Journal of the Institute of Circuit Technology

2008 Events

24/25th January	*EIPC Winter Conference,Rome*
6/7th February	*Southern Manufacturing & Electronics FIVE, Farnborough, Hants*
12th February	14.00 Council Meeting 17.00 AGM 17.30 Evening Seminar, all at White Swan Hotel, Arundel. Supported by Eurotech Group plc
4th March	17.00 Evening Seminar, Davenport Hotel, Darlington.
16/22nd March	*6th EIPC Technology Trip, Shanghai, China.*
31st March / 3rd April	Annual Foundation Course, Loughborough University.
22th May	12.30 Council Meeting - London Canal Museum
29/30 May	*EIPC Summer Conference Dresden*
3rd June	34th Annual Symposium, Tweed Horizon Centre, Newtown, St.Boswells.
5th August	15.00 Afternoon Seminar, Design Suite, Loughborough University.

Contents

vol.1 no.2 March 2008

Editorial

This is our second issue of the Journal and once again we have attempted to report on something of interest to all our Members. There is, however, scope for participation by the Membership and your contributions would be very welcome. For example news and views of the people in the Printed Circuit and associated Industries, pictures would not be out of place.

To provide an alternative to Individual Subscriptions the Institute has introduced a Group Membership Scheme for all relevant Organisations. Many Companies have taken up this option, whilst others will continue memberships by paying Individual Fees. This replaces the old Corporate Members sector and is proving very popular.

We have continued to foster close links with other Organisations such as the NUKCG, EIPC, IMF and SMART. The Institute now plans to offer a truly national coverage and representation and, in addition, seeks Members from the PCB Design community as well as Fabricators, Suppliers and Electronic Assemblers.

During 2007 we successfully held our Annual Symposium at the National Physical Laboratory in Teddington. This year, on the 3rd June, we are moving north to the Tweed Horizons Business and Conference Centre in the Scottish Borders. There were 4 free evening Seminars held in 2007 at such locations as Arundel, St Ives and York, all of which were well attended.

Events in 2008 are planned to have a greater national coverage with evening Symposia planned for Darlington, Arundel, Loughborough, Exeter and possibly at St Ives once again..

Our Web site (www. InstCT.org) is now seen as an important Portal through which our members can seek information and advice. During 2007 we have been successful in updating the site and now plan to expand its popularity.

I take this opportunity of saying goodbye to David Woodley, Frank Coultard and Kate Geraghty from the ICT Council, all of whom have given valuable service to the Institute but now are moving to pastures new. By the time you read this copy of the Journal following the AGM in February, we may well have fresh blood aboard.

Steve Payne Chairman ICT

Membership New members voted into membership by the Council

4th December 2007

Associate Member (A.Inst.C.T.)

Thomas Taylor	10067

Members (M.Inst.C.T.)

Eric Butchert	10062
Mark Gordon	10063
Steve Snell	10064
Ian Cox	10066
Rob Haslett	10068

Fellow (F.Inst.C.T.)

Darren Southee	10065

12th˙Febuary 2008

Student Member

Zhiwel Zhang	10080

Members (M.Inst.C.T.)

Mark Drewett	10070
Norman Fergusson	10071
Viv Amos	10072
Dean Foyle	10073
Andrew Norton	10074
Keith Netting	10076
Andrew Clemie	10077
Rud Lewis	10078
James Zhu	10079
David Knight	10081

Fellow (F.Inst.C.T.)

Gavin Barclay	10069
Peter Taylor	10075

Members regraded

Peter Grundy **M.Inst.C.T.**	2027
Shaun Tibbals **M.Inst.C.T**.	9920
Steve Woods **M.Inst.C.T.**	9962
Mark Heaton **M.Inst.C.T.**	10012

Technical News

This paper was prepared by **Len Pillinger** *when he was Certification Manager of BSI Product Services.*

REACh – time to sit up and take notice.

Imagine that you are your employer's Compliance Manager. You are mightily relieved that some of the fuss over the European RoHS Directive has died down, and your production processes and supply chain management have been enhanced to remove the restricted substances. You have attended more seminars and symposia on substance management than you would ever want to. Your boss has even noticed what a great job you did! You have told yourself that it is time to sit back and congratulate yourself on handling RoHS whilst hoping that the European Commission never pass another law affecting your organisation. Just when you thought it was safe to go back in the water.....

Rather than sit back, it is now time to sit up and pay attention to REACh. This is the Registration, Evaluation, Authorisation and Restriction of Chemicals or EC Regulation 1907/2006 dated the 18th of December 2006. Whilst this is a European initiative, it is almost certain that it will ripple around the globe in much the same way as the RoHS Directive.

What has it got to do with electronics?

Will the REACh Regulation impact the electronics industry? It is actually quite difficult to think of any area of business that REACh will not touch.

Engineering organisations will eed to consider paints, oils, alloys and metal finishes and many other process consumables. The construction industry will need to think about their use of paints, road materials, polymers and some cementatious products; and Electronics companies will not escape due to the use of fluxes, resins, cleaning solvents and even the components themselves.These lists are certainly not exhaustive and the impact is all along the supply chain from chemical supplier to reformulators to downstream users. The impact will vary but everybody will need to undertake some form of compliance review.

What exactly is REACh?

