Gerald's Column
by Gerald Fitton

As usual I am starting to write my column before receiving the Archive containing my previous submission. The difference this month is that I think I'll probably finish it before my copy of Archive arrives, so any comments thereon will have to wait another month.

Over the last twelve months or so I have received many letters about many of the wide variety of subjects I've raised in Archive. I believe that I've replied to nearly all of these personally but, it is with some regret that I have to admit that I've not included enough of what you've written in Archive. In particular I have been taken to task, but in a friendly way, for not following up many of the open ended questions which I've put to you or expanding on personal views which have been implied by some of my throw away remarks. There is no way of going back over all the subjects of the last twelve months or so, filling the gaps and expanding somewhat with my thoughts and yours. What I've decided to do this month is to choose a topic or the two which have come up in my correspondence most often and expand on them a little.

Calculators at Primary School

As I expected, I have received many letters from proud parents whose children did learn or are learning all about fractions and decimals, place notation and long division. All I can say is that your children have been lucky to have a teacher who understands mathematics. My response to these lucky parents and children must include the fact that I've had even more letters from parents who themselves received the sort of teaching in arithmetic that I did but whose children graduated from pencil and paper sums to calculators at various young ages down to six! The tone of these latter letters is one of gratitude for explaining to them the how and why of the arithmetic which they can do themselves and supporting their suspicion that calculators at an early stage is not right. Some tell me that they've understood what I have written well enough to attempt teaching their own children the routines which they learned themselves at school.

I received an interesting letter from Christine Shardlow. Christine may not read this (unless Paul sends her a complementary copy) because she ends her letter with: "It is a coincidence that I saw your article as I . . . . (received) . . . . three free issues of Archive." I hope that Christine will not mind me revealing the fact that she had: "a good formal grammar school education in the 1940s" and taught 7 to 11 year olds in the 1970s. She says that in her experience "most eleven year olds of reasonable ability leave primary school equipped with quite good (mathematical) skills but, when they transfer to secondary school, many appear to lose their (knowledge of) basic mathematical concepts" and that "Calculators were only used as a special treat with specially designed worksheets." I shall return to this point later.

Worksheets and Computors

Perhaps I should remind my younger readers that in the early 1970s computers were mainframes and that the desk top computer came into existence in 1978 but was not generally available until 1980. What Christine refers to as a worksheet was probably what, at that time, I used to call a spreadsheet. It was towards the end of the 1950s I taught a

group of ‘computors’ (with an ‘o’ rather than an ‘e’) how to do sums using a spreadsheet. It may come as a surprise to those who believe in political correctness that in those days computors were invariably young females. Young females were considered to have little or no career aspirations beyond marriage and they received less than half the pay of a male doing a similar job! I found them all most efficient, accurate and careful—the minimum qualification was a Merit standard O Level in Maths.

Jill

I think that I’ve mentioned that one of the twenty or so girls doing sums on aeroplane design under my direction was called Jill. Jill became my wife, and, when we got married, in accordance with the custom of the time, she left Vickers to work for a different employer from her husband. In response to those who have asked what happened to Jill, she went to work in the Pathology Laboratory at our local hospital. Over the 25 or so years she worked there she took the various examinations and practical tests of that profession and, for the last fifteen years or so, headed up the Virology Section and became one of only two Technicians who were authorised to use the Category B room where she worked on lethal organisms such as the HIV virus and Lassa Fever.

Jill contracted Repetitive Strain Injury, now called Upper Limb Disorder, after a heavy week of entering laboratory results into the hospital computer terminal and had to take early retirement on the grounds of ill health. During the first year of suffering from this condition her wrists were unable to manage the weight anything heavier than a cup of tea but, after a few years, she recovered enough to be able to drive a car and carry light shopping—but not for as long as you and I might manage these tasks.

She asks me to say to you that the early symptoms are tingles in the fingers rather like pins and needles, particularly the morning after a heavy day of keyboarding. She stresses that she used a keyboard for a few hours each day for years with no ill effects but the permanent damage was done in less than a week when she was short staffed. That week she spent about 4 consecutive hours at the end of a 10 hour day for 5 days entering the day’s results into the local terminal. She woke up on the Saturday morning with wrists swollen to double their normal diameter. Her final piece of advice is not to take any pain killers if you do get the tingles. She did and now regrets it; the pain, without pain killers, would stop you further abusing your hands and arms.

