# *Quality - Good Enough? - or - who will know?- or- Just lie about it?*

Dennis Monk was remembered in The Journal of the SM&EE several months ago. Mr Monk acted as a Judge in model engineering competitions. Mr Monk apparently irritated some entrants by running his finger along the hidden side of components to determine whether the finish on the concealed side matched that on the side which was visible. I am not as organised as Mr Monk appears to have been, and the quality of my workmanship will be much lower than his. Nevertheless I wholeheartedly agree that the *pursuit* of excellence is a worthy activity.

I started my working life as a quality control technician in a chemistry lab. In those days, the emphasis on care, cleanliness, and accuracy, paralleled that required in the toolroom. I took pride in carrying out the analyses to the best of my ability. Automated methods had yet to make their appearance and "*Wet*" chemistry techniques were predominant. The factory retained a stock of samples of its product batches in case there were any customer complaints. One day, the lab manager asked me to test an old batch sample. The analysis showed the product to be well out of spec. I thought I might have made a mistake but gave my result to the manager just the same. He simply asked me to repeat the test and double check every step. The fresh analysis agreed with the first one. The lab manager then asked me to have a look at another sample. A series of tests ensued with a large number of the samples turning out to be defective. It seemed unlikely that complaints had been received in respect of all these batches, but I was too naive to grasp the reason for the set of tests. All the batches from which the samples had been taken had originally been approved by the person who had tested them. Many of them ought to have been rejected and returned for blending to bring them into spec.

That lab was one of the happiest places I have ever worked, but my heart wasn't in Chemistry and I left the company to follow Physics. (My mother held certain strong opinions which would nowadays be termed feminist extremism. There were certain establishments which no young man should ever enter. In increasing order of depravation they were, pubs, betting shops, and engineering companies. In fact, engineers belonged somewhere below cockroaches in the scheme of things. So although engineering ought to have been my career choice, physics it was. Interestingly, mum felt obliged to conduct a radical review of her opinions when my wife became a Chartered Mechanical Engineer.)

Shortly after I had left the chemical works, I heard that another member of the staff had quit somewhat abruptly. It turned out that he had been the person who had originally approved all the batches which I had been asked to retest. Probably the manager had been suspicious of the other technician's integrity, but did not want to alert him by having someone else repeat the tests he was carrying out on current samples.

One of the appeals of working with technology is that with one exception, it doesn't cheat, lie, or steal. Its behaviour is determined by the laws of Nature. By endeavouring to work to the best possible standard, one develops faith in the methods used and an appreciation of their strengths and limitations. If a test result is unfavourable the measuring may be wrong, but the careful practitioner knows that it is more likely due to a fault in the object or system under test.

Phil Hutchings was a good electronics technician. He and I had been trying to trace a fault in a piece of equipment without any success. After several hours we were stumped. Then Syd Isaacs, a senior engineer from another group came into the lab. Phil called him over. "Here Syd, what do make of this?" Syd came over and looked at the signal from the instrument for a minute or so as he absent mindedly cleaned his pipe. I don't why he bothered cleaning that pipe, I can't recall seeing him smoke it in all the time I knew him. Syd stuck the pipe in his mouth and sucked on it. "*I don't really know*" he said, "*But I think it might be the power supply.*" We had the fault traced and fixed in a matter of minutes. Syd's years of careful work at his bench had developed that insight which distinguishes exceptional people from the rest of us.

In one third level establishment where I worked, I sometimes spent my lunch break reading through MSc manuscripts. One I came across was outstanding. The presentation of the arguments and supporting theory were thorough and a delight to read. Undoubtedly, that man deserved his Masters Degree. Some weeks later, I was referring to a textbook when I realised that the subject matter looked somewhat familiar. A quick cross check confirmed extensive plagiarism within the Masters Thesis. Content which ought to have been recognised by his supervisors and excluded, had been permitted to pass as the candidate's own work.

One of my duties in that establishment was acting in support of postgraduate students. Most were willing to take advice regarding experimental methods, but one postgrad in particular had no desire to exercise care. All that he wanted was pretty pictures. The equipment he was using at that time was of the highest quality, though somewhat dated.

The system produced output on a chart recorder which required simple calibration prior to each test. Despite the accuracy of the plotted output, the appearance of the chart was plain by modern standards.