It will not be possible to tell you everything about REACh, which extends to 278 pages of small double-column print, in this paper. KPMG have published a report suggesting that direct costs for chemical suppliers will be between Eur.15,000 and Eur.300,000 per substance equating to between 6% and 17% of turnover. Additionally, there are requirements placed on every "actor in the supply chain". This means that in the electronics industry every chemical supplier or blender, every PCB base material supplier, every PCB assembler and any other organisation in the supply chain such as importers and distributors need to pay attention to REACh.

REACh has been under discussion in Europe since 1998 and it builds on and consolidates 42 individual pieces of legislation, citing several other European Regulations and Directives. It is estimated that 100,000 substances will be affected in a staggered implementation. REACh is a Regulation rather than a Directive and this distinction is worth explaining. Directives usually require EU Member States (now numbering 27 with further applicants) to draft and enact their own Statutes before the Directive becomes enforceable. Regulations are effective without the need for 27 implementations. This method is becoming increasingly common to avoid delays in introducing new initiatives.

The EU has introduced REACh following several high-profile incidents involving fatalities and long-term illness. In addition to the protection of human and animal health, the environment is an additional concern with the drive to eliminate Persistent Organic Pollutants (POPs) and other environmentally unfriendly substances. A further driver is the desire to reduce animal testing which is often duplicated due to the failure to exchange information in the interests of commercial confidentiality. There is strong pressure within Europe to completely eliminate animal testing ranging from legitimate lobbing to occasional but high profile terrorist activity.

There will be some existing substances for which use will require authorisation rather than simply registration. It is estimated that these include 850 substances known to be carcinogenic, mutagenic or toxic for reproduction (CMRs). It is thought that the REACh process will identify a further 500 CMRs. Also requiring authorisation will be POPs and persistent, bio-accumulative and toxic substances (PBTs). If some substances require authorisations, then it must be assumed that some will be refused – effectively a ban. Also be aware that that authorisation is at the European level rather than by Member States. A single European Chemicals Agency has been established in Finland.

REACh concerns itself with substances on their own, substances in preparations and substances and preparations in articles, each of which is defined in REACh.

Why now and what should I do?

The EU Commission feels that REACh will enhance competitiveness through the promotion of the use of acceptable substances and through innovation in replacing unacceptable substances.

The success of REACh will satisfy certain World Trade Organisation (WTO) obligations; hence the belief that REACh will follow RoHS into the general global community. It will also ensure a single European system replacing a wide range of existing but different Member State laws.

The mantra of REACh is ' No Data = No Market. '

This applies to every actor in the supply chain. Failure to take REACh seriously could cost you your product market. Moreover, it applies to :-

1. Substances as individual substances (e.g.: potassium permanganate used for de-smearing PCB plated-through holes)
2. Substances in preparations, and similarly
3. Substances in articles (e.g.: tetrabromobisphenol-A added to resin for use in a PCB laminate)

Given this alarmingly wide scope, it is a relief to find that the implementation is to be phased:

June 2007	Entered into Force
June 2008	European Chemicals Agency operational (registration of dossiers)
June – Dec 2008	Pre- Registration of 'phase in' substances
November 2010	Registration of substances > 1000 tonnes carcinogens, mutagens repro-toxics > 100 tonnes substances classified as very toxic to aquatic organisms > 1000 tonnes carcinogens, mutagens repro-toxics
June 2013	> 100 tonnes registration
June 2018	> 1 tonne registration

Knowledge of tonnage requires a significantly different approach to that taken for RoHS compliance where Maximum Concentration Values (MCVs) are specified.

The first substances to be considered are those whose properties are already known and appear in the European Inventory of Existing commercial Chemical Substances (EINECS) which can be found at http://ecb.jrc.it/esis/index.php.

By pre-registering during the second half of 2008, these substances benefit from the transition periods shown above. Otherwise, you may encounter a shortened timeframe. These are known as phase-in substances.

Pre-registration will involve identifying the substance, the original source and the tonnage (which helps define the deadline). The European Chemical Agency will collate and publish data to assist applicants.

Registration is required for all substances with a usage greater than 1 metric tonne per annum; and users of substances need to be aware that registrations must define the usage and method of application. Materials with a usage of greater than 10 metric tonnes per annum will need to submit a CSR (Chemical Safety Report) with their application.

The Regulation is seeking the following information.

1. identification of the substance / preparation and of the company / undertaking;
2. hazards identification;
3. composition / information on ingredients;
4. first-aid measures;
5. fire-fighting measures;
6. accidental release measures;
7. handling and storage;
8. exposure controls / personal protection;
9. physical and chemical properties;
10. stability and reactivity;
11. toxicological information;
12. ecological information;
13. disposal considerations;
14. transport information;
15. regulatory information;
16. other relevant information.

If the information is not available, suitable testing may have to be agreed. There will be a process for data sharing in order to reduce animal testing. Substance Information Exchange Fora (SIEFs) will be encouraged. However, innovative organisations may be reluctant to divulge their 'trade secrets'.

It is possible for consortia or other collectives to jointly register thereby reducing / sharing costs both in terms of registration / testing fees and in-house resource.