Most people don’t realise how rapidly the syndrome strikes. It is not something which creeps up on you over months. It takes only a few days to cripple you for the rest of your life—so take care to heed any early warning signs.

The First Spreadsheet

I received much correspondence about the invention of the computer spreadsheet. Many of you referred to a TV programme which attributes the invention to Apple Computers. Whilst I don’t doubt what you saw on the TV programme I still maintain that there is so much in common between the paper spreadsheet which I was taught at Imperial College as part of my Maths degree in the early 1950s—and which I taught to Jill in the late 1950s—and a typical early computer spreadsheet of the 1960s that it can not be coincidence.

My comment has always been: “Computerisation of spreadsheets was an invention of the late 1960s used on mainframes ten years before the desk top computer. Pencil and paper spreadsheets were used by engineers and accountants for many hundreds of years before that. The software engineers who created these early spreadsheet programs, to their everlasting credit, took into account the centuries of expertise hard won by their predecessors. That is one reason why it is so very hard to improve on the main features of spreadsheets.”

Apple may have invented the desk top computer in the late 1970s but I don’t believe that they invented the computer spreadsheet; I believe that the computer spreadsheet appeared ten years before the first Apple desk top computer and that it was based on centuries of experience.

Primary and Secondary School

Another point raised by Christine in her fascinating letter is whether enough is done at secondary school to “test basic (mathematical concepts)”, or to introduce “old fashioned problems which make students think of what kind of calculation is needed”. Christine “wonders” about these things whereas I have little doubt. I believe that at the heart of this matter is the fact that being non-numerate is much more socially acceptable than being illiterate. If pupils at secondary school showed the same lack of what is now called “Communication skills” as they do in their “Application of Number skills” parents and school governors would riot.

The most recent example from my GNVQ level 3 students is as follows: A calculation to find the average length of a rail journey yielded the answer 0.04286. This is the result of dividing about 30 billion passenger Km by about 700 million passenger journeys. I achieved some limited success in getting agreement that the correct units in which this answer should be expressed is thousands of Km per journey. All but a few agreed that the average journey length is undoubtedly 0.04286 thousand Km per journey.

I asked the students to convert this to Km per journey. Last Tuesday morning I tried this with three different classes of about twenty students each. None of the sixty students could convert thousands of Km to Km with or without a calculator! At my request I had a Learning Support Lecturer in the classroom ‘observing’ my treatment of this subject (units etc). After the first and second lesson we discussed improvements to my approach. After my third failed attempt the support lecturer congratulated me (I’m not sure what for) and suggested that we consult with the Educational Psychologist! I have—but that’s another story.

Christine has an alternative hypothesis which is that “new learning forces out the old.” My response is that I’m not sure what that new learning is; for sure it isn’t mathematical learning. Seriously though, if Christine is right and the educational problem is not at Primary level then what is going wrong in the Secondary schools?

Calculators or Spreadsheets

In one of my articles I put forward the view that calculators were about to enter the Decline phase of their life cycle. To summarise my assessment. Spreadsheets have the advantages

over calculators that they display the whole of a calculation; errors in data input can be corrected more simply since you don't have to redo the whole calculation; what-if sums are easy to implement; repeat calculations with different data require no extra work beyond entering the new data; the result and all stages of the calculation can be printed out together once the data and formulae have been verified as correct. The main disadvantage of a spreadsheet is that it isn't as portable as a calculator—but this is changing and hence the Decline of the calculator is underway.

I've had many letters on the subject, particularly from secondary school teachers. Their general view is (a) that spreadsheets will never be as portable as a calculator and (b) they take too long to set up when all you want to do is a simple calculation. Opposing this view are practitioners from industry and commerce who tell me that they haven't used a calculator for years but use a spreadsheet every day both at work, at home and, in some case, on the train.

As a Statistician I don't believe one should take too much notice of what is called anecdotal evidence but I can not resist this one. A colleague at College who teaches one of the more numerate Business modules came to me last Friday week and asked me if I thought the students were "having him on" when he could uncover only 4 calculators amongst the 25 students in his class. I assured him that of the 60 students I teach who are on the same course he would find no more than 10 calculators. I went on to suggest that next time he needs some sums doing during the class he should move to a 'teaching resource room' containing computers with Excel, a windows spreadsheet, installed. With some reservations he did this the following week—and achieved much more success.

