjects who went on to be successful. Thereafter, Schmidt was meticulous in his recruitment of participants with an apparent psychic gift for guessing correctly. The effects were likely to be so minuscule, he figured, that he had to maximize his chances of success. With his first set of studies, Schmidt got 27 per cent – a result that may appear insignificant, but which was enough of a deviation in statistical terms for him to conclude that something interesting was going on.[12]

Apparently, there'd been some connection between the mind of his subjects and his machine. But what was it? Did his participants foresee which lights would be lit? Or did they make a choice among the colored lamps and somehow mentally 'force' that particular lamp to light? Was the effect precognition or psychokinesis?

Schmidt decided to isolate these effects further by testing psychokinesis. What he had in mind was an electronic version of Rhine's dice studies. He went on to build another type of machine – a twentieth-century version of the flip of a coin. This machine was based on a binary system (a system with two choices: yes or no; on or off; one or zero). It could electronically generate a random sequence of 'heads' and 'tails' which were displayed by the movement of a light in a circle of nine lamps. One light was always lit. With the top lamp lit at the start, for each generated head or tail the light moved by one step in a clockwise or anticlockwise direction. If 'heads' were tossed, the next light in clockwise order would light. If 'tails', the next light in the anticlockwise direction would light instead. Left to its own devices, the machine would take a random walk around the circle of nine lights, with movements in each direction roughly half the time. After about two minutes and 128 moves, the run stopped and the numbers of generated heads and tails were displayed. The full sequence of moves was also recorded automatically on paper tape, with the number of heads or tails indicated by counters.

Schmidt's idea was to have his participants will the lights to take more steps in a clockwise direction. What he was asking his participants to do, on the most elementary level, was to get the machine to produce more heads than tails.

In one study, Schmidt worked with two participants, an aggressive, extroverted North American woman and a reserved male researcher in parapsychology from South America. In preliminary tests, the North American woman had scored consistently more heads than tails, while the South American man had scored the reverse – more tails than heads –

even though he'd been trying for a greater number of heads. During a larger test of more than 100 runs apiece, both kept to the same scoring tendencies – the woman got more heads, the man more tails. When the woman did her test, the light showed a preference for clockwise motion 52.5 per cent of the time. But when the man concentrated, the machine once again did the opposite of what he intended. In the end, only 47.75 per cent of the lit lights moved in a clockwise direction.

Schmidt knew he had come up with something important, even if he couldn't yet put his finger on how any known law of physics could explain this. When he worked it out, the odds against such a large disparity in the two scores occurring by chance were more than 10 million to one. That meant he'd have to conduct 10 million similar studies before he'd get the results by chance alone.[13]

Schmidt gathered together eighteen people, the most easily available he could find. In their first studies, he found that, as with his South American fellow, they seemed to have a reverse effect on the machine. If they tried to make the machine move clockwise, it tended to move in the other direction.

Schmidt was mainly interested in whether there was any effect at all, no matter what the direction. He decided to see whether he could set up an experiment to make it more likely that his subjects got a negative score. If these participants ordinarily had a negative effect, then he'd do his best to amplify it. He selected only those participants who'd had a reverse effect on the machine. He then created an experimental atmosphere that might encourage failure. His participants were asked to conduct their test in a small dark closet where they'd be huddled with the display panel. Schmidt studiously avoided giving them the slightest bit of encouragement. He even told them to expect that they were going to fail.