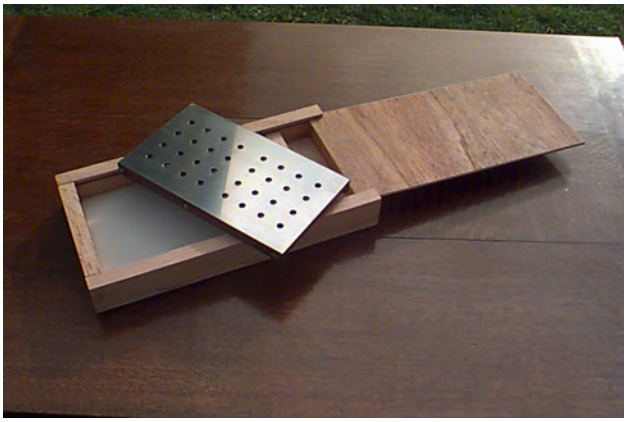
The student considered the appearance unsuitable for inclusion in his thesis. There was also a serial interface provided on the instrument with an output of its raw data. It was a straightforward matter to import the results into a PC for glitzy presentation purposes. However, nobody had bothered to obtain an interface lead and do the simple programming which was required to enable a PC to use the data stream. At every opportunity, this particular student complained that the only solution was a new instrument. I made up a lead and wrote the necessary PC software to take advantage of the direct data output from the instrument, but the student declined to make use of it. The effort of having to use a spreadsheet to produce graphs was perhaps too much for him. He continued to insist that a new instrument was the only way forward, and eventually a new instrument was purchased. It was technically inferior to the original equipment in a number of respects, and in one essential respect, but it produced fancy graphics at the click of a mouse. The pretty coloured graphs stacked into thick reports. His work was worthless in technical and scientific terms, but as one academic once observed. "*Nobody reads these reports...they weigh them.*" The student was awarded his Doctorate. Other, much more conscientious students, did not achieve such a favourable outcome. In fact, the budget spent on that new and totally unnecessary instrument contributed to one girl ultimately being unable to complete her doctorate work through lack of funding.

Photograph 1. Some of the stainless steel sample holders intended for the rheometer. Several have been used and remain contaminated with polymer residue.

One of my own areas of interest at that time was rheometry. Rheometry deals with the viscosity of materials. In this particular case, the materials were polymers. Some time before my being appointed, specialist equipment had been ordered to enable precise rheometric measurements to be made. I was informed that it was due to be delivered any day. A year later, the rheometer finally arrived and was installed by "*Specialists*" from the company.

They broke the apparatus during installation. This led to a six month back and forth saga before the instrument was declared serviceable. This period was not entirely wasted. I was at least able to take certain measurements from the instrument workhead. From these I was able to design components which would be required for specific tests which I had planned. The components shown in Photograph 1 are some of those manufactured on the Myford I owned.

Our son Bill did the turning with minimal supervision. He was 14 years old at the time. The material is 316 stainless and *all* dimensions were achieved to within 0.001". Photograph 2 shows a fixture intended for the purpose of regrinding the parts Bill had made once they became seriously contaminated with use.



Photograph 2: Regrinding fixture intended to hold components of the type shown in Photograph 1.

The fixture and its box were made by Mike who is 18 months Bill's junior. The plate, which has backing strips welded to it, was machined on Mike's own Cincinnati Universal Mill. Mike had bought the mill as scrap from a local engineering works using money he had earned by helping local farmers. Both sides of the plate were machined flat until the distortion from the welding was corrected. Mike then drilled the holes, also using the Mill. Like his brother, Mike could be relied upon to work with minimal supervision. I subsequently carried out the surface grinding at the college.

Once the rheometer was operational, I began to test each function in order to satisfy myself that everything operated as it ought. This was standard acceptance procedure to me and I thought nothing of it. The machine was complete and the broken parts had been replaced. However, it was not long before problems were identified in the control software of the system. I soon had a list of faults and contacted the supplier. Their response was that I would have to wait for the next software release due sometime the following year. Until then, it was obvious that results from the equipment could only be relied upon to be of questionable veracity.

I regarded the state of affairsas an unsatisfactory in respect of a small item which had cost more than a substantial family home. I contacted the company's head office and spoke to the person who had supposedly designed the apparatus. Not surprisingly the man held a doctorate. When I explained to him that the instrument did not meet their published specification, - the one on which our purchasing decision had been based - his response was instant. "*Specifications are just for advertising purposes.*" So too, it would seem, are promises of early delivery. Had I known that there would have been an 18 month delay for an unsatisfactory piece of equipment, I could well have used the time to design and construct a better one from scratch. I could hardly have ended up worse off.

Since there was no help forthcoming from the supplier, I considered the matter further. It soon occurred to me that control for the instrument was communicated through a standard serial interface. All that was required was a second computer with two serial interfaces.