I still believe that spreadsheets will replace calculators within the next couple of years. What I would like to see at Primary and Secondary school is a revival of the skills of what I knew as mental arithmetic but now called 'Living with Approximations'. My vision of the future is mental arithmetic to get an approximate answer and spreadsheets for more detailed calculations; the only place in my vision for calculators is alongside the slide rule.

Wordprocessors

I had an interesting discussion with the Lecturer who teaches Communications skills. She has given up trying to teach the correct spelling of those words which pass through a spell checker with impunity. She is lobbying for a software package which corrects common grammatical errors. I've told her it's a 'cop out'! She claims that, so far as teaching the written word is concerned, she is being set a task which is impossible to achieve. I would add that Communications skills lessons include such things as the interpretation of body language which she teaches inventively and with great skill!

It seems to me there will come a day when there will be teachers and lecturers who will ban the use of computers in the same way that some already ban calculators—at present so called IT skills figure higher in priority in the curriculum than being able to read and write.

My somewhat cynical comment is that an Art package will not turn someone into a Rembrant, a spreadsheet will not turn someone into a Newton (nor a Gauss nor Archimedes) and a wordprocessor will not turn someone into a Shakespeare; to be a Rembrant, Newton or Shakespeare you need talent if not genius. I would add that if Shakespeare had a wordprocessor then he might have written twice as many plays in his

lifetime and if Newton had a spreadsheet then he may have had even more time to develop his ‘fluxions’ (Integral calculus). If I might misquote Christine, computers should be made available only as a special treat after the pupils have become literate and numerate and then only with specially designed worksheets.

Selling Technology

I can not find my reference to this in Archive but it must be there since I’ve had a lot of letters about it. Let me first summarise my view. In the past companies kept their technology much to themselves in the belief that it would allow them to steal a march on their competitors. They took out patents and protected them vigorously. They introduced non disclosure clauses into the contracts of their employees. Nowadays I see more companies selling what they call technological solutions in the hope that they can increase the user base for their technology to the point where it becomes a de facto standard.

I teach a subject related to Marketing called Statistics for Marketing. There are two classic cases quoted in the text books for not patenting good ideas. The first is the Davy safety lamp for use in mines. It was invented in 1815 by Sir Humphrey Davy (1778–1829) and reduced the number of mine explosions dramatically. It was the practical use of this freely available invention which promoted the concept that Science could be useful and hence profitable to Industrialists. The Royal Institution and later the Royal Society both benefited financially by sponsorship from industry as did Scientific research generally primarily because Sir Humphrey made this invention freely available. The second classical example is the Philips compact cassette which you now know as the ubiquitous audio cassette. The alternative technology called 8-track was much better. Philips succeeded in wiping out the competition because they asked a minimum royalty for their technology and gave excellent technical support to those wanting to use it.

I am pleased that Acorn are selling technology and technological solutions. You can buy chip sets containing the essential hardware and with it the kernel of the operating systems. I believe that this will help ensure the future of the personal computers we have known as the Archimedes series. I remember Paul suggesting at one time that he would commission a set of Stork computers if the Archive readership showed sufficient demand. It is my view that, in the event of Acorn making the unlikely decision to cease design and manufacture of RISC OS desk top computers, many third parties such as Paul will see a niche market and continue development with complete support from Acorn.

Standard Deviations

I don’t have too many letters from Colin Singleton but all of them are not only well written but also most thought provoking. I always read his column and try to solve his puzzles. Sometimes I succeed but I don’t think I’ve ever sent him my solutions—well maybe once. By the way Colin, thanks for your letter about Archimedes floating point arithmetic. Most interesting. You echo some of my own thoughts; I’ll refer to them in a future article.

In one letter Colin Singleton refers to one of my articles in which I find the standard deviation of six numbers. Colin says “According to my statistics books the standard deviation (of a set of numbers) is the root mean square of the differences between the numbers and their mean. . . . . How do Nik and Gerald obtain . . . ? . . (They) have divided

. . . by five instead of six as instructed in my text books."

Colin's letter is not the only one asking me this question. I had a dozen at the time of the original article. Since then I told you the story of Brenda, Val and myself in which we each taught the same subject, A Level Maths, to similar students. A quick reminder: the mean mark achieved by each of our groups was the same but the spread of results was markedly different. My group had the smallest spread and Brenda's the greatest. The measure of dispersion or spread which I used was the standard deviation. That article has renewed the demand for an explanation of the way in which standard deviation is calculated; many have pointed out that their spreadsheets and calculators give two different standard deviations. I am asked "Which is right?"

