



COLLEGE OF ENGINEERING
DEPARTMENT OF ELECTRICAL ENGINEERING
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COMPUTER SCIENCE DIVISION

BERKELEY, CALIFORNIA 94720

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C. Gordon Bell
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Dear Gordon Bell,

A copy of the letter Don Knuth sent you, but without that postscript, was sent to me too although I neither solicited his letter nor told him that DEC as a corporation was obstructing progress. I did answer his questions, when he phoned me, about the proposals for an IEEE floating point standard, and I did say briefly, when asked, why I thought DEC's participants were adamantly opposed to the proposal favoured by the majority of the subcommittee (and now by him). What I said then, except for speculations about loss of face within DEC, can be found in the enclosed sheet "Two Questions...".

What makes DEC look bad is not what I say but how a few of DEC's engineers have behaved. You can check this out by telephoning the past few chairmen (Dave Stevenson, Dick Delp, Bob Stewart) or some other participants (John Palmer, David Hough, Jerry Coonen) in the floating point standard subcommittee. You could telephone me too were I not to be out of the country for the next ten days or so; hence this letter.

Lest anyone persuade you that I'm anti-DEC, be reassured that countless PDP-11's surround me as well as several VAXs with more to come. The first VAX around here was purchased, largely out of a research grant to Prof. R. Fateman and myself as co-principal investigators, after we estimated that the VAX's floating point arithmetic would probably never match the KCS proposal for a standard. Why did I not veto that purchase? Because VAX serves my non-numeric needs better than alternatives available then and now. Besides, numbers can be crunched as well as KCS on a VAX that we are modifying, or on another machine, so easily that I need not twist DEC's arm to do arithmetic that way although I am convinced that something like the KCS proposal written up by Coonen in "Computer" (Jan. 1980) would suit DEC and DEC's customers better in the long run than the G and H formats announced by Drs. Payne and Bhandarkar as a VAX enhancement.

The crucial difference between the enhanced VAX and KCS appears at first to be gradual underflow. (What is that? An explanation is enclosed elsewhere.) Certainly if gradual underflow were so bad as Dr. Payne has claimed we should eliminate it from KCS and adopt instead the VAX's F, G, and H formats. But since Drs. Payne and Bhandarkar have recently offered a grungy version of gradual underflow as a compromise that most of the rest of us have rejected, the crucial issue must lie elsewhere.

I think the crucial technicality lies in the reserved operands. KCS uses each format's smallest exponent to represent tiny de-normalized (gently underflowed) numbers and zero, while the largest exponent is reserved for ∞ and diagnostic aids. VAX reserves only the smallest exponent for zero and also for everything else special; consequently VAX cannot support both gradual underflow and other special symbols without either abandoning some of the functionality of KCS or trapping on a second exponent. Implementors at Intel, Motorola, National Semiconductor, Zilog, Tektronix and Beckman Instruments have not hesitated to distinguish the largest and smallest exponents from all others, perhaps because they felt no obligation to respect the precedent set by the PDP-11.

I doubt that DEC's customers would protest much if each format's largest exponent were reserved for ∞ and diagnostic aids, and if the smallest exponent (0) were used to provide gradual underflow. I doubt that the exponent difference (2) between KCS and VAX's F and G formats for the unexceptional numbers would matter much since it merely allows every normalized KCS number to be reciprocated without losing much more (2 bits) to underflow than to roundoff, whereas the reciprocals of normalized VAX numbers too near the underflow threshold must overflow. So DEC could match almost all of the functionality of KCS by making nuisance changes to the VAX. Whether DEC should do that or not is more your business than mine. My business is a standard for everyone who wants to build the best new equipment unencumbered by past commitments. Mary Payne has made it her business to confuse mine with yours.

Over the past two years every proposal and counter proposal from DEC's engineers (Payne, Strecker, Bhandarkar,...) has had one common theme: to do it all with just one reserved exponent (0) and the VAX's F and G (and optionally H) formats. Here is a list in roughly chronological order:

1. Finesse over/underflowed numbers into a heap of numbers with widened exponents, using reserved operands as pointers into that heap. (This possibility was first suggested as an option, not an obligation, in KCS.)
2. The poor man's gradual underflow packed, with ∞ and a few diagnostic symbols, into one reserved operand at the cost of the last few bits of precision. Though abandoned for over a year, this "compromise" was resurrected in 1980.
3. Funny numbers, with a very wide exponent and about 8 bits of precision, all packed into one reserved operand. The stated intention was to avoid non-numeric entities like ∞ but the cure proved worse than the disease.
4. Epsilon symbols and a "Risky" flag using just one reserved operand. This scheme resembles capriciously the otherwise conservative Fraley-Walther scheme which is derived from a scheme of mine (SHARE SSD 159 Item C4537, Dec. 1966) which was anticipated by Zuse in the 1940's but, fortunately for software producers, never built.
5. Quadruple precision back-up for double and single, all flushing underflow to zero (the enhanced VAX).

The first four half-baked schemes deserved their fate: hastily conceived, promptly ignored. The fifth, with obligatory quad, causes indigestion among 8-bit and 16-bit microprocessors. The only result besides delay has been the loss of Mary Payne's credibility.

I do not complain to you about our disagreements or her mistakes; she has the same right to make mistakes and to learn from them as I do. But there are some things that you should know. One is the inescapable impact of the foregoing follies upon DEC's reputation. And some other things...

Early in 1979 our subcommittee met in Maynard and Sam Fuller took the opportunity to bring in another error-analyst, Prof. G.W. Stewart, to provide DEC with what might have been a perspective different from mine. Prof. Stewart wrote a report about which some of us enquired on behalf of the sub-committee, only to be told by Mary Payne and Bob Swartz first that the report had been classified "Confidential", and later that it had been so classified at the author's request. Recently Prof. Stewart, while voting in favour of the KCS proposal, expressed surprise that his report had not been made available to the subcommittee. His only reservation had been to avoid being quoted in advertisements promoting DEC equipment. Is this all just another misunderstanding?

Over the past two years I have offered at least a dozen times to discuss with Mary Payne and anyone else interested at DEC the reasons for our differences. The offers have all been declined; the reason given not long ago was the fear that DEC's engineers might be blinded (permanently?) by my eloquence. Another reason given earlier was that I was "too quick on my feet" and might intimidate DEC's people. Intimidate Bill Strecker? May 15's offer was that I spend about three days with Mary Payne, either in Maynard or in Oakland, playing school. Half of each day (3 or 4 hours) would be spent with me as professor and her as student. The other half (her choice) could be spent with roles reversed or in any other way she pleased; if in California, she could play tourist and I host. I did ask that at least one other DEC person be present at our talks and that one chosen from a short list from which she selected Tom Eggers; she could bring anyone else she pleased. But she declined again. Why? She says she wants everything in writing; but besides the time taken to write letters like this one the energy required to create a correspondence course in computational error analysis is more than I can spare if it is doomed to degenerate into the kind of petty exchange that enveloped Mary and Harold Stone last year.

What else should I do?

I seek relief from the twofold exasperation that has grown over the past two years. On the one hand is the footless delay imposed upon the subcommittee's work. On the other hand is the erosion of my confidence in the engineers responsible for the line of computers I have chosen for myself and my students. Can you do something?

Yours sincerely,

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WK:cnv
cc: Dr. Mary Payne