

An image of science and business

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A Machine Called Indomitable. By Sonny Kleinfeld. *Times Books, New York:1985.* Pp.250. \$16.95.

RAYMOND Damadian, the main subject and inspiration for this book, could, it seems, have chosen to make a career as a violinist or a tennis player had he not chosen to study science and later medicine. By the end of Sonny Kleinfeld's rather shallow account, his subject has become a business man, grown rich by selling the nuclear magnetic resonance (NMR) scanner that he had pioneered. But this is much less a story of how the son of some poor Armenian immigrants made good in the great American tradition, than how a misfit in the conventional world of medical research was forced into business to support himself.

Damadian's problems with his fellow researchers seem to have been catalysed by his early association with Gilbert Ling, a physiologist who believes that the interior of cells comprises multiple polarized layers of water molecules which account for phenomena such as those otherwise interpreted as a sodium pump in the cell membrane. Falling under the spell of Ling — who remains a voice in the wilderness — Damadian first reasoned that the water structure of cancer cells would differ from that of normal cells, and then came across NMR as a means of detecting that difference: "One afternoon, peering at the pool... Damadian went off into his own mind. Gradually, swirling like smoke, visions emerged. Perhaps some sort of giant NMR machine might be just the device that could be used to scan his stomach (which was still acting up)..." (p.27). In the style of the reporter (for the *New York Times*) that he is, Kleinfeld recounts how the dream of 1970 became the prototype machine of 1977, and the business of today.

Damadian's first "mistake" was to outline in *Science* his vision of using NMR to detect tumours on the basis of their abnormal water structure. The paper seems to have been the subject of a good deal of derision, from which its author never really recovered in the eyes of many of his peers. The result was a continual struggle for money to support his work and a growing contempt and fear of his rivals, especially Paul Lauterbur at the University of New York at Stony Brook, whose paper on NMR imaging (for which he coined the unused term *zeugmatography*) was published in *Nature* in 1973. Damadian was incensed that the paper contained no reference to his own work; he was, however,

inspired by Lauterbur's achievement to switch his own efforts to imaging.

Perhaps Damadian's character is best illustrated by his financial struggles. When his first grant application was turned down he wrote directly to President Nixon: "The rejection of my grant by the National Institutes of Health is a colossal stupidity [which] reflects only the enduring ignorance and the complete absence of vision of the men who decide". Urged by NIH to reapply, he received a three-year grant with which he bought his first NMR machine. When that grant ran out and the "appallingly disgusting" peer review system failed him again, he raised money privately with the help of a brother-in-law

Reasoning that his fatness was the problem, he put pressure on his only slim associate to be scanned by the machine — by then christened *Indomitable*. Persuasion took two months, the scan itself four and three-quarter hours. But the result was an image. And a press conference. And more hostility.

Failing to get recognition, promotion or papers published, and once again without the money to proceed, it was then that Damadian decided to go into business. He also decided to switch from a superconducting magnet, with its problematic requirements for cooling by liquid helium, to a permanent magnet, which weighs 3,000 g in the latest machines. They now

Tumor Detection by Nuclear Magnetic Resonance

Abstract. Spin echo nuclear magnetic resonance measurements may be used as a method for discriminating between malignant tumors and normal tissue. Measurements of spin-lattice (T_1) and spin-spin (T_2) magnetic relaxation times were made in six normal tissues in the rat (muscle, kidney, stomach, intestine, brain, and liver) and in two malignant solid tumors, Walker sarcoma and Novikoff hepatoma. Relaxation times for the two malignant tumors were distinctly outside the range of values for the normal tissues studied, an indication that the malignant tissues were characterized by an increase in the freedom of tissue water.

Cause of controversy: the opening lines of Damadian's paper in *Science*, 19 March 1971.

through a Citizens' Campaign for New Approaches to Cancer. There followed a large National Cancer Institute grant (and a patent) but again no renewal. Later, in desperation, Damadian travelled to Plains, Georgia, to try and persuade the newly-elected President Carter of his case. Hugh Carter, a cousin, did his best on Damadian's behalf but no money was forthcoming. In the end it was a wealthy businessman who came to the rescue.

Despite financial problems, Damadian was making progress in the construction of a human NMR scanner. But the lack of money meant that much labour and ingenuity had to be spent on building everything, including the superconducting magnet, from scratch and often from junk. He was driven to a considerable extent by the fear that Lauterbur, or one of the British groups that had entered the field, would be the first to produce NMR images of the human body, in which case Damadian foresaw that he would lose any remaining chance of getting the credit for his invention. Lauterbur, however, seems not to have been concerned. A research associate at the time is quoted as saying "He didn't think Damadian was capable of producing an image. He thought he was some crazy doctor".

Whereas Lauterbur and others were busy imaging lemons, green peppers and even rats, Damadian was going for broke. Finding no volunteer among his colleagues to be the first human to be NMR scanned — there was some apprehension about the possible effects of a long exposure to a strong magnetic field — Damadian became his own guinea pig in May 1977. The result was not even a lemon.

sell for more than \$1.6 million and have to compete with similar machines from at least a dozen rival companies.

Kleinfeld's book has its attractions. It provides a plausible picture of a man who suffered the results of allowing his enthusiasm to get the better of him when the rules of the game demand a more measured approach. It is easy to see both why he became almost paranoid about his peers and why they took him less than seriously. It is, however, hard to be too enthusiastic about a writer who can say (p.8): "Two of the important substances that get reabsorbed [in the kidney] are sodium and potassium; they are the secret to biological electricity, which is the foundation of life. It allows us to move our arms and legs and to breathe". Also, even though the book does not pretend to be a balanced account of the development of NMR imaging, it would have benefited from a less Damadian-dominated version of the story. The author talked to Lauterbur and some of the British rivals, but one learns little of the former and next to nothing of the latter.

Ironically, NMR scanners are still of little use in detecting tumours, the point of departure for Damadian's quest. Undaunted, Damadian now foresees the development of *Indomitable* into a tumour-killing device. And, indomitably, he still believes that in cancer "the real event that's taking place is that the water is becoming more and more disorganized and less structured in the cell". For better or for worse there is probably more room for such characters in business than in science. Or even in music or tennis. □

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