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From the archives: a 2011 report on the worst factory we've ever visited…

A report on a visit to [redacted], [redacted]

In [redacted] I was asked to visit [redacted] to make a general assessment of its facilities and capabilities. In the course of this, I had meetings at [redacted]'s [redacted] head office, the R & D facility in Shenzhen and the factory at [redacted]. I was accompanied throughout by [redacted]'s [redacted] agent, Mr [redacted], who made all necessary arrangements.

Meeting in [redacted]

The first meeting took place at the [redacted] office on [redacted]. [redacted] staff members present were [redacted] I had encountered [redacted] on previous occasions when he was working for various UK companies; his last post was Director of Quality for [redacted]. He stated that his brief with [redacted] was to "…sort out the factories and improve communication".

[redacted]'s opening position was that the overall return rate on products produced for [redacted] was below 15% and that this was broadly satisfactory. I strongly dissented from this, pointing out that [redacted] experienced considerably higher return rates on many products and that a figure nearer 1% was the minimum desirable. Some discussion took place in respect of the reasons for the high return rate although attempts to broaden the debate into technical areas were somewhat thwarted by the poor English of [redacted]. However, with the assistance of [redacted] it was established that Mr [redacted]'s knowledge of electronic design was actually rather limited and that his overall awareness of the environment in which his products operated was essentially zero. For example, when the possible substitution of a [redacted] for the existing [redacted] product was being discussed, it was clearly evident that no-one at [redacted] possessed the ability to interpret the data sheet for the unit and work out what the advantages or disadvantages of the substitution would be. The issue of [redacted]'s very limited professional engineering knowledge was to recur throughout the visit.

Factory visit [redacted]

On the following day the factory at [redacted] was visited. This is a large establishment occupying several floors in multiple buildings. It should be said at the outset that as a manufacturing facility for modern consumer electronic equipment, this factory is by a long way the worst I have ever visited. Amongst its major shortcomings were the following:

- At the time of the visit the outside air temperature was about 27°C. The temperature within the factory was at least five degrees higher. The relative humidity on the day of the visit was in the region of 90-95% and the figure within the factory must have been similar. It is well established that

human operators cannot possibly work efficiently in these conditions for any period of time, and that the desirable range of temperature and humidity for manufacturing establishments is 18-20°C and 50-55% Rh. It is understood that air-conditioning equipment is available in the factory but is not used because of the expense. Quite apart from the effect on the manufacturing staff, the high temperature (and particularly the high humidity) is in part responsible for some of the very poor-quality printed-circuit boards for which [redacted] is notorious.

- Overall lighting levels were very uneven and poorly controlled. Some areas were grossly overlit with multiple fluorescent tubes and no diffusers. Other areas were very underlit and in some cases tubes and lamps were noted to be on the point of failure (with concomitant flickering) or to have failed completely.

- No systematic markings for fire exits or emergency exits were provided, and no evidence was available of knowledge of or commitment to modern health and safety requirements on the part of the factory management.

- There appeared to be no formal staff training or progression system, no proper supervisory chain and no means for product-improvement suggestions or reporting. Although much lip-service appeared to be paid to quality assessment and quality control, in practice these functions nominally were carried out by a few staff wearing yellow tee-shirts who were never seen to intervene actively in any production process. Their main role appeared to be the gathering of statistical data.

- The majority of soldering irons used within the factory were extremely old with ratings of about 100W. No temperature control was provided. All were fitted with crudely manufactured and formed tips which would have been more appropriate to the repair of domestic utensils than the assembly of modern electronic components. Astonishingly these instruments were used even when modern DIL integrated circuits were being soldered into position. There was no use of solder pastes or creams, or of other modern soldering technology. There was also no awareness of proper bit-cleaning techniques or flux removal. On several occasions the bits of large irons were seen to touch or pass very close to wires and cables forming part of the sub-assembly, with consequent damage to the insulation. Anti-static precautions were conspicuous by their absence. Most working areas were dirty.

- Random examination of semi-finished samples produced several boards on which components had either not been correctly positioned prior to soldering or had not received the correct amount of solder. On one notable occasion an operative was seen to slide the un-cleaned bit of a 100W iron directly across the pins of an IC package, moving it completely out of position whilst using a grossly excessive amount of cored solder to secure it to the PCB lands. This is entirely the wrong technique for use with such devices.

- The form of wave soldering used in the factory was quite extraordinary. The ‘wave’ was generated by two operatives manually passing paddles across the top of a pot of molten solder which appeared not to possess any form of temperature control. Prior to being soldered, the assembled board was quickly brushed with a coat of what looked and smelled like poor-quality rosin flux. The board was then placed on top of the solder for an indeterminate period, during which it visibly flexed into a very bowed shape. On removal it was given a cursory examination and then -- no doubt before the larger joints had had time to cool -- it was dropped into a tray. Not surprisingly the result was

that several joints were visibly crystalline and others were either not properly wetted or were granular. As well as the obvious shortcomings of the process itself, treatment of this type applied to SRBP boards under conditions of high humidity is practically guaranteed to generate early failures of tracks and lands. Out of a sample of about sixty boards, four were seen where edge delamination was already visible.