Not surprisingly, the team had a significantly negative effect on the RNG. The machine moved more in the opposite way than what they'd intended. But the point was that the participants were having some effect on the machine, even if it was a contrary one. Somehow, they'd been able to shift the machines, ever so slightly, away from their random activity; their results were 49.1 per cent against an expected result of 50 per cent. In statistical terms, this was a result of major significance – a thousand to one that the result had occurred by chance. Since none of his subjects knew how the RNG worked, it was clear that whatever they were doing must have been generated by some sort of human will.[14]

Schmidt carried on with similar studies for a number of years, publishing in *New Scientist* and other journals, meeting with like-minded people and achieving highly significant scores in his studies – sometimes as high as 54 per cent against an expected result of 50 per cent.[15] By 1970, the year before Mitchell's moon walk, Boeing suffered a setback in profits and needed to cut back sharply on staff. Schmidt, along with hundreds of others, was one of its casualties. Boeing had been such a key source of R&D jobs in the area that without the aerospace giant, there was virtually no work to be had. A sign at the border of Seattle read, 'Will the last one to leave Seattle please turn off the lights?' Schmidt made his third and final career move. He would continue on with his consciousness research, a physicist among parapsychologists. He relocated to Durham, North Carolina, and sought work at Rhine's laboratory, the Foundation for Research on the Nature of Man, carrying on his RNG research with Rhine himself.

A few years later, word of Schmidt's machines filtered through to Princeton University and came to the attention of a young university student in the school of engineering. She was an undergraduate, a sophomore, studying electrical engineering, and something about the idea of mind being able to influence a machine held a certain romantic appeal. In 1976, she decided to approach the dean of the engineering school about the possibility of replicating Helmut Schmidt's RNG studies as a special project.[16]

Robert Jahn was a tolerant man. When campus unrest had erupted at Princeton, as it did at most universities across America in response to the escalation of the Vietnam War, Jahn, then a professor of engineering, had found himself an unwitting apologist for high technology, at a point when it was being blamed for America's stark polarization. Jahn had argued persuasively to the Princeton student body that technology actually offered the solution to this divisiveness. His conciliatory line not only had settled down the campus unrest but also had helped to create an accepting atmosphere for students with technical interests at what was essentially a liberal arts university. Jahn's skill at diplomacy may have been one reason he'd been asked to serve as dean in 1971.

Now his famous tolerance was being stretched nearly to its limit. Jahn was an applied physicist who had invested his entire life in the teaching and development of technology. All of his own degrees came from Princeton, and his work in advanced space propulsion systems and high temperature plasma dynamics had won him his current distinguished position.

He'd returned to Princeton in the early 1960s with the mission of introducing electric propulsion to the aeronautical engineering department. The project he was now being asked to supervise essentially belonged to the category of psychic phenomena. Jahn wasn't convinced it was a viable topic, but the sophomore was such a brilliant student who was already on a fast track through her program that he eventually relented. He agreed to subsidize a summer project for her out of his discretionary funds. Her task was to research the existing scientific literature on RNG studies and other forms of psychokinesis and to carry out a few preliminary experiments. If she could convince Jahn that the field held some credibility and, more importantly, could be approached from a technical perspective, he told her, then he'd agree to supervise her independent work.

Jahn tried to approach the topic as an open-minded scholar might. Over the summer, his student would leave photocopies of technical papers on his desk and even managed to coax him into accompanying her to a meeting of the Parapsychological Association. He tried to get a feel for the people involved in studying what had always been dismissed as a fringe science. Jahn rather hoped that the entire subject would go away. Much as he was amused by the project, particularly by the notion that he somehow might have the power to influence all the complicated array of equipment around him, he knew that this was something, in the long run, that might mean trouble for him, particularly among his fellow faculty members. How would he ever explain it as a serious topic of study?

Jahn's student kept returning with more convincing proof that this phenomenon existed. There was no doubt that the people involved in the studies and the research itself had a certain credibility. He agreed to supervise a two-year project for her, and when she began returning with her own successful results, he found himself making suggestions and trying to refine the equipment.

By the second year of the student's project, Jahn himself began dabbling in his own RNG experiments. It was beginning to look as though there might be something interesting here. The student graduated and left her RNG work behind, an intriguing thought experiment, and no more, the results of which had satisfied her curiosity. Now it was time to get serious and return to the more traditional line she'd originally chosen for herself. She embarked on what would turn out to be a lucrative career in conventional computer science, leaving in her wake a body of tantalizing data and also a bomb across Bob Jahn's path that would change the course of his life forever.