Impact on the supply chain

If you do not produce substances or reformulate or blend them, you are still likely to be involved as a downstream user which is de-fined as any professional or industrial user of a substance or preparation that is neither a manufacturer nor an importer. This includes:

1. Formulators of substances and preparations;
2. Industrial users of substances and preparations in production processes;
3. Manufacturers of articles; and
4. Professional users,

but does not include:

5. Retailers;
6. Distributors; and
7. Consumers.

The downstream user will need to demonstrate that he has fulfilled a number of obligations including:

8. The need to identify risk and apply control measures (e.g.: exposure scenarios);
9. Communicate these control measures to customers.
10. The need to communicate up the supply chain (e.g.: confirm that your use of a substance has considered in any registration.).
11. Report to authorities: (e.g.: register your use if your supplier has failed to do so.).
12. Review usage / tonnage changes and report if necessary; and.
13. Review and communicate data both up and down the supply chain.

Exemptions

By this time you will be thinking, to quote W C Field's alleged last words, "I'm looking for a loophole". (He was dying in bed whilst drinking bourbon and reading the Bible at the time!)

Exemptions do exist for:

1. Substances whilst in transit due to customs regulations;
2. Radioactive material covered by Directive 96 / 29 / Euratom;
3. The carriage of dangerous substances and preparations;
4. Waste as defined in Directive 2006/12/EC;
5. Foodstuffs;
6. Medicines;
7. Implanted medical devices; and
8. Defence Interest.

If you manufacture the occasional product for a military contractor, do not expect to claim a general exemption. Exemptions are granted by the Member States' Competent Authority and are likely to be rare and specific.
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A knock-on effect of this legislation will be in the area of supply-chain management and security of supply. It is likely that some substances will be taken off the market due to reasons of toxicology or it may cease to be viable to supply where turnover does not support registration and / or testing costs. This needs to be mitigated by a good knowledge of the materials science of your processes and products, and by good communications with your suppliers.

Manufacturing articles outside the European Union will provide some relief in as much as REACh requirements for articles only apply to substances 'intended to be released' during usage. Even this is a grey area. Consider the use of our workhorse flame retardant in FR4 glass epoxide laminate: Tetrabromobisphenol-A. The printed circuit board is not intended to burn, but the flame retardant is released in the event of combustion in order to steal oxygen and extinguish the fire. Therefore is the Tetrabromobisphenol-A intended for release? Expect a debate on any number of these material science niceties.

In any event, if you are exporting to the European Union, be prepared to supply data to your import agent.

Enforcement & Registration

You may decide to use the services of a REACh 'only representative' to register on your behalf, in which case your importers become downstream users. With multiple import channels, this may be a useful way to proceed. A number of chemical consultancies have already established themselves in this role.

Enforcement of REACh is devolved to Member States, and in the case of the United Kingdom is the responsibility of the *Health and Safety Executive (HSE).*

There has been considerable scepticism about the level of enforcement of RoHS within Europe. It is always difficult to publicise enforcement measures before defendants come to trial – which they rarely do.

Significant RoHS enforcement activity has taken place in the UK, the details of which being only known to the enforcement body and representatives of the organisation subject to an enforcement notice.

Similarly, a lack of visible REACh enforcement will not mean that nothing is happening. It is likely that the two most common reasons for enforcement will be competitor informants and investigations of (potentially unrelated) industry accidents and 'near misses'. With HSE having responsibility for such investigations, REACh compliance is likely to be considered each time.

Final Thoughts

The Commission's own FAQs include the following comparison between the present fragmented system and REACh :-

Present System	*REACh*
There are gaps in our knowledge about many of the chemicals on the European market.	REACh will close the knowledge gaps by providing information on hazards and risks of chemicals produced or imported in volumes higher than :- 1 tonne/year per manufacturer/importer.
The 'burden of proof' is on the authorities: they need to prove that the risk from the use of a chemical substance is unsafe before they may impose restrictions.	The 'burden of proof' will be on industry. It needs to demonstrate that the risk from the use of a chemical can be adequately controlled, and recommend appropriate measures. All actors in the supply chain will be obliged to ensure the safety of the chemical substances they handle.
Notification requirements for 'new substances' start at a production level of 10 kg. Already at this level, one animal test is needed. At 1 tonne, a series of tests including other animal tests have to be undertaken	Registration will be required for both old and new substances when the production or import reaches 1 tonne. As far as possible, animal testing will be minimised
It is relatively costly to introduce a new substance on the market. This encourages the continued use of "existing", untested chemicals and inhibits innovation.	Innovation of safer substances will be encouraged under REACh through: more exemptions for research and development; lower registration costs for new substances; and the need to consider substitute substances when applying for authorisations.
Public authorities are obliged to perform comprehensive risk assessments that are slow and cumbersome.	Industry will be responsible for assessing the safety of identified uses, prior to production and marketing. Authorities will be able to focus on issues of serious concern

The most onerous change is the change of responsibility and burden of proof away from the various authorities. IInstead this falls squarely on the shoulders of industry.

The Commission recognizes the need for clear guidance for industry to ensure consistent, cost-effective and smooth operations. Extensive guidance, software tools etc. will be made available.

Detailed information is available at a number of commercial website and at:

http://ec.europa.eu/enterprise/reach/index_en.htm
http://register.consilium.eu.int/pdf/en/05/st15/st15921.en05.pdf
http://ec.europa.eu/echa/home_en.html
http://www.hse.gov.uk/reach/index.htm

There are already a number of organisations offering REACh services. These include training, gap analysis / impact assessment and dossier preparation and registration services. It is also conceivable that REACh could be considered in certification programmes such as IECQ Hazardous Substance Process Management.