- No fume-extraction hoods or other protective systems were provided and there was no protection whatsoever for staff against solder splash or other contamination. The level of solder fumes in certain parts of the factory was so high as to be unpleasant and the level of particulate lead in the atmosphere must be well in excess of what is either permitted by European legislation or desirable on safety grounds.

- At various places on the production line, sub-assemblies were subjected to rapid, uncontrolled and heavy lateral 'banging' from side to side on the workbench by operatives, presumably as a coarse check for dry joints or loose connections. It was subsequently calculated that the assemblies were thereby subjected to acceleration forces of something in excess of 80g which is far in excess of what they will encounter in normal operation. Devices such as laser pick-ups, servos, VF displays, ferrite cores in RF inductors and permeability-tuner heads are very likely to be damaged by such treatment. Completed units were handled in a similar way by the 'inspectors'.

- Product life testing was carried out in a manner which could best be described as lacking in engineering insight. Vibration and temperature testing was carried out on small batches of product, but only insofar as they were switched on and left to run for set -- and rather short -- periods of time. No attempt was made to exercise mechanical functions (in what appeared to be a standard [redacted] refrain throughout the visit, "…it would cost too much") despite the fact that these are the very functions whose early failure would be most likely to be discovered by [redacted]'s limited test methods. Vibration testing was carried out at a standard 15Hz and 0.8g, with no attempt to use the sweep facilities on the vibration table to establish where failures occur and to use the information for product improvement. In all, it is considered that almost none of [redacted]'s factory testing is useful. Coupled with the company's evident lack of commitment to product improvement (and indeed its evident lack of knowledge of how product can be improved) it would seem that the 'testing facility' is mere window-dressing. There appears to be no knowledge anywhere in the company of modern statistical processes for establishing and improving component and product life.

- The 'inspection' facilities are also not considered useful. The 'inspectors' carry out simple functional tests and dutifully record the results, but the information -- which is in what might be called a tick-in-the-box format rather than useful numeric data -- is not fed back in any meaningful way into production. At the time of my visit a batch of 311 samples had been inspected, of which no less than 43 required rework. By modern standards this is a very poor result and it was interesting to hear that [redacted] considered it quite acceptable.

- At the final assembly and packaging stage, a high-pressure air-line was freely used to blow detritus out of the completed units. This was deployed with vigour, both inside and outside the units, and the resulting swarf and particulate matter was widely dispersed. This technique possibly explains the fine striations sometimes seen on [redacted] displays, and is also very likely to be responsible for a proportion of infant-mortality damage to semiconductor devices. It is well established that

blowing air across printed-circuit boards can generate voltage gradients in excess of 20kV which is clearly undesirable.

As well as these major issues, the [redacted] factory displayed a spectacular variety of minor shortcomings. Some curious management decisions appeared to have been made in terms of equipment procurement: for example, auto-insertion machines were used at about half their potential capacity and with very inefficient allocation of the associated sequencers. Overall, however, the impression was gained of an establishment which is just about capable of producing low-technology electronic products using obsolescent discrete components. Unfortunately the manner in which they are produced practically guarantees poor reliability, as do some of the astonishingly archaic testing and inspection practices.

R & D Centre visit, [redacted]

The R & D facility at [redacted] was also visited on [redacted] and several lengthy discussions took place with Mr [redacted] and also with [redacted], the Technical Director. I gained the strong impression that this establishment was not so much concerned with research and development as with ways and means of imitating competitors' products at the lowest possible cost. I raised the issue of the poor performance of the [redacted] currently used in [redacted] units, but it rapidly became evident that even the so-called Technical Director lacked any real knowledge of the RF environment in which the [redacted] operated, what its shortcomings were and how they could be improved. It emerged that the design had been obtained from Korea some time ago and since then had been merely reproduced without any attempt to consider basic engineering issues such as "does it work well enough?" and "how could we improve it without increasing cost?" or alternatively "how can we make a tuner of similar performance which costs less?" Other engineering issues appeared to be treated in the same rather perfunctory way. For example, I looked at a small screened room which was stated to contain a facility for carrying out pre-compliance EMC testing. It was difficult to see how the equipment available could be used for meaningful emissions tests. Equally, since there was no visible apparatus such as a G-TEM cell for carrying out susceptibility testing, it was also rather difficult to see how this might be achieved.

Allowing for possible cultural differences and misunderstandings, I was again struck by what can only be described as a complete lack of professional engineering curiosity. [redacted]'s engineering abilities do not appear to include the ability to produce original designs. The company's 'design' policy seems to be heavily reliant on reverse-engineering of their competitors' products and application of the findings to their own units without real insight or knowledge.