With one interface connected to their control system and the other to their instrument, a simple piece of software could interdict commands from their controller and responses from the apparatus. These could be parsed and edited to eliminate the errors which the control software was generating. However, it seemed that my brief discussion with the individual at company headquarters was already having repercussions.

A week or so after I had contacted the company's head office the department head called me into his office. He informed me that a newly appointed postgraduate student had been assigned to using the instrument full time.

There was no scope for me to carry out *any* of the work for which I had planned and prepared for more than 18 months. I surmise that since there were very few manufacturers of rheometers, the market was very competitive. It would not have been good for business if word spread that this manufacturer's equipment produced results which were quite likely to be wrong. Perhaps my boss got a kick-back from the suppliers. Whatever the explanation, purchasers of that equipment would have been making measurements and reaching conclusions which were possibly incorrect because the instrument design was faulty. In all likelihood, none of them would have been aware that they were publishing quantitative bunkum.

I enquired how my boss expected me to complete the research programme on which I had been engaged. "*Just do some creative writing*" he replied. These were the words of a man who had been the doctoral supervisor of students over a period of some 20 years. He equated scientific research to creative writing. The plagiarised MSc and casual attitude of certain of his students were immediately explained.

This man was highly regarded, so it was reasonable to conclude that his "*Standards*" were comparable to those in other institutions. In fact there could be *no other explanation*. Higher degrees are validated by external supervisors. With that one sentence my boss had uttered it became clear to me the extent to which the qualification of doctorate had been degraded.

One conclusion was inescapable. There was no place in that particular department for *any* person who pursued the objective of achieving accurate and repeatable results. I suspect that experiences similar to those recounted above are commonplace. The well known phrase in job specifications "*Must be a Team Player*" speaks volumes. A Team *Player* is worlds away from being a Team *Worker,* and *any* business conducted as a game has a questionable ethos. It would be somewhat difficult for a company to state that they are looking for an individual who "*Will turn a Blind Eye to Incompetence and Corruption* ". However, that is perhaps the most accurate interpretation of the *Team Player* business ethos.

I have been a user of computers for most of my life. I have designed and built data acquisition and control systems. I have written many programs for analysis and simulation. As a consequence I am acutely aware of the potential shortcomings in any digital system. There are simple things like rounding errors in complex calculations and conversion errors between the real world and its digital representation. However, there are many subtler errors too. Non-linearities, sampling issues, and timing problems, to name a few, have to be taken into account. These are quite separate from possible programming errors. Yet for all its pitfalls, the computer enjoys unrivalled status as the discriminator between acceptance and rejection.

I believe that much of this may be attributable to the isolation which computer controlled equipment introduces between the observer and the observed quantity. It is hard for the operator to develop a "*Feel*" for the variable being measured. Computers can also produce representations of data which are nothing short of artistic and can be quite beautiful. However, most persuasive is the sheer power of "*Number*".

Computers can produce wrong answers with the utmost precision. The power of number is inescapable. Numbers endow facile arguments with credibility. Listen to any news report or political speech and one could reasonably conclude that no matter what the subject under discussion, everybody wants to support their argument with a bigger number than anyone else. Nowhere is this more noticeable than in the reporting of economic statistics. Recently I heard that the UK economy had grown by 0.3%. An hour later, the same radio station reported that it had grown by 0.4%.

Allowing for the fact that the figure is probably subject to an error band of about 6% it could be anywhere between about 3% growth and 3% recession. Nevertheless, it would seem that someone considered 0.3% to be unacceptably close to zero. As one might have surmised, the computer is one area of technology which can be caused to lie, and in the right (Wrong?) hands, cheat and steal.

In engineering and science, the colourful pictures produced by numerical techniques such as the Finite Element Method have had a considerable impact on design. On one occasion I was visiting the engineering department of a university. The corridor walls were decorated by several Finite Element printouts. Each was mounted in a frame with an explanatory caption underneath. One picture I came to caught my attention. I could not be satisfied that the output was a correct analysis of the problem described in the caption underneath.

When the academic I was visiting came to greet me, I drew his attention to the picture. He was somewhat taken aback by my assertion, and assured me that if I thought about it further I would realise that the analysis was correct. A few weeks later I visited the department again. There was a blank space on the wall where that picture had been. Correctly implemented, computer based techniques can highlight problem areas in the design of equipment. However, the need for the user to comprehend the underlying problem is heightened by the compelling nature of the program output. Perversely, however, the ease of producing computer analyses undermines the motivation for the user to develop such critical perceptiveness.