Jahn respected many of the investigators into consciousness research, but privately he felt that they were going about it the wrong way. Work like Rhine's, no matter how scientific, tended to be placed under the general umbrella of parapsychology, which was largely dismissed by the scientific establishment as the province of confidence tricksters and magicians. Clearly what was needed was a highly sophisticated, solidly based research program, which would give the studies a more temperate and scholarly framework. Jahn, like Schmidt, realized the enormous implications of these experiments. Ever since Descartes had postulated that mind was isolated and distinct from the body, all the various disciplines of science had made a clear distinction between mind and matter. The experiments with Schmidt's machines seemed to be suggesting that this separation simply didn't exist. The work that Jahn was about to embark on represented far more than resolving the question of whether human beings had the power to affect inanimate objects, whether dice, spoons or microprocesses. This was study into the very nature of reality and the nature of living consciousness. This was science at its most wondrous and elemental.

Schmidt had taken great care to find special people with exceptional abilities who might be able to get especially good results. Schmidt's was a protocol of the extraordinary – abnormal feats performed by abnormal people with a peculiar gift. Jahn believed that this approach further marginalized the topic. The more interesting question, in his mind, was whether this was a capacity present in every human being.

He also wondered what impact this might have on our everyday lives. From his position as dean of an engineering school in the 1970s, Jahn realized that the world stood poised on the brink of a major computer revolution. Microprocessor technology was becoming increasingly sensitive and vulnerable. If it were true that living consciousness could influence such sensitive equipment, this in itself would have a major impact on how the equipment operated. The tiniest disturbances in a quantum process could create significant deviations from established behavior, the slightest movement send it soaring in a completely different direction.

Jahn knew that he was in a position to make a unique contribution. If this research were grounded in traditional science backed by a prestigious university, the entire topic might be aired in a more scholarly way.

He made plans for setting up a small program, and gave it a neutral name: Princeton Engineering Anomalies Research, which would thereafter always be known as PEAR. Jahn also resolved to take a low-key and lone-wolf approach by deliberately distancing himself from the various parapsychological associations and studiously avoiding any publicity.

Before long, private funding began rolling in, launching a precedent that Jahn would follow thereafter of never taking a dime of the University's money for his PEAR work. Largely because of Jahn's reputation, Princeton tolerated PEAR like a patient parent with a precocious but unruly child. He was offered a tiny cluster of rooms in the basement of the engineering school, which was to exist as its own little universe within one of the more conservative disciplines on this American Ivy League campus.

As Jahn began considering what he might need to get a program of this size off the ground, he made contact with many of the other new explorers in frontier physics and consciousness studies. In the process, he met and hired Brenda Dunne, a developmental psychologist at the University of Chicago, who had conducted and validated a number of experiments in clairvoyance.

In Dunne, Jahn had deliberately chosen a counterpoint to himself, which was obvious at first sight by their gaping physical differences. Jahn was spare and gaunt, often neatly turned out in a tidy checked shirt and casual trousers, the informal uniform of conservative academia, and in both his manner and his erudite speech gave off a sense of containment – never a superfluous word or unnecessary gesture. Dunne had the more effusive personal style. She was often draped in flowing clothes, her immense mane of salt-and-pepper hair hung loose or pony-tailed like a Native American. Although also a seasoned scientist, Dunne tended to lead from the instinctive. Her job was to provide the more metaphysical and subjective understanding of the material to bolster Jahn's largely analytical approach. He would design the machines; she would design the look and feel of the experiments. He would represent PEAR's face to the world; she would represent a less formidable face to its participants.

The first task, in Jahn's mind, was to improve upon the RNG technology. Jahn decided that his Random Event Generators, or REGs (hard 'G'), as they came to be called, should be driven by an electronic noise source, rather than atomic decay. The random output of these machines was controlled by something akin to the white noise you hear when the dial of your radio is between stations – a tiny roaring surf of free electrons. This provided a mechanism to send out a randomly alternating string of positive and negative pulses. The results were displayed on a computer screen and then transmitted on-line to a data management system. A number of failsafe features, such as voltage and thermal monitors, guarded against tampering or breakdown, and they were checked religiously to ensure that when not involved in experiments of volition, they were producing each of their two possibilities, 1 or 0, more or less 50 per cent of the time.

