In June, 1985, I was the Shannon Lecturer at the ISIT in Brighton, England. Claude Shannon himself was in the audience! It was the first time that he had attended an ISIT since he gave the *first* Shannon Lecture in Ashkelon, Israel, in 1973. I chatted with him on a number of occasions in Brighton, but not on technical subjects of any depth. In general conversation he seemed totally lucid, but there were significant gaps in his remembrance of prior events.

For one of the most important technological innovators of the twenthieth century, Claude Shannon was remarkably modest and unassuming. I was one of many younger researchers whom he encouraged, and I certainly benefited significantly from my association with him.

James L. Massey
(1988 Shannon Lecturer)

I had the great luck as a graduate student at M.I.T. in the fall of 1960 to enroll in Professor Fano's course, Transmission of Information. His enthusiastic and entertaining lectures conveyed the beauty and excitement of information theory. I decided that this was the field for me and, in the following semester, enrolled in the course, Advanced Topics in Information Theory, which was taught by Shannon himself. I still treasure, and often re-read, my notes from those lectures. Shannon was a brilliant lecturer, if not in the classical style. His style of treating a subject was to present a sequence of increasingly complex examples, each having a solution that was obvious by inspection, until he had covered all the essential points, after which he would state the general theorem. I think that we graduate students all understood how to make the proofs then on our own. Whenever I have given a particularly good lecture since then, it has been because I consciously imitated Shannon's approach—the disasters have come when I forgot to do so.

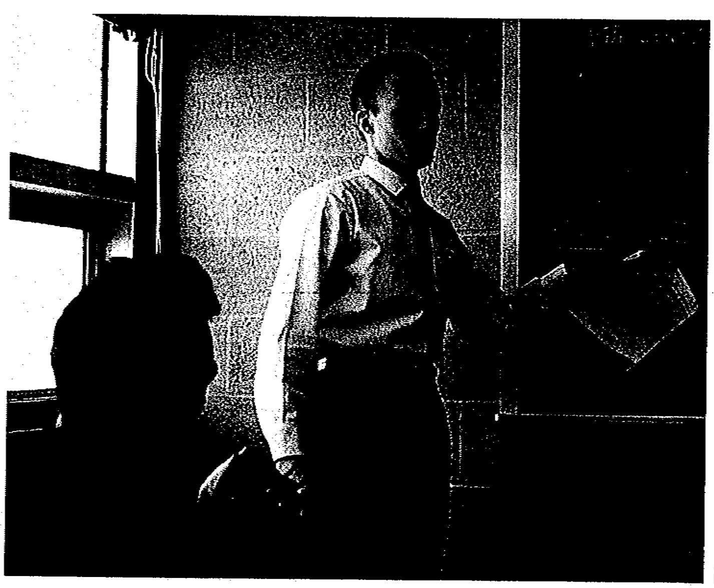

Photo courtesy of Jim Massey

Jim Massey as a young student under the watchful eye of C. Shannon.

Already then a very famous man, Shannon was nonetheless personally shy. He never seemed to me to be at ease in a crowd, but he was very relaxed and accessible to us struggling graduate students. Still it took me a long time to screw up my courage to the point where I dared to ask him to be a reader of my doctoral thesis, which he immediately agreed to do. He provided me with some excellent advice on my research—I also have copied the cross-examination technique by which he got me to explain what I was trying to do.

The second greatest honor of my life was being named a Shannon Lecturer. The greatest occurred during the 1986 ISIT in Ann Arbor, Michigan. Shortly before I gave my eminently forgettable talk, Claude and Betty Shannon entered the small lecture room, expressly to listen to me. To me this was one more proof that Claude Shannon is not only one of the great scientific figures of this century, but also a kind and generous human being.

Thomas M. Cover
(1990 Shannon Lecturer)

I bought two books with interesting titles the summer before starting graduate school at Stanford, Shannon's 1948 book on information theory and von Neumann and Morgenstern's book on game theory. Both books were extremely exciting. I spent over 100 hours using the game theory book to develop optimal strategies in various scenarios in poker. But Shannon's work seemed deeper and even more intriguing. I couldn't believe that something as intangible as information could be given such a satisfactory definition and have so many deep properties. I was also impressed by the relaxed and accessible writing style.