It is a well known saying that "*If it looks right, then it probably is right.*" That particular engineering department had no doubt given a lot of careful consideration to which Finite Element examples it would frame for display in its corridors. To them the results "*Looked right*" yet they were incorrect. There is a wealth of examples of well made reliable products which definitely "*Look right*". Their proportions and styling are a pleasure to the eye. However, there are many excellent products which are just plain ugly. A willingness to permit judgement to be swayed by appearance over function is perhaps one of the greatest failings of human nature. In technical and scientific matters it is a failing which must be guarded against. The Myford lathe is regarded as a prestige item amongst many model makers. Consequently it has become a target for counterfeiters. The counterfeiter's product looks right, but is it as good as the genuine article?

A report relating to the biological sciences stated that about 20% of photographic images incorporated in research papers submitted for publication showed evidence of having been "*Edited*" in an unacceptable way. Another report by a specialist in Human Resources found that around 20% of c.v.s contained materially false descriptions of the candidates' backgrounds. The report went on to state that the level of deception had remained constant at around the 20% level for at least 20 years. One wonders if it is the same 20% of people who altered the photographs.

In one sense these figures are amusing. Having appeared on different occasions, before panels of up to 10 interviewers, it gives me cause to ponder. "*I know my c.v. is straight. So with more than 5 people present in the room how many of them lied about their background to obtain the appointment they were holding?*" In the modern age, if it looks right, one is well advised to be doubly careful in confirming that it actually *is* right.

The effect of such fraudulent behaviour can be somewhat devastating. In my own experience, a forgery of my father's handwriting, penned by some unidentified individual, was a significant factor in the ultimate loss of my home in Scotland.

There are people who are not themselves model makers, but who wish to own fine models. Evidently a model which has won a Duke of Edinburgh trophy is likely to command a higher price than an equally good model which does not hold that accolade. Like the name Myford, model engineering awards have developed a currency value. Consequently, there are regular calls to create more categories for models and widen the specifications to include models which, to an increasing extent, are comprised of commercially manufactured components.

This is merely a reflection of the dilution of achievement standards which universities underwent in the early 1990s. At that time a number of technical colleges were upgraded to university status. I recall one institution in particular with which I was associated. The students who completed their HND that year were awarded degrees instead, some of them with Honours. Students who, a few years earlier, had not been good enough to earn entry to a university, found themselves with qualifications which appeared to be as good as, and in some cases superior to, their former schoolmates who had achieved entry to university, had pursued more demanding courses, and had been judged against more stringent standards.

Dilution of the PhD qualification was subsequently implemented with the introduction of "*Professional Doctorates.*" To quote one Professor who had resigned in disgust, "*They're handing out degrees with the postage.*" The currency value of higher qualifications had been quantified and everybody had to have one. Industry called for "*More qualified people*" and they were given more people with qualifications.

Perhaps industry ought to have demanded a higher quality of training and third level education. If it looks right???

The educational charade has now just about come full circle. Vacancies for technical staff which would once have stipulated a requirement for an HNC or Full Tech certificate now demand a degree as the necessary qualification. Although it is no comfort when you are excluded from the short list, the Full Tech or HNC obtained 40 years ago or more was just as demanding as some modern GT Go Faster Honours degrees. Only the title of the certificate has changed. The stipulation of a degree as a requirement for employment which would hitherto have been carried out competently by a person holding a technician qualification is confirmation of the academic currency devaluation.

Government embarrassment has grown and ways are now being found to force low grade "*Universities*" out of business. A favoured technique is the preferential allocation of funding. One report stated that 70% of research funding was allocated to 12 universities in the UK. The latest innovation is the extension of tuition fees. It is fairly certain that the top rated institutions have their pick of candidates and can charge top rate fees. They thereby obtain the bulk of available funding. Universities which produce a low grade product are no better than irresponsible banks which gamble away money entrusted to their safekeeping. There can be few right minded people who would favour propping up either type of institution. For too long the education system has been bloated with funding. Perhaps downright preferential treatment for the "*Blue Chip*" Institutions is the shortest route back to a society in which third level education is not regarded as a right but something worthwhile for which one has to strive. Quality has its price.

However, I have reservations regarding use of the taxpayer's pocket for funding even the Blue Chip Institutions. On the one hand, research funding from the taxpayer leads to commercially valuable breakthroughs. Yet the taxpayer is not the beneficiary. Any payoff goes to the academics and universities who made the breakthrough. Furthermore, a high proportion of courses offered provide little or no added value to society. Despite the fact that Accountants, Lawyers, MBAs, and many other corporate specialists are being disgorged from third level institutions at an unprecedented rate, the economy is in a parlous state. These are the specialists who are supposed to be able to provide the *essential* expertise for a healthy economy. Whatever is being taught, the product isn't up to the job. If these types of university course were any good at all, they ought to be able to obtain their income from commercial organisations eager to use their product. At this point I declare an element of envy, for I know from experience that the life of an academic remains one of the most comfortable available.