Meeting in [redacted]

This meeting was also attended by the [redacted] VP for Far East Operations. The [redacted] staff present were [redacted], the Managing Director, and [redacted]

The main points I made to [redacted] were as follows:

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- As a facility for the manufacture of electronic products for a consumer market, the [redacted] factory was the worst I had ever seen.

- I had not seen the slightest evidence of effective management, supervision, staff training or concern for product development, either there or anywhere else in [redacted].

- I considered the factory to be manufacturing in such a way as to guarantee high failure rates and a high proportion of infant-mortality failures.

- The inspection process was pointless insofar as the poor quality had been built into the product by then and could hardly be inspected out of it.

- The testing processes lacked any systematic foundation and were essentially a waste of time and space.

- Modern concepts of product quality and reliability and associated statistical processes appeared to be entirely alien to the company.

- I saw no prospect whatsoever of [redacted]'s factories being able to make the type of products now required by the market, and that their commitment to antediluvian manufacturing methods would ensure that they had almost nothing to make -- and probably no customers -- in a few years' time.

- Any notion that products such as [redacted] could be reliably manufactured under the conditions found at [redacted] was ill-founded and I would strongly recommend that [redacted] did not consider the purchase of such products from [redacted].

I ended by saying that from an engineering point of view it would be difficult to avoid recommending to [redacted] that they carefully consider the issues involved in their relationship with [redacted]. Existing return rates were too high for comfort, no notice had been taken of repeated requests for product improvement and it appeared that the situation could only become worse.

Conclusions

Given their evident shortcomings, it is difficult to avoid the conclusion that no-one would willingly do business with [redacted]. The company appears to have adopted the strategy of obtaining market share at all costs. As usual, this has been achieved by driving down prices to the point at which is very difficult for competitors to make headway. Standard economic models suggest that the result is inevitably a functional monopoly[redacted]

Unfortunately this process can only work to the advantage of both buyer and seller if the product is either unique or is backed by first-class design and manufacturing facilities. If neither is the case, the corner-cutting involved in driving prices down inevitably has an unavoidable impact on quality and reliability. In the case of [redacted] the quality is demonstrably very poor and can only worsen because the requirements of modern manufacturing will become increasingly divergent from the abilities and facilities available to the company. The manufacture of electronic equipment with cost as the primary driver is only ever an option when the level of technology embodied in the product is low. Modern

manufacturing techniques are considerably more capital-intensive than [redacted] appears to realise or wishes to recognize.

The profitability of [redacted] as a percentage of its turnover is understood to be extremely low. This is of course partly because of the emphasis on pricing rather than other factors as the driver for manufacturing quality. This being so, there are likely to be few resources available for investment in better staff and facilities and hence an increasing divergence between where the company is and where it will need to be. Again, the standard economic models suggest that the result will be that [redacted] will end up as a monopoly supplier of poor-quality low-end product but entirely unable to compete elsewhere.

Like its competitors, most of who are also forced on price grounds to buy from [redacted], [redacted] appears to be locked into a system whereby the quality of products bearing its brand can only be expected to degrade. Whether this situation is tolerable or not depends partly on the attitude of senior management to the company's reputation. However, if [redacted] wishes to be (and remain) in the business of supplying [redacted], it may have no option but to remain in some form of relationship with [redacted].

Some possibilities exist for improving the situation, however. The first is to become much more involved in the early stages of the design process. Given [redacted]'s inability to design items which perform well and display acceptable levels of quality and reliability, this might well be fertile ground especially given the level of engineering expertise available to [redacted]. To avoid benefiting its competitors, it might be possible for [redacted] to design, manufacture or supply certain components [redacted] and insist that these are fitted to its products.

It might also be feasible for [redacted] in effect to lease, rent or purchase manufacturing space at [redacted] where products are made to its standards rather than [redacted]'s. Bringing about large-scale improvements to [redacted]'s factories would be a major operation requiring a degree of investment. On the assumption that [redacted] is as aware of the issues as [redacted] is, it might be possible to apply a degree of encouragement to [redacted] to make the necessary investment in staff and facilities to ensure a) an improvement in product quality and b) an ability to make tomorrow's products reliably.

Finally it is important not to misunderstand the nature of the fundamental problem. Although it manifests itself as high return rates, which are *prima facie* an engineering issue, the real difficulty lies in [redacted]'s corporate culture and in particular its short-sighted concentration on costs rather than standards. No company operating in contemporary electronic manufacturing will survive very long if managed and directed along the lines of [redacted] and its philosophy of total reliance on unit price rather than quality and reliability to drive its market is fatally flawed when viewed in the longer term.

Given that some sort of relationship between [redacted] and [redacted] looks inevitable whilst the latter operates in the [redacted] market, it would seem necessary to take some action to address the issues at senior corporate level rather than expecting them to be addressable merely from an engineering point of view. This implies more radical action than inserting a few more "inspectors" or adding more layers of factory management.

The client severed all links with this manufacturer a week after receiving this report.