

# JAPAN progresses down the lead-free path

A mission to Japan had the task of assessing the progress of lead-free implementation.

Tim Fryer spoke to the team on their return.



A team with a mission in Tokyo

Japan has not treated the lead-free age as a revolution, rather as an accelerated evolution. Moreover, the Japanese, having adopted a lead-free path as the only way forward, are not deviating from this path - with a 'no problems, only solutions' type philosophy. That this was the overriding thought that the seven-man delegation to Japan returned with is the most surprising aspect of the mission. Surprising mainly because the host of technical difficulties that surround this topic in Europe and America were of secondary importance.

## The Mission

This was a SMART Group Mission supported by the DTI's International Technology Service. Its purpose was to establish the status of lead-free soldering in Japan, a country that is widely regarded as the leader in implementing lead-free electronic assemblies. The range of companies on the programme was designed to reflect the industry as a whole by including academics, government and companies

involved in supplying lead-free materials and components and using them. The visit was organised through the British Embassy and JIETA (Japan Electronics and Information Technology Industries Association), Japan's leading trade association for the electronics industry.

Members for the mission team were selected by the EMIF (Electronics Manufacturing Industry Forum), which comprises many of the UK's leading trade associations and organisations. Team Leader, Bob Willis, Technical Director of the SMART Group, explained how the Mission team was selected: "The key thing to making a success of this project is having people who would take responsibility for certain areas of technology, write about it in the report and be able to present this information at seminars."

Bob Willis apart, the team was made up of (with area of expertise in brackets): Dr Malcolm Warwick, Multicore Solders (materials); Rob Horsley, Celestica (assembly); Dr Chris Hunt, National Physical Laboratory

(research/academia); Phil Fulker, Invicta Contract Engineering (equipment); Nick Jolly, DTI (legislation); and Phillip White - International Trade Promoter for Japan (translator/facilitator!).

The first appointment for the team was at the British Embassy, where each member gave presentations about their own organisations and the impact (mainly perceived) that lead-free was having on it. PhillipWhite commented: "To invite an atmosphere of mutual exchange we started out by giving the Japanese information about what we were doing. The seminar was a sell-out - it was the biggest number they have ever had for one of these 'mission meetings'. A list of who attended reads like a who's who of electronics and went right across the board - consumer, telecommunications and every other field of the industry."

Having gone through the preliminary 'ice breaking' exercise, the team embarked on an itinerary that included

such companies as Sony, Matsushita, TDK, Senju Metals and NEC, as well as the Osaka University.

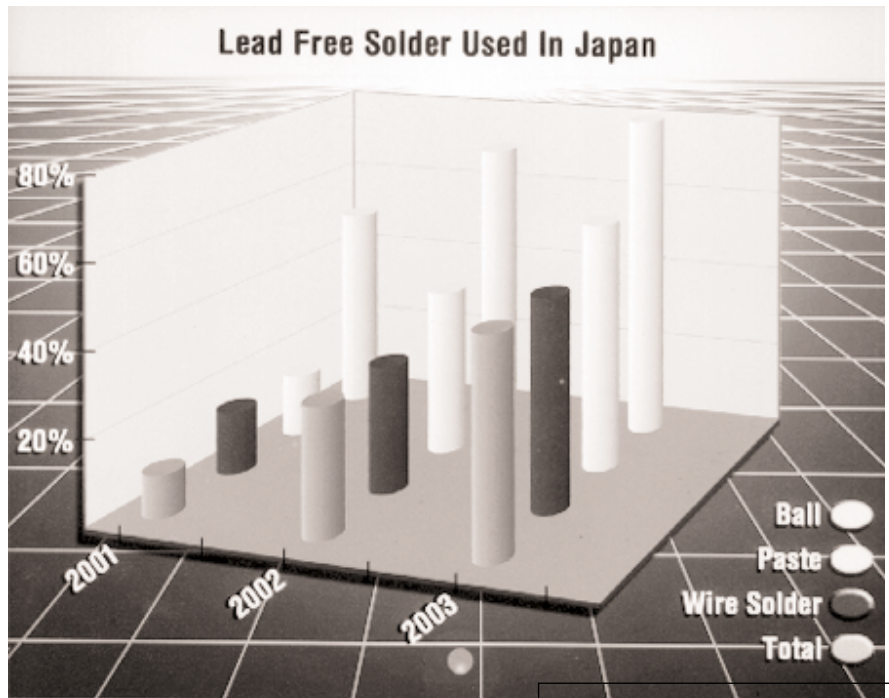
### Company driven

An important step before embarking on the trip was to identify preconceptions about what the team would find. The principal one of these was that market forces were pushing along the move to lead-free manufacturing. A hunt round Tokyo's shops soon dispelled this theory. It became clear that vendors were unaware of the environmental benefits of individual products. More surprisingly, there was very little information on the product packaging. Many companies have environmental logo's based around a 'green leaf' theme, but there is no universally accepted symbol. Moreover, these symbols only indicate that a product conforms to its manufacturers environmental code of practice. This may include the use of lead-free solders but only a small number conveyed this on the packaging. It was obvious from this that adoption of lead-free is not market driven. A new TV advert for a Panasonic mini-disc player is the first to mention lead-free as a selling point, even though a lead-free version of the product had been available for two years.

Nick Jolly commented: "Most of the companies we looked at did mention lead-free in their brochures, and usually had separate brochures on their environmental policy and performance, but for whatever reason they did not decide that it was necessary or appropriate to market this to the consumers."

Nor has legislation played a significant role, not Japanese legislation anyway. It is true that the added impetus for the abolition of lead was driven by the first draft of the European WEEE directive back in 1998. The slipping back of a European lead ban from 2004 to 2008, has not altered the roadmaps of the Japanese companies who planned to work well within the initial date.