I think it is fair to say that there has always been an inherent animosity between the proponents of excellence and those of expedience. The era of the personal computer has swayed the balance of power in favour of the proponents of expedience. As already noted, the personal computer has facilitated deception to an extent which could scarcely have been imagined even in the 1970s. I find it difficult to envisage circumstances which would reverse the trend. Consequently, although I rely heavily on computer systems I view them as a serious blight on society.

I have tremendous admiration for those designers who lived and worked in the pre-computer era. Innumerable incredibly demanding problems were solved using analytical or graphical methods. Subjects like harmonic analysis, which a modern engineer might think impossible to address without computer software, were solved graphically. Gear design and manufacturing problems which have to satisfy subtle 3 dimensional geometry were worked out at the drawing board. Some of the methods were approximations, while other techniques were theoretically exact. Integrations were performed using graphical methods and mechanical instruments. As tools, nomograms and slide rules in their many forms exemplify an ability to tame quantitative problems which is nothing short of 100% Proof genius. Charles Babbage with the assistance of Lady Ada Lovelace developed the mechanical calculating engines used for calculating tide tables and log tables. In my opinion, their achievements stand head and shoulders above those of the electronic computer in terms of intellectual brilliance. Many years ago, I came across a poem which was both amusing and instructive.

*A whale of great porosity and small specific gravity*
*Dived down with great velocity beneath the sea's concavity*

*But soon the weight of water crushed in his fat immensity*
*Which varied - As it ought'er, inversely as his density*

*It would have moved to pity an Ogre or a Hessian*
*To see poor spermaceti thus suffering compression.*

I cannot recall the next few lines, but the upshot was that with increasing density and consequent loss of buoyancy, the whale sank to the sea bed and was crushed to death. Perhaps a reader can provide the missing verses and the name of the poet. The moral of the story is:

*The lower down your course is - The upward path's the steeper.*

As for individuals, so for Nations.

An academic who specialised in Cognitive Psychology once told me that "*Perfectionists tend to achieve very little*". I think he intended the comment as a friendly warning to me, but the statement begs two questions. How is achievement to be measured? If the gauges are wealth, rank, status, awards, medals and so on, then the assertion apparently has some degree of merit. Note, however, that *all* of these things actually result from the perceptions others have of the individual's achievements. Consequently, those who master the art of deception often *distinguish themselves* as the great "*Achievers*" of this world. On the other hand, if the gauge is an internal one based on honest self criticism, then perfectionists emerge as the individuals whose achievements are likely to be greater, though they may never achieve recognition.

Also contained in the statement is an implied importance of quantity. What is meant by "*Very little*"? Is quantity invariably an appropriate measure of achievement? The notion that quantity and quality are somehow interchangeable units has its roots in accountancy and the profit motive. If a task is to be done to the highest standard, then it takes as long as it takes. A single good achievement cannot be matched by any number of mediocre efforts.

Quality is often the thing which one discovers is missing just as one is congratulating oneself on the money saved through buying the cheaper product. If one's business serves the Model Engineering community, then one is obliged to be driven by the profit motive. On the other hand, model engineering itself *as a recreational activity* is a self imposed personal challenge. Absurd as it may seem, the greatest degree of achievement is displayed by those who employ the most primitive methods utilising the lowest level of raw materials. The standard of finish achieved by modern day modelmakers overshadows that of models from half a century ago. Nevertheless much of that improvement is attributable to the ready availability of machine tools, materials, and measuring equipment. It would be foolish to conclude that the standard of modelmaking has improved. In a sense, machine tools are to recreational engineering what performance enhancing drugs are to sport. The relaxation of standards to accommodate entrants' desire for some kind of certificate, ultimately leads to the logical conclusion of making awards for ownership of commercially manufactured products.

It may be embarrassing to the model maker when the Dennis Monks of this world run their finger behind the connecting rods to assess the finish on the concealed parts. Nevertheless if that is the required standard, anyone who wants their work to be judged should expect to be judged against that standard and strive to achieve it.

The *only* form of respect worth having is self respect. It is not to be confused with self confidence or arrogance. These latter are most effectively fuelled by seeking the approval of others. The former is derived from the knowledge that whatever standard was achieved, it was through one's own honest efforts. That represents a very powerful driving force for the pursuit of perfection in any endeavour.

Jim Cahill
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sysman@eigenmorph.com
www.eigenmorph.com