All the hardware failsafe devices guaranteed that any deviation from the normal 50–50 chance heads and tails would not be due to any electronic glitches, but purely the result of some information or influence acting upon it. Even the most minute effects could be quickly quantified by the computer. Jahn also souped up the hardware, getting it to work far faster. By the time he was finished, it occurred to him that in a single afternoon he could collect more data than Rhine had amassed in his entire lifetime.

Dunne and Jahn also refined the scientific protocol. They decided that all their REG studies should follow the same design: each participant sitting in front of the machine would undergo three tests of equal length. In the first, they would will the machine to produce more 1s then 0s (or 'HI's, as PEAR researchers put it). In the second, they would mentally direct the machine to produce more 0s than 1s (more 'LO's). In the third, they would attempt not to influence the machine in any way. This three-stage process was to guard against any bias in the equipment. The machine would then record the operator's decisions virtually simultaneously.

When a participant pressed a button, he would set off a trial of 200 binary 'hits' of 1 or 0, lasting about one-fifth of a second, during which time he would hold his mental intention (to produce more than the 100 '1's, say, expected by chance). Usually the PEAR team would ask each operator to carry out a run of 50 trials at one go, a process that might only take half an hour but which would produce 10,000 hits of 1 or 0. Dunne and Jahn typically examined scores for each operator of blocks of 50 or 100 runs (2,500 to 5,000 trials, or 500,000 to one million binary 'hits') – the minimum chunk of data, they determined, for reliably pinpointing trends.[17]

From the outset it was clear that they needed a sophisticated method of analyzing their results. Schmidt had simply counted up the number of hits and compared them to chance. Jahn and Dunne decided to use a tried-and-tested method in statistics called cumulative deviation, which entailed continually adding up your deviation from the chance score – 100 – for each trial and averaging it, and then plotting it on a graph.

The graph would show the mean, or average, and certain standard deviations – margins where results deviate from the mean but are still not considered significant. In trials of 200 binary hits occurring randomly, your machine should throw an average of 100 heads and 100 tails over time – so your bell curve will have 100 as its mean, represented by a vertical line initiated from top of its highest point. If you were to plot each result every time your machine conducted a trial, you would have individual points on your bell curve – 101, 103, 95, 104 – representing each score. Because any single effect is so tiny, it is difficult, doing it that way, to see any overall trend. But if you continue to add up and average your results and are having effects, no matter how slight, your scores should lead to a steadily increasing departure from expectation. Cumulative averaging shows off any deviation in bold relief.[18]

It was also clear to Jahn and Dunne that they needed a vast amount of data. Statistical glitches can occur even with a pool of data as large as 25,000 trials. If you are looking at a binary chance event like coin tossing, in statistical terms you should be throwing heads or tails roughly half the time. Say you decided to toss a coin 200 times and came up with 102 heads. Given the small numbers involved, your slight favouring of heads would still be considered statistically well within the laws of chance.

But if you tossed that same coin 2 million times, and you came up with 1,020,000 heads, this would suddenly represent a huge deviation from chance. With tiny effects like the REG tests, it is not individual or small clusters of studies but the combining of vast amounts of data which 'compounds' to statistical significance, by its increasing departure from expectation.[19]

After their first 5000 studies Jahn and Dunne decided to pull off the data and compute what was happening thus far. It was a Sunday evening and they were at Bob Jahn's house. They took their average results for each operator and began plotting them on a graph, using little red dots for any time their operators had attempted to influence the machine to have a HI (heads) and little green dots for the LO intentions (tails).

When they finished, they examined what they had. If there had been no deviation from chance, the two bell curves would be sitting right on top of the bell curve of chance, with 100 as the mean.