There is a limited amount of indirect



Senjus predication for lead-free sales

pressure from Japanese legislation.

Lead is only permitted in certain types of landfill site which carries a cost premium, and there is also new legislation concerning recycling that requires companies to take back products, although there is no specifics as to how much of them is recycled.

Instead the initiative has been taken up by the individual companies. 'Corporate Environmental Consciousness' was a term that recurred at many of the companies visited and it was this that left the most profound impression on the returning mission team.

Philip White explained: "They have senior level directors who are responsible for the environmental programme, which includes lead-free, and having this at such a high level, it is then a case of it will be done and so just getting on with it. Lead-free is not a stand-alone issue, it just forms part of the overall environmental package."

Malcolm Warwick took up the theme: "They have a completely different philosophy. In Europe we say 'How much is it going to cost you?' in Japan they decide they are going to do something and then decide the most efficient and profitable way of going about it. It is all about belief in what they are doing."

### Implementation

According to Senju Metals, current implementation is probably only about 10%. But the team reported that uptake should be quite rapid now and it will be widespread in 18 - 24 months. Most companies are looking at having one lead-free product, then one lead-free product for each division, then all new products within a division and so on. Companies such as Panasonic (with lead-free mini-disc player, VTR, stereo all currently available), Sony (VTR, TV, minidisk), Hitachi (camera, notebook, calculator, washing machine) and NEC (notebook, pager) are all on course to achieve abolition within 1 - 3 years.

That such major companies are committed is proving an obvious driver in Japanese industry as its effects filter down the supply chain. Also included on many companies roadmaps is a rolling out of lead-free manufacturing to its overseas operations and suppliers. Both Sharp and Sony for example plan to implement lead-free assembly overseas by Spring 2002.

### Technology

Despite the philosophical issues around environmental performance, the thrust of the team's remit was to look at the

technical issues concerned. Bob Willis said: "Basically we were trying to look at the materials, the manufacturing processes, the reliability aspects and proof of use - ie seeing products that were actually being made using lead-free processes and in the marketplace."

At the heart of the issue worldwide has been the identification of a suitable alloy. Malcolm Warwick said: "It is fair to say that there is still a fair degree of evolution going on. The process of coming to the alloy of choice has been different by and large from what has happened in Europe but they are arriving at much the same conclusions as we are. However, they are still using a variety of alloys and there is still no final consensus as to what the alloy of choice should be. SnAgCu is being regarded as a universally reliable solution, but there are plenty of other examples of alloys being used. Even within individual companies there are different alloys for different applications. What is important is that whatever alloy they are using they

made it work."

It appeared that the SnAgCu alloy was preferred for higher reliability products, whereas the lower melting temperature alloys, particularly SnZnBi was used more in consumer applications. Initially supply of these pastes was confused by some patent issues, but the suppliers appear to have sorted this out having realised that companies were unwilling to be totally dependent on a single supplier.

*"Even within individual companies there are different alloys for different applications. What is important is that whatever alloy they are using they made it work."*

In addition to their consumer experience in Tokyo's shops, the team also looked at the cost of the lead-free products. Certainly there seemed to be

no price premium on the high street, but there were also no additional costs to the manufacturer, as Chris Hunt explained: "They don't consider any costs in isolation. It comes as part of an overall environmental objective, so where some material costs may rise, other aspects of the factory, for example power consumption may be falling. The requirements of lead-free processing (e.g. higher process temperatures) has led to the Japanese getting a greater understanding of their surface mount processes and consequently they have much better control over the process. So despite our perceptions to the contrary, the yields are higher and the process costs are not more expensive."

Nitrogen has often been regarded as a necessity for lead-free processing, but this was not the case. Sony claimed that it was not using Nitrogen atmospheres in its ovens at all, while others said that they use it in select applications (notably for Zinc based alloys) but not all. Once again, the changes in process requirements using the lead-free alloys

came from re-engineering and optimising the current equipment, rather than introducing Nitrogen or raising the peak temperatures significantly.

Similarly, other parts of the production process were being adapted where necessary to allow the lead-free processes. The biggest changes observed were simply changes in operating temperatures for rework, and setting different tolerances on the AOI equipment to accommodate the duller finishes of the lead-free solder joints. Only one company used a cleaning process, all the rest were no clean.

The issue of component damage due to high process temperatures was addressed by Bob Willis: "There are suppliers who have the stipulation on their components of processing peak temperature requirements, even though the parts are able to stand up to higher temperatures. One particular company said it deliberately ran higher temperatures because it knew the components would stand up to it. But again it comes

down to process control. If you have a delta T across the oven and across the board of plus or minus 5° then you can have lower peak temperatures. If the delta T across the board is bigger then peak temperature needs to be higher. But we did see some high technology boards that in the real world of manufacture would have a good 20° differential, and these had not caused any assembly problems."

*"The only thing standing in our way, which the Japanese have admirably surmounted, is the corporate drive to make lead-free assembly processes a reality."*

Component availability and board finishes were not proving to be an obstacle in Japan, although there were indications that backwards compatibility with Bismuth alloys could be a

problem. Other finishes presented no problems to lead or lead-free processes.

### Conclusion

While it might have been expected that the Mission team would return with a host of technical information, the key message was that we have the equipment and expertise already at our fingertips. The only thing standing in our way, which the Japanese have admirably surmounted, is the corporate drive to make lead-free assembly processes a reality.

*The report is available on CD ROM from the SMART Group at a cost of £50. It will be presented at a series of events in England, Scotland and Wales over the coming months.*

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