Shannon wrote his landmark paper as if the technical work had already been done and it was time to write an expository article on the subject. In fact, some of the greatest works in mathematics and physics have been written in this style. For example, Einstein, in his 1905 paper on relativity theory, had as one of his first equations: velocity = light path/time interval. And he described the notion of simultaneous events by saying, " 'The train arrives here at 7 o'clock,' means something like this: 'The pointing of the small hand on my watch to 7 and the arrival of the train are simultaneous events.' " This is craziness. Crazy or not, Shannon's paper is a great example of this tradition, in which no underlying intuition remains unrevealed. Indeed, the research literature in information theory is very readable, perhaps because of Shannon's influence.

As a result of Shannon's work, I have remained interested in the tangibility of information. One line follows the work of Kelly, in which Kelly shows that the increase in the growth rate of wealth from betting on a horse race is equal to the decrease in entropy. Another fascinating line of inquiry is the development of algorithmic complexity by Kolmogorov, Chaitin and Solomonoff in the mid 60s. The identification of the information in a sequence with its shortest computer de-

Photo courtesy of L. Zadeh

Claude Shannon (right) with (from left) Joe Weizenbaum, Fredkin, and John McCarthy in April '68.

scription leads to a concrete theory which is everywhere parallel to information theory.

Summing up, I would say that the results of Shannon, other than the major ones, of course, which have intrigued me the most are his proof that feedback does not increase capacity (which Gallager made transparent), Shannon's paper on the two-way channel, and Shannon's statement of the entropy power inequality.

There is certainly one piece of intriguing old business remaining. It is a quote from Shannon's 1959 paper on the fidelity criterion: "This duality can be pursued further and is related to a duality between past and future and notions of control and knowledge. Thus we may have knowledge of the past but cannot control it; we may control the future but have no knowledge of it." Shannon said he would write more about it in a subsequent paper, but the paper never appeared. I have tried, without success, to come up with an information theoretic statement on this subject equal to the summary.

Andrew J. Viterbi
(1991 Shannon Lecturer)

In my opinion, Shannon's contributions of 1948 and the subsequent decade are among the most remarkable and lasting theoretical achievements of the twentieth century. I have often remarked that the transistor and information theory, two Bell Laboratories breakthroughs within months of each other, have launched and powered the vehicle of modern digital communications. Solid state electronics provided the engine while information theory gave us the steering wheel with which to guide it.

Shannon theory not only establishes the limits on maximum efficiency of both source coding and channel coding, but it also points us in the right direction toward implementations which approach these limits. The vast majority of digital communication and broadcasting networks employ channel coding techniques based on Shannon theory. Furthermore, their designs are influenced by fundamental statistical ensemble concepts which were first expounded by Shannon in his founding 1948 paper. After nearly half a century of progressively more powerful coding techniques, we are within sight of the Shannon limit; almost error-free communication over a Gaussian channel can be achieved at above 80% of channel capacity, by iterative soft-decision decoding of concatenated codes. These so-called "turbo decoding" techniques require large block lengths and hence considerable delays to achieve such high efficiency, as clearly predicted by Shannon theory. As the very high speed data requirements of the Internet and similar multimedia applications become commonplace, delays which appear long in terms of bit times, become insignificant in real time, and such powerful methods will find wide usage. In a broader and more abstract sense, the spread spectrum techniques, which most digital wireless voice and data networks have already or will soon implement, are conceptually the logical extensions of Shannon theory.

Again we note that the sophisticated computation and memory intensive processing required for the implementation of Shannon theoretic concepts has become feasible and economically favorable through the amazing capabilities of solid state electronics to reduce size, power and cost while increasing speed, all by many orders of magnitude in the last three decades. This trend is likely to continue for some time to come.

Elwyn R. Berlekamp
(1993 Shannon Lecturer)

Claude Shannon has long been widely recognized as one of the foremost intellects of the 20th century. He discovered or invented Information Theory, which has become one of the key pillars of our digital society. He also made legendary contributions to topics now viewed as belonging to other fields, such as the applicability of Boolean algebra to the design of digital circuits, and the basic algorithm for computer-playing chess and checker programs.

He has also been a wonderful human being. He has been a major source of direct and indirect inspiration to me and to numerous others, and through a surprisingly small number of levels of indirection, to our entire community.

One unfamiliar with the man might easily assume that anyone who has made such an enormous impact must have been a promoter with a supersalesman-like personality. But such was not the case. He was actually a very modest man. Even though I worked with him directly over a period spanning several years, much of the influence he had on me was through others.

The earliest event in my career which I can remember occurred in 1946, when I was in the first grade and I learned to play the game called "Dots and Boxes." The second occurred around 1951, when I heard (by word of mouth) the problem of finding one off-weight coin mixed in with eleven