Their results were nothing like that. The two types of intention had

each gone in a different direction. The red bell curve, representing the 'HI' intentions, had shifted to the right of the chance average, and the green bell curve had shifted to the left. This was as rigorous a scientific study as they come, and yet somehow their participants – all ordinary people, no psychic superstars among them – had been able to affect the random movement of machines simply by an act of will.

Jahn looked up from the data, sat back in his chair and met Brenda's eye. 'That's very nice,' he said.

Dunne stared at him in disbelief. With scientific rigor and technological precision they had just generated proof of ideas that were formerly the province of mystical experience or the most outlandish science fiction. They'd proved something revolutionary about human consciousness. Maybe one day this work would herald a refinement of quantum physics. Indeed, what they had in their hands was *beyond* current science – was perhaps the beginnings of a new science.

'What do you mean, "*that's very nice*"?' she replied. 'This is absolutely . . . *incredible*!'

Even Bob Jahn, in his cautious and deliberate manner, his dislike of being immoderate or waving a fist in the air, had to admit, staring at the graphs sprawled across his dining-room table, that there were no words in his current scientific vocabulary to explain them.

It was Brenda who first suggested that they make the machines more engaging and the environment more cosy in order to encourage the 'resonance' which appeared to be occurring between participants and their machines. Jahn began creating a host of ingenious random mechanical, optical and electronic devices – a swinging pendulum; a spouting water fountain; computer screens which switched attractive images at random; a moveable REG which skittled randomly back and forth across a table; and the jewel in the PEAR lab's crown, a random mechanical cascade. At rest it appeared like a giant pinball machine attached to the wall, a 6-by-10-foot framed set of 330 pegs. When activated, nine thousand polystyrene balls tumbled over the pegs in the span of only 12 minutes and stacked in one of nineteen collection bins, eventually producing a configuration resembling a bell-shaped curve. Brenda put a toy frog on the moveable REGs and spent time selecting attractive computer images, so that participants would be 'rewarded' if they chose a certain image by seeing more of it. They put up wood paneling. They began a collection of teddy bears. They offered participants snacks and breaks.

Year in and year out, Jahn and Dunne carried on the tedious process of collecting a mountain of data – which would eventually turn into the largest database ever assembled of studies into remote intention. At various points, they would stop to analyze all they had amassed thus far. In one 12-year period of nearly 2.5 million trials, it turned out that 52 per cent of all the trials were in the intended direction and nearly two-thirds of the ninety-one operators had overall success in influencing the machines the way they'd intended. This was true, no matter which type of machine was used.[20] Nothing else – whether it was the way a participant looked at a machine, the strength of their concentration, the lighting, the background noise or even the presence of other people – seemed to make any difference to the results. So long as the participant willed the machine to register heads or tails, he or she had some influence on it a significant percentage of the time.

The results with different individuals would vary (some would produce more heads than tails, even when they had concentrated on the exact opposite). Nevertheless, many operators had their own 'signature' outcome – Peter would tend to produce more heads than tails, and Paul vice versa.[21] Results also tended to be unique to the individual operator, no matter what the machine. This indicated that the process was universal, not one occurring with only certain interactions or individuals.

In 1987, Roger Nelson of the PEAR team and Dean Radin, both doctors of psychology, combined all the REG experiments – more than 800 – that had been conducted up to that time.[22] A pooling together of the results of the individual studies of sixty-eight investigators, including Schmidt and the PEAR team, showed that participants could affect the machine so that it gives the desired result about 51 per cent of the time, against an expected result of 50 per cent. These results were similar to those of two earlier reviews and an overview of many of the experiments performed on dice.[23] Schmidt's results remained the most dramatic with those studies that had leapt to 54 per cent.[24]