The quick answer is that both are 'right' in different circumstances. Both appear on calculators and in spreadsheets. To find a standard deviation you first find the mean of your numbers; if you have six numbers you add them together and divide by 6 to arrive at the mean! Next you subtract the mean from every number to find the variation from the mean. Square these variations and add them together. Now here's the place where the two calculations differ. In one case you divide by 6 to find the average of the squared variations; in the other case you divide by one less than the number of numbers, in our case you divide by 5. Having found this average of the squared variations you take the square root. The answer is the standard deviation and it has the same units as the mean. In a sentence: "The standard deviation of a set of numbers is the square root of the average of the square of the variations from the mean value (of the numbers)." The difference between the two standard deviations is the number you divide by when calculating the average of the squared variations.

So what is the right thing to do? Well it depends where the original numbers came from.

You might have built up the numbers theoretically by using the concept of symmetry. For example, you might use symmetry to work out the pattern of frequencies with which four child families have zero, one, two, three or four male children. This pattern is 1, 4, 6, 4, 1 respectively (eg 4 out of every 16 four child families will have 1 male child). When you work out the standard deviation of a pattern built up theoretically this way you divide by n and not $(n - 1)$.

If you go out into the big wide world and count the number of male children in four child families then, when you work out the standard deviation, you divide by $(n - 1)$ and not n. It can be proved that if you divide by $(n - 1)$ the number you get is more likely to be the same as that which you'd get from the theoretical distribution (1,4,6,4,1) than if you divide by n. I won't give the proof but my hint is that when you go out sampling you might get the wrong mean and, if you use this wrong mean to calculate your standard deviation, then you compound the error if you divide by n but mitigate the error if you divide by $(n - 1)$.

So, which function do you use on your calculator or spreadsheet when you have experimental results? The way I remember it is that when finding the standard deviation of experimental data you use the version of the sd function which gives the slightly larger answer. It gives the slightly larger answer because you've divided by $(n - 1)$ instead of n. If the distribution has been built up theoretically, an example is the normal distribution I used with the Brenda, Val and Gerald data, then divide by n.

The Time Line

My digression into the nature of infinity and eternity yielded more post than any other single subject. Let me add to what I said.

If we take all the moments of time that we know of and extend them indefinitely to encapsulate the concept of all of time as we know it, then we might still not have accounted for all the moments there are. There are some eminent theoretical physicists who subscribe to the conjecture that there are a lot more moments hidden in the time line between the moments that we experience. They use this conjecture to explain some of the reversed causality paradoxes which arise in quantum electrodynamics. If you have heard of the tale of Schrödingers' cat then you'll know the type paradox I mean; if you haven't then an oversimplified version is that the hypothetical death of this eminent physicists' cat preceded in time the quantum electrodynamic cause of its death. This reversed causality worried Erwin Schrödinger (1887–1961)—the paradox has not been resolved.

Conditional Probability

In view of the mass of mail I received on this topic I must mention that I shall leave discussion of the oil well problem and its survey for another occasion. Sorry! However, look forward to it because I shall use it as an example which allows me to introduce you to matrix multiplication using a spreadsheet.

E-mail

This month I had intended to let you know how difficult I have found the process of getting onto the Internet but I am out of space. My thanks must go to John Stewart for his initial help in getting started and to Paul for the opportunity.

Anyway, I am available as gerald@abacusline.demon.co.uk and I think I can receive mail even if sending it sometimes goes wrong for me. Demon tell me I have 5 Mb of web space. I was on line for over 20 minutes yesterday trying to download instructions from http://www.demon.net/www/homepages/ about how to use this 5 Mb and all I got from it was a file of about 10 Kb with instructions that it will take me a while to understand let alone use.

Anyway, eventually, there should be something from me on www.abacusline.demon.co.uk which is where you'll find my 5 Mb. If you have any ideas how we can use this 5 Mb to our mutual advantage then I shall be most pleased to hear from you.

In the meantime: (a) Please send a disc, self addressed label and return postage if you want a problem solved—don't try to append a file to an e-mail because I don't think I'll be able to unravel it; (b) My snail mail and e-mail address is that of Abacus Training (see back inside cover); (c) Many thanks for all your letters.