In conclusion REACh will have a distinctly different impact to RoHS but requires the same systematic approach, and it will stretch far beyond the six RoHS substances and the electronics industry.

So; be kind to your Compliance Manager. He has a lot on his plate (Plates are considered as an article by the REACh Regulation!!).

This article was originally published in 'Circuitree' in December 2007 and was prepared by Len Pillinger who was Certification Manager of BSI Product Services. Len has subsequently left BSI and if you require any support regarding REACh; this can be discussed by contacting mike.inman@bsi-global.com

ICT Evening Seminar

Tuesday, 4th December 2007
The White Swan Hotel, Arundel

The ICT's Evening Seminar on **Design for Manufacture** was held at its regular southern venue, the White Swan Hotel in Arundel. The good sized audience was welcomed to the event by **Bill Wilkie**, the ICT's Technical Director. Bill continued by thanking the event's sponsor, **Martin Morrell** and **Artetch Circuits**. He also gave an overview of the benefits of ICT membership and outlined the ICT's recent activities and its plans for the future. He then described the theme of the seminar before introducing the evening's first speaker.

Sue Critcher of **Routability Ltd** and *Total Board Solutions Ltd* gave the opening presentation on PCB Design and it was entitled '**The Design Community'.** Sue had been working on PCB design for many years and the aim of her presentation was to give an overview of some of the standard problems that could impact design and which were frequently encountered by designers.

The first of these was 'Annular Ring' where there were often discrepancies between the dimensions that the board makers needed and what the designers intended.

Copper slivers were another area that had attained increasing significance because of the need to achieve ever higher interconnect densities and the consequent need to route tracks through smaller spaces and ever closer to each other.

Solder mask materials could also lead to issues where libraries had not been updated and where autorouters were used. A post routing command could be utilised to help space out traces but this was not often used. Solder mask issues could also occur between two closely located components and this was particularly important as boards moved to higher frequencies and where impedance control was more important (seebelow).

When designing impedance matched boards there was a even greater need for dialogue between the designers and the fabricators in order to ensure that the designed boards could actually be fabricated.

Sue also highlighted the importance of developing an early dialogue with the fabricators and the importance for the designer of understanding their capabilities. One good way of achieving this dialogue and of getting a better understanding of just what could be manufactured was for the designer to visit the fabricator's facility and to see the actual board making process in operation.

The second paper of the seminar was presented by **Neil Chamberlain** of **Polar Instruments** and was called **'Controlled Impedance'.** The main focus of the presentation was on impedance modelling on multiple dielectric substrates and their influence in impedance control.

The key challenge for many manufacturers was not just to move to higher frequency devices but to move to higher frequencies while still being able to use standard materials.

Despite their shortcomings conventional laminates such as FR4 were often the preferred choice rather than the more 'exotic' high frequency materials since these were often considered to be too expensive for many applications. FR4 was a difficult material to model because of its composite structure of epoxy and glass. Local structural inhomogeneities could lead to significant variations in important properties such as dielectric constant across a board. This could be important where, for example two tracks passed over different board structures eg one that was glass rich and the other resin rich.

Neil also described how some board builds were made of mixed materials which again complicated the situation. For example a multilayer might be mostly composed of standard FR4 material but could also contain an inner layer of a more specialist material.

He then described how other important materials such as solder mask could have an influence on high frequency properties. He cited the example of solder mask thickness, which could have an impact on impedance especially in the intertrace region between closely spaced tracks. Similarly, the resin layer in a differential microstrip design also had an impact on impedance.

The ever increasing move to finer line widths and higher operating frequencies would result in more lossy lines. The IPC's D24/C 'High frequency - High speed' Committee was currently working on a the development of a standard method for loss measurement.

In conclusion, it was also stated that there was a need for simplified approach to the modelling of structures, although it would still be necessary to measure impedance.

The next presentation on '**Data Management in Elec-tronics Design and Manufacturing'** was given by **Jan Keijzer** from **Adeon Technologies BV,** a company based in Oosterhout in the Netherlands. Jan began by introducing Product Lifecycle Management (PLM)., which was defined as the process of managing the entire lifecycle of a product from conception to end of life.

Smooth collaboration across the supply chain was the key to success, especially with consumer electronics, and data management was a key part of this activity. There was likely to be an increasing need, and demand, from OEMs for all supply chain partners to provide information into some type of PLM system.

Jan described how the established large and formal PLM systems were typically not able to handle fast changing data or to interface with other PLM systems.

He then introduced a new design information management system

known as CXInsight. This was developed to be a scaleable system and had been built to operate in a fast moving dynamic and distributed environment. It provided full traceability for all users and yet provided 128 bit data encryption to give high levels of security.

The system allowed project managers in both the design and manufacturing environments to have full visibility across projects and activities and tasks.

The seminar concluded with a presentation from **Matthew Beadel, Product Development Manager** of **Artetch Circuits** on **'Control Centre – Automated Design for DFM'**.

Matthew began by giving a definition of :-

Design for Manufacture.

This was described as a pre-manufacturing check of the suitability of a design for manufacture and an assessment of the product's likelihood of being manufactured with a high acceptable yield through a given manufacturing process.

DFM was used at Artetch every time a board design was submitted to the company.

He then went on to describe how Artetch offered both a standard and a premium DFM service for customers to help them make an assessment of their board designs.