Although 51 or 54 per cent doesn't sound like much of an effect, statistically speaking it's a giant step. If you combine all the studies into what is called a 'meta-analysis', as Radin and Nelson did, the odds of this overall score occurring are a trillion to one.[25] In their meta-analysis, Radin and Nelson even took account of the most frequent criticisms of the REG studies concerning procedures, data or equipment by setting up sixteen

criteria by which to judge each experimenter's overall data and then assigning each experiment a quality score.[26] A more recent meta-analysis of the REG data from 1959 to 2000 showed a similar result.[27] The US National Research Council also concluded that the REG trials could not be explained by chance.[28]

An effect size is a figure which reflects the actual size of change or outcome in a study. It is arrived at by factoring in such variables as the number of participants and the length of the test. In some drug studies, it is arrived at by dividing the number of people who have had a positive effect from the drug by the total number of participants in the trial. The overall effect size of the PEAR database was 0.2 per hour.[29] Usually an effect size between 0.0 to 0.3 is considered small, a 0.3 to 0.6 effect size is medium and anything above that is considered large. The PEAR effect sizes are considered small and the overall REG studies, small to medium. However, these effect sizes are far larger than those of many drugs deemed to be highly successful in medicine.

Numerous studies have shown that propranolol and aspirin are highly successful in reducing heart attacks. Aspirin in particular has been hailed as a great white hope of heart disease prevention. Nevertheless, large studies have shown that the effect size of propranolol is 0.04 and aspirin is 0.03, respectively – or about ten times smaller than the effect sizes of the PEAR data. One method of determining the magnitude of effect sizes is to convert the figure to the number of persons surviving in a sample of 100 people. An effect size of 0.03 in a medical life-or-death situation would mean that three additional people out of one hundred survived, and an effect size of 0.3 would mean that an additional thirty of one hundred survived.[30]

To give some hypothetical idea of the magnitude of the difference, say that with a certain type of heart operation, thirty patients out of a hundred usually survive. Now, say that patients undergoing this operation are given a new drug with an effect size of 0.3 – close to the size of the hourly PEAR effect. Offering the drug on top of the operation would virtually double the survival rate. *An additional effect size of 0.3 would turn a medical treatment that had been life-saving less than half the time into one that worked in the majority of cases.*[31]

Other investigators using REG machines discovered that it was not simply humans who had this influence over the physical world. Using a variation of Jahn's REG machines, a French scientist named René Peoc'h also carried out an ingenious experiment with baby chicks. As soon as they were born, a moveable REG was 'imprinted' on them as their 'mother'. The robot was then placed outside the chicks' cage and allowed to move about freely, as Peoc'h tracked its path. After a time, the evidence was clear – the robot was moving toward the chicks more than it would do if it were wandering randomly. The desire of the chicks to be near their mother was an 'inferred intention' that appeared to be having an effect in drawing the machine nearer.[32] Peoc'h carried out a similar study with baby rabbits. He placed a bright light on the moveable REG that the baby rabbits found abhorrent. When the data from the experiment were analyzed, it appeared that the rabbits were successfully willing the machine to stay away from them.

Jahn and Dunne began to formulate a theory. If reality resulted from some elaborate interaction of consciousness with its environment, then consciousness, like subatomic particles of matter, might also be based on a system of probabilities. One of the central tenets of quantum physics, first proposed by Louis de Broglie, is that subatomic entities can behave either as particles (precise things with a set location in space) or waves (diffuse and unbounded regions of influence which can flow through and interfere with other waves). They began to chew over the idea that consciousness had a similar duality. Each individual consciousness had its own 'particulate' separateness, but was also capable of 'wave-like' behavior, in which it could flow through any barriers or distance, to exchange information and interact with the physical world. At certain times, subatomic consciousness would get in resonance with – beat at the same frequency as – certain subatomic matter. In the model they began to assemble, consciousness 'atoms' combined with ordinary atoms – those, say, of the REG machine – and created a 'consciousness molecule' in which the whole was different from its component parts. The original atoms would each surrender their individual entities to a single larger, more complex entity. On the most basic level, their theory was saying, you and your REG machine develop coherence.[33]

Certainly some of their results seemed to favor this interpretation. Jahn and Dunne had wondered if the tiny effect they were observing with individuals would get any larger if two or more people tried to influence the machine in tandem. The PEAR lab ran a series of studies using pairs of people, in which each pair was to act in concert when attempting to influence the machines.

Of 256,500 trials, produced by fifteen pairs in forty-two experimental

series, many pairs also produced a 'signature' result, which didn't necessarily resemble the effect of either individual alone.[34] Being of the same sex tended to have a very slight negative effect. These types of couples had a worse outcome than they achieved individually; with eight pairs of operators the results were the very opposite of what was intended. Couples of the opposite sex, all of whom knew each other, had a powerful complementary effect, producing more than three and a half times the effect of individuals. However, 'bonded' pairs, those couples in a relationship, had the most profound effect, which was nearly six times as strong as that of single operators.[35]

If these effects depended upon some sort of resonance between the two participating consciousnesses, it would make sense that stronger effects would occur among those people sharing identities, such as siblings, twins or couples in a relationship.[36] Being close may create coherence. As two waves in phase amplified a signal, it may be that a bonded couple has an especially powerful resonance, which would enhance their joint effect on the machine.

A few years later, Dunne analyzed the database to see if results differed according to gender. When she divided results between men and women, she found that men on the whole were better at getting the machine to do what they wanted it do, although their overall effect was weaker than it was with women. Women, on the whole, had a stronger effect on the machine, but not necessarily in the direction they'd intended.[37] After examining 270 databases produced by 135 operators in nine experiments between 1979 and 1993, Dunne found that men had equal success in making the machine do what they wanted, whether heads or tails (or HIs and LOs). Women, on the other hand, were successful in influencing the machine to record heads (HIs), but not tails (LOs). In fact, most of their attempts to get the machine to do tails failed. Although the machine would vary from chance, it would be in the very opposite direction of what they'd intended.[38]

At times, women produced better results when they weren't concentrating strictly on the machine, but were doing other things as well, whereas strict concentration seemed important for men's success.[39] This may provide some subatomic evidence that women are better at multitasking than men, while men are better at concentrated focus. It may well be that in microscopic ways men have a more direct impact on their world, while women's effects are more profound.

Then something happened which forced Jahn and Dunne to reconsider their hypothesis about the nature of the effects they were observing. In 1992, PEAR had banded together with the University of Giessen and the Freiberg Institute to create the Mind–Machine Consortium. The consortium's first task was to replicate the original PEAR data, which everyone assumed would proceed as a matter of course. Once the results of all three laboratories were examined, however, they looked, at first glance, a failure – little better than the 50–50 odds which occur by chance alone.[40]

When writing up the results, Jahn and Dunne noticed some odd distortions in the data. Something interesting had occurred in the secondary variables. In statistical graphs, you can show not only what your average ought to be but also how far the deviations from it ought to spread from your mean. With the Mind–Machine data, the mean was right where it would be with a chance result, but not much else was. The size of the variation was too big, and the shape of the bell curve was disproportionate. Overall, the distribution was far more skewed than it would be if it were just a chance result. Something strange was going on.

When Jahn and Dunne looked a little closer at the data, the most obvious problem had to do with feedback. Up until that time they'd operated on the assumption that providing immediate feedback – telling the operators how they were doing in influencing the machine – and making an attractive display or a machine that people could really engage with would crucially help to produce good results. This would hook the operator into the process and help them to get in 'resonance' with the device. For the mental world to interact with the physical world, they'd thought, the interface – an attractive display – was crucial in breaching that divide.

However, in the Consortium data, they realized that the operators were doing just as well – or sometimes better – when they had no feedback.

One of their other studies, called ArtREG, had also failed to get significant overall results.[41] They decided to examine that study a bit more closely in light of the Mind–Machine Consortium results. They'd used engaging images on a computer, which randomly switched back and forth – in one case a Navajo sand painting switched with Anubis, the ancient Egyptian judge of the dead. The idea was for their operators to will the machine to show more of one than the other. The PEAR team had assumed once again that an attractive image would act as a carrot – you'd be 'rewarded' for your intention by seeing more of the image you preferred.

Once they'd examined the data of the study in terms of yield by picture, those images which had produced the most successful outcomes all fell into a similar category: the archetypal, the ritualistic or the religiously iconographic. This was the domain of dreams, the unexpressed or unarticulated – images that, by their very design, were intended to engage the unconscious.

If that were true, the intention was coming from deep in the unconscious mind, and this may have been the cause of the effects. Jahn and Dunne realized what was wrong with their assumptions. Using devices to make the participant function on a conscious level might be acting as a barrier. Instead of increasing conscious awareness among their operators, they should be diminishing it.[42]

This realization caused them to refine their ideas about how the effects they'd observed in their labs might occur. Jahn liked to call it his 'work in progress'. It appeared that the unconscious mind somehow had the capability of communicating with the subtangible physical world – the quantum world of all possibility. This marriage of unformed mind and matter would then assemble itself into something tangible in the manifest world.[43]

This model makes perfect sense if it also embraces theories of the Zero Point Field and quantum biology proposed by Pribram, Popp and the others. Both the unconscious mind – a world before thought and conscious intention – and the 'unconscious' of matter – the Zero Point Field – exist in a probabilistic state of all possibility. The subconscious mind is a preconceptual substrate from which concepts emerge, and the Zero Point Field is a probabilistic substrate of the physical world. It is mind and matter at their most fundamental. In this subtangible dimension, possibly of a common origin, it would make sense that there would be a greater likelihood of quantum interaction.

At times, Jahn kicked around the most radical idea of all. When you get down far enough into the quantum world, there may be no distinction between the mental and the physical. There may be only the concept. It might just be consciousness attempting to make sense of a blizzard of information. There might not be two intangible worlds. There might be only one – The Field and the ability of matter to organize itself coherently.[44]

As Pribram and Hameroff theorized, consciousness results from superradiance, a rippling cascade of subatomic coherence – when individual quantum particles such as photons lose their individuality and begin acting as a single unit, like an army calling every soldier into line. Since every motion of every charged particle of every biological process is mirrored in the Zero Point Field, our coherence extends out in the world. According to the laws of classical physics, particularly the law of entropy, the movement of the inanimate world is always toward chaos and disorder. However, the coherence of consciousness represents the greatest form of order known to nature, and the PEAR studies suggest that this order may help to shape and create order in the world. When we wish for something or intend something, an act which requires a great deal of unity of thought, our own coherence may be, in a sense, infectious.

On the most profound level, the PEAR studies also suggest that reality is created by each of us *only by our attention*. At the lowest level of mind and matter, each of us creates the world.

The effects that Jahn had been able to record were almost imperceptible. It was too early to know why. Either the machinery was still too crude to pick up the effect or he was only picking up a single signal, when the real effect occurs from an ocean of signals – an interaction of all living things in the Zero Point Field. The difference between his own results and the higher ones recorded by Schmidt suggested that this ability was spread across the population, but that it was like artistic ability. Certain individuals were more skillful at harnessing it.

Jahn had seen that this process had minute effects on probabilistic processes, and that this might explain all the well-known stories about people having positive or negative effects on machines – why, on some bad days, computers, telephones and photocopiers malfunction. It might even explain the problems Benveniste had been having with his robot.

It seemed that we had an ability to extend our own coherence out into our environment. By a simple act of wishing, we could create order. This represented an almost unimaginable amount of power. On the crudest level, Jahn had proved that, at least on the subatomic level, there was such as thing as mind over matter. But he'd demonstrated something even more fundamental about the powerful nature of human intention. The REG data offered a tiny window into the very essence of human creativity – its capacity to create, to organize, even to heal.[45] Jahn had his evidence that human consciousness had the power to order random electronic devices. The question now before him was what else might be possible.

CHAPTER SEVEN

Sharing Dreams