This service required the customers, or potential customers, to submit a variety of information including their ODB++ or Gerber 274X data. Artetch could offer a rapid turnaround with results were communicated back to premium users within 30 minutes by email.

Matthew then showed some examples of the typical DFM reports that were generated and how they highlighted potential problems. The DFM tool could also compare the results from a specific board design against company or industry standard specifications and then give an immediate response.

The standard and premium service was offered free of charge by Artetch and could be located at www.DFM4FREE.com or via the Artetch website; www.artetchcircuits.co.uk.

Overall, this was a very useful and focussed seminar with four presentations from industry experts on a topic that had attracted an audience of both designers and manufacturers. The seminar concluded with a visit from Father Christmas (rumoured to have been Bill Wilkie in drag) who distributed gifts to the audience and thanked the speakers for their presentations.

The evening continued with a buffet supper and an opportunity to network with the speakers and delegates.

Martin Goosey
ICT Council
4th December 2008

The Evaluation of Sonochemical Techniques for Sustainable Surface Modification in Electronic Manufacturing

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Abstract

Traditional methods of 'wet' surface modification used in electronic manufacture are characterized by the use of hazardous chemistry, high process temperatures, copious rinsing and long dwell times. This IeMRC funded research programme addresses these issues by evaluating sonochemical surface modification techniques with the objective of producing a one step process using benign chemistry at lower temperature with less rinsing.

In this short paper we report the use of ultrasound applied through DI water for the surface modification of four materials and evidence is produced to indicate that sonochemical surface modification of a least three of them is feasible in DI water at 40ºC.

1.0 Introduction

Traditional 'wet' manufacturing techniques for surface modification lend themselves most readily to high volume manufacturing but are often characterized by the use of hazardous chemistry, operate at high temperatures and require copious rinsing[1]

Increasing environmental and health and safety legislation coupled with concern about the industry's carbon footprint means that the use of 'clean and green' processes for such manufacturing methods need to be re-evaluated, and one such technology is sonochemistry.

1.1 Sonochemical Surface Modification[2,3,4]

When ultrasound is applied to a liquid medium bubbles are formed in a process known as acoustic cavitation[5]. Eventually these bubles grow to an unstable size and then undergo violent collapse and consequently, even in a benign aqueous solution, acoustic cavitation can cause a number of effects that are useful for surface modification.

a. Localised high temperatures and pressures

These generate radical and other oxidizing species which can attack the surface of the substrate. Also, under these extreme conditions, bonds (both chemical and physical) can be broken on the surface of the material (e.g. polymer scission) and other chemical reactions can take place.

b. Microjetting

Microjetting causes mechanical or physical erosion of the substrate, destroys boundary layers and improves heat and mass transfer ensuring that products are removed from, and reactants brought to, the surface of the material efficiently. However, once the ultrasonic energy is turned off this aggressive oxidizing environment will rapidly return to a benign state.

This research study was instigated to investigate sonochemical surface modification techniques. It is believed that these methods could have the flexibility to process a diverse range of substrates, employ fewer process stages, require less rinsing, utilize non-hazardous, benign aqueous solutions and be operated at lower temperatures.

It is important to note that ultrasound has been used for many years in the electronics industry to clean substrates or to improve solution movement in the desmear process. The novelty of this research is that it will attempt to optimise the ultrasonic conditions (frequency, power, temperature, chemistry etc) to obtain good surface modification, rather than 'bolting on' ultrasound to an existing surface modification process.

We report here some of the work performed in Phase 1 of this 3 year IeMRC funded project which focuses on sonochemical surface modification in water.

2.0 Experimental

A Jencons VibraCell VCX600 was employed with a 20 kHz ultrasonic horn. The use of ultrasonics led to an increase in temperature of the solution under test and for this reason experiments were carried out in a vessel surrounded by a water jacket to ensure that a constant temperature could be maintained.

Comparative experiments were performed on the same solutions but using a 'silent' set-up i.e. without the use of ultrasonics.

When an ultrasonic horn was employed the generator was set to an amplitude of 50% giving an applied power of 35.1W (determined calorimetrically [3]).

The process flow shown below was used when carrying out surface modification

1. Surface Modification Treatment 40ºC 60 minutes
2. Cold water rinse 5 minutes
3. Dry

The four materials investigated are detailed below.

1. Ceramic material - ceramics have been of interest in the electronics industry for many years but are becoming more so in the displays industry and with the emergence of optical circuits.
2. GE Plastics, Noryl HM4025, a glass filled polyphenylene ester, polystyrene blend used in the manufacture of Moulded Interconnect Devices (MIDs) and supplied by Moulded Circuits Ltd.
3. GE Plastics, Cycolac S705 ABS/PC blend, used for the casings of various electronic devices e.g. mobile phones.
4. Isola, Duraver 104, Modified FR4, glass woven, brominated, laminate, used in Printed Circuit Board (PCB) manufacture.

In this short paper the results for weight loss and SEM analysis are reported.

.3. Results and Discussion

The weight loss results (Figure 1) clearly indicate that for the ceramic, Noryl and FR4 substrates the application of ultrasound causes a significant increase in the material removed. When one considers that to accomplish any discernable weight loss on such materials normally requires the use of oxidizing, hazardous and high temperature processes the fact that this has been achieved in DI water at 40 ºC is quite a noteworthy result.

The SEM data correlated with these findings for the ceramic and Noryl materials. The SEM findings for the FR4 laminate, however, showed very little change in texturing.

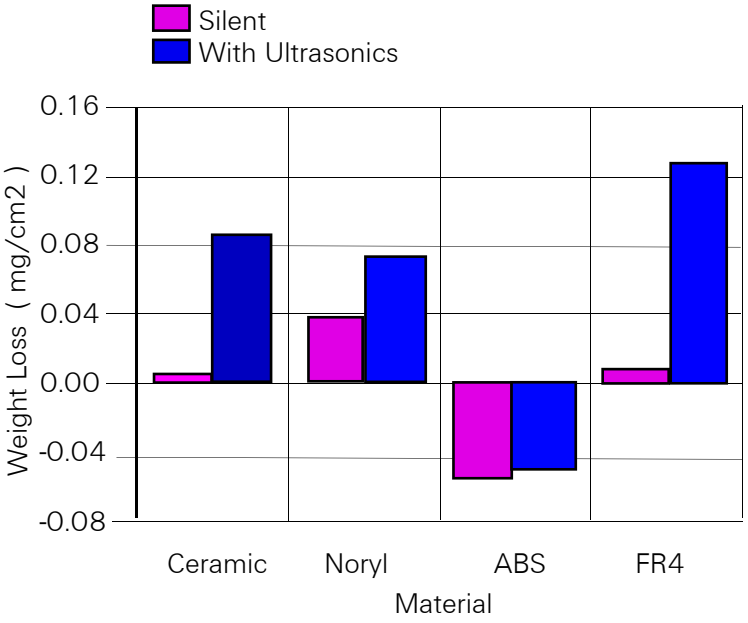
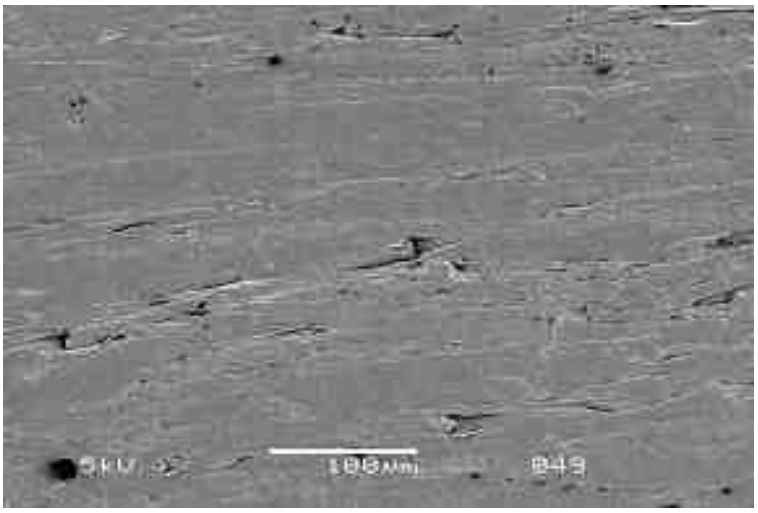
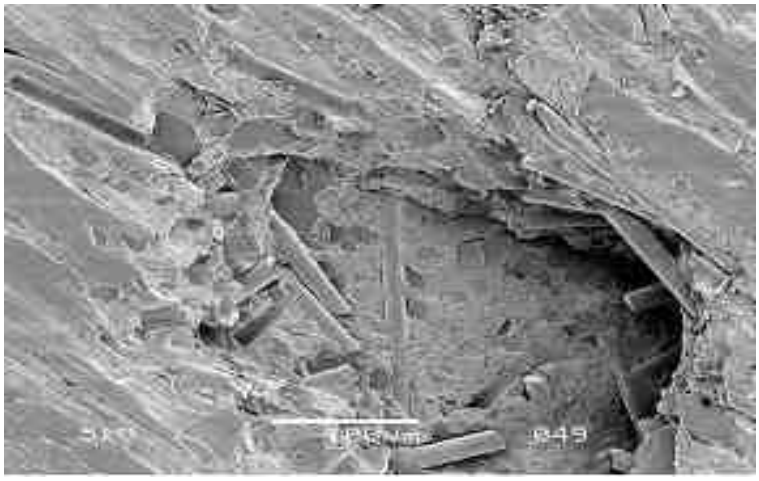


Figure 1 - Weight loss results after Sonochemical and 'Silent' Treatments



Photograph 1
(X250).
HM4025 - DI Water,
60 minutes, 40ºC, Silent



Photograph 2
(X250).
HM4025 - DI Water,
60 minutes, 40ºC, Ultrasonic Horn

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ICT Evening Seminar

Tuesday, 8th February 2008
The White Swan Hotel, Arundel

The ICT's First Evening Seminar of 2008 took place at the White Swan Hotel in Arundel following the AGM. The event was chaired by the ICT's Technical Director, **Bill Wilkie**, and before the seminar's first speakerwas introduced, he broke the sad news of the death of **David Kingsley**. David had spent many years in the PCB industry and had made a significant contribution to the ICT until his retirement.

Unlike some recent ICT seminars, this one did not have a specific theme and the programme was therefore able to cover three wide ranging subject areas that were of specific interest to members. These were legislation, new technology and forecasting the future of the industry.

The first presentation of the evening was given by **Mike Inman** of **BSI** and this covered the recently introduced **REACh regulations.**

He began by giving an over-view of the various related pieces of producer responsibility legislation that were already impacting much of the electronics industry supply chain from design to end of life.

These included the RoHS and WEEE Directives, as well as the Battery and Accumulators Directive and the Energy Using Products Directive. REACh was another piece of similar legislation and this would impact all users of chemical substances.

It was estimated that around 100,000 substances would be implicated in REACh and Mike emphasised that REACh would have an impact on virtually all industrial sectors, including the downstream users. The REACh regulations would replace 42 existing pieces of legislation and, instead, would give one unified European system. REACh would also address World Trade Organisation obligations and reduce animal testing, as well as supporting Duty of Care.

Mike stated that if there was no data on a substance there would be no market for it !

He then outlined the REACh timetable and, although the regulations came into force in June2007, the next key date was June 2008, when the six month pre-registration period for 'phase in' substances began. Other registration deadlines, which depended on tonnages, were in 2010, 2013 and 2018.

There were a number of exemptions in REACh and examples included substances in transit, radioactive substances and waste, which was covered by other directives. Also, food and pharmaceuticals were exempt.

There was now a single central agency based in Helsinki, known as the European Chemicals Agency (ECHA), which was tasked with supporting REACh implementation across Europe and with providing the requisite guidance and software tools.

Pre-registration would be paper less and could be achieved using one of the database systems such as REACh-IT or IUCLID 5 and this process would close on 1st Dec 2008.

Mike then went on to give a description of just what constituted a so-called 'phase-in' substance. For substance quantities above 100tonnes per annum Evaluation was required and a test programme would be agreed by the ECHA. The ECHA was also responsible for coordinating the testing and any substances of high concern would require Authorisation. Examples of such materials included carcinogens, POPs, and mutagens. There would be a central data repository and Substance Information Exchange Forums (SEIFs) that would be used to facilitate data exchange.

Safety data sheets would be used to communicate information down supply chains and some examples were shown.

Within REACH there were also REACh Implementation projects (RIPs).

Mike then went on to outline what substance users must do to comply with REACh and this included letting manufacturers know of the proposed uses of their substances and participating in a two-way communication process.

BSI was offering training services and help with GAP analysis, file preparation and the pre-registration process.

The second presentation of the evening was given by **Darren Southee** from **Brunel University**, who gave a talk on the work of the Cleaner Electronics Research Group.

His presentation was entitled '**Printed Interconnects, Components and Batteries using Offset Lithography'.** The aim of the Cleaner Electronics Group was to work towards the reduction of environmental impacts from electronics products and it had over eleven years of experience in this area.

Darren gave a brief review of the history of the group and said that much of the work had been centred on use of the offset lithographic printing process, which is more traditionally used for printing books and magazines. Early work had focussed on the printing of silver-based conductive inks to form conductive tracks and the technique was capable of both high resolution and high printing speeds, whilst also being low cost.

A key initial challenge had been to achieve low enough sheet resistances to make the inks of practical use in interconnect applications. Later work had then been focussed on increasing the conductivity of the silver inks and subsequently on replacing the silver with copper oxide.

Examples of the circuits produced were shown and these included a working telephone, a strain gauge and a digital thermometer.

More recently, Darren had been investigating the fabrication of voltaic cells using the conductive lithographic film route. An initial feasibility study funded by the Innovative Electronics Manufact-uring Research Centre (IeMRC) had shown that this route was indeed possible and zinc-carbon-manganese dioxide type cells had been successfully demonstrated. Two substrate materials had
been used, namely PolyArt and Melinex and different paste thicknesses were also evaluated. Peak currents of 18 mA had been achieved.

Areas for further work were also identified and these included improving to cell shelf life and peak current capability. Data was shown illustrating the wet shelf life

improvement that had already been achieved and cells with a stability of several weeks could now be fabricated. Cell capacities of 10 mA hours had also been attained.

A technique known as Electrochemical Impedance Spectroscopy had been used to characterise the cells. This gave an indication of what was happening inside the cells and example spectra were shown for cells produced at Brunel and they were compared to spectra from conventional cells. There were several industrial partners supporting this work including Hallmark, Gwent Electronic Materials and DuPont.

Work had also been carried out on the manufacture of electroluminescent displays that could be printed using offset lithography and data was given showing how the luminance varied with applied voltage. Low power thermo-chromic displays had also been fabricated. A key part of the presentation was when the lights were dimmed in the room for the demonstration of a printed electroluminescent device that was powered by a printed battery!

The final presentation of the seminar was given by **Francesca Stern** of **BPA Consulting Ltd** and was entitled **'Forecasting for the PCB Industry'.**

Francesca began by outlining why forecasting was needed; essentially, good forecasting enabled senior company managers to take their businesses in the appropriate direction. When forecasting for the PCB industry, it was important to monitor a number of other economic sector growth factors e.g. the semiconductor industry.

Most economic factors tended to show positive growth curves, but quite often these could also be quite erratic when data was reported on a month by month basis.

Smoothing over a suitable period such as three, six or twelve months could thus be useful in ironing out these erratic swings for forecasting.

Leading indicators were also useful for analysing the general economic state of the economy, e.g. house build starts and this type of information was just one of the many sources that were used to help produce an accurate industry forecast.

BPA had also developed a methodology for longer-term forecasting which enabled them to produce accurate sectoral forecasts e.g. for PCBs and computers etc.

BPA also had over thirty years of cumulative data which it could draw on to help produce future forecasts. Some examples of historic forecasting were given and compared to what happened in reality; the results had generally turned out to be remarkably accurate. Some of the factors that could upset a forecast were also discussed.

Information such as PCB lead times was also able to help give a good indication of what was actually happening in the industry.

European PCB price trends were shown and it was stated that European PCB prices were currently showing a slight increase, despite the pressure on prices from China. European electronic equipment production was predicted to be flat during 2008 with some resumption of growth occurring in 2009.

Towards the end of the presentation, example road mapping information was also presented including the **'Flipchip BGA Substrate Technology**' roadmap and this included information on the likely trends in materials and pitches as well as who was typically using this technology.

Kyocera's CPCore, Ibiden's Filled Via Stacked-up Structure (FVSS) and Endicott Interconnect's interconnection technologies were also introduced.

Overall, this seminar provided the attendees with information on three disparate but important and interesting subjects that should be of key interest to all those involved in the PCB industry.

Martin Goosey
12th February 2008

This paper is reproduce in memory of **David Kingsley** who died recently. (Obituary page17) David wrote this in 1989 and presented it at the **'Printed Circuit World Convention 5'** held in Glasgow in 1990'

PCB'S on the Cheap

by David Kingsley

Adstract

During the last two decades printed circuits have become highly sophisticated requiring new dielectric materials and higly expensive capital equipment..

However, over the same period, whilst. the actual cost of manufacturing has risen allowing for inflation, the relative price of boards has fallen such that many fabricators have ceased trading because of supplying boards 'On the cheap'.

This paper attempts to put the case for board manufacturers to receive a fair price for todays highly sophisticated products.

1.) Introduction

The content of this paper is provocative and intentionally so since the author holds the belief that for many years the true value of certain types of printed circuit boards are being sold at unrealistic prices, hence the title - PCB'S on the Cheap.

It must be stated that the views expressed are those of the author and do not necessarily reflect the view of the authors company nor of any other individual.

As a result of low prices we have in the U.K. an industry which is having to lower its standards in quality, service and technology jn order to survive. During the last year or so many companies have not survived and we are now experiencing a reduction in the number of qualified U.K. sources.

The main area of concern is that of the military multilayer market where volume is low, product mix is high, qualification and maintenance of approval is expensive and technology is at its highest level.

In order to draw meaningful comparisons the product must be qualified as a multilayer board of 6 layers or more, generally manufactured in FR4 materials and released in accordance with military requirements. Typical quantities would be a max call off of perhaps 20 - 30 per month and with a total per type 200 - 400 spread over a relatively long period. Because of the wide range of board style and shape it is easier to equate prices with the square foot area of product based onloaded blank size.

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2.) History

Twenty years ago, multilayer boards were in production for military requirements and the state of the art was such that there were a number of facilities in the U.K. which were able to produce such boards in production quantities. In other words, the prices being paid for such boards in 1969/70 were subject to competition, there was no monopoly of the market by a single source.

Although it is fair to say that the number of able manufacturers were less than of today the requirements for multilayer boards were also less, supply and demand formilitary product in 1969/70 was more or less the same as today.

So what was the state of the art in 1969/70

	1969	1989	2009
No. of Layers	6	8	
No. of Holes	1000	1500 - 2000	
Track widths/gap Track	.015" (.375mm)	.008" (.2mm)	
Hole size	.035" (.9mm)	.014" (.35mm)	
Hole / thickness ratio	1 : 2	1 : 4	
Solder Mask	Screen Print	Dry Film/Photoimagable	
Plated Finish	Tin Lead	HAL / Flow melt	
Registration	± .008" (.2mm)	± .002" (.05mm)	
Artwork	Metal masters / glass Camera reduction	CAD Generated Photo plotted	
Inspection	Manual	A.O.I.	
Test	0/V - power isolation	Full electrical to net list Robotic via CAD data	
Conformance	DEF 59-48 / BS4597	BS9761,MILP55110, CECC	
Difficulty Rating	1	18	
Tooling costs*	£65,000 per set	£5,000 per set	

Table 1 Typical parameters - Double Eurocard

** Based on 17 types per set. Value as per 1989 factor x 7*

This means that the cost of implementing quality control has risen dramatically in recent years particularly with the added needto qualify to national (BS.9000) and international specs. (CECC, MIL).

The cost of obtaining approvals and then maintaining them is increasing yearly and again a great deal of capital eqipment is necessary in order to actually test and measure the product.

Table 1 shows typical parameters for both 1969 and 1989; remember that we are discussing fairly standard production items rather than advanced technology.

Firstly was the realisation of the design into working film and in the U.K. this was achieved by camera reduction of a metal master from 4 : 1 down to 1 : 1 on either photographic film or glass. The metal masters were hand drawn using an adhesive backed opaque tape which was of course very labour intensive, and then photographically coverted into 1 : 1 secondary masters. Working photography was then produced by contact printing onto thinner film which was subsequently punched with tooling holes for registration.

Included on the film were targets which allowed each piece of film to be punched relatively accurately, the overall accepted accepted registration tolerance between any two layers was ±.008"

The usual number of layers of a military board was 6 comprising a pair of ground and voltage planes, two internal tracking layers and two external tracking and pads combined. Gold plated edge contacts were normally required and the typical number of holes in double eurocard (8" x 6") was 1000 at .035" - .039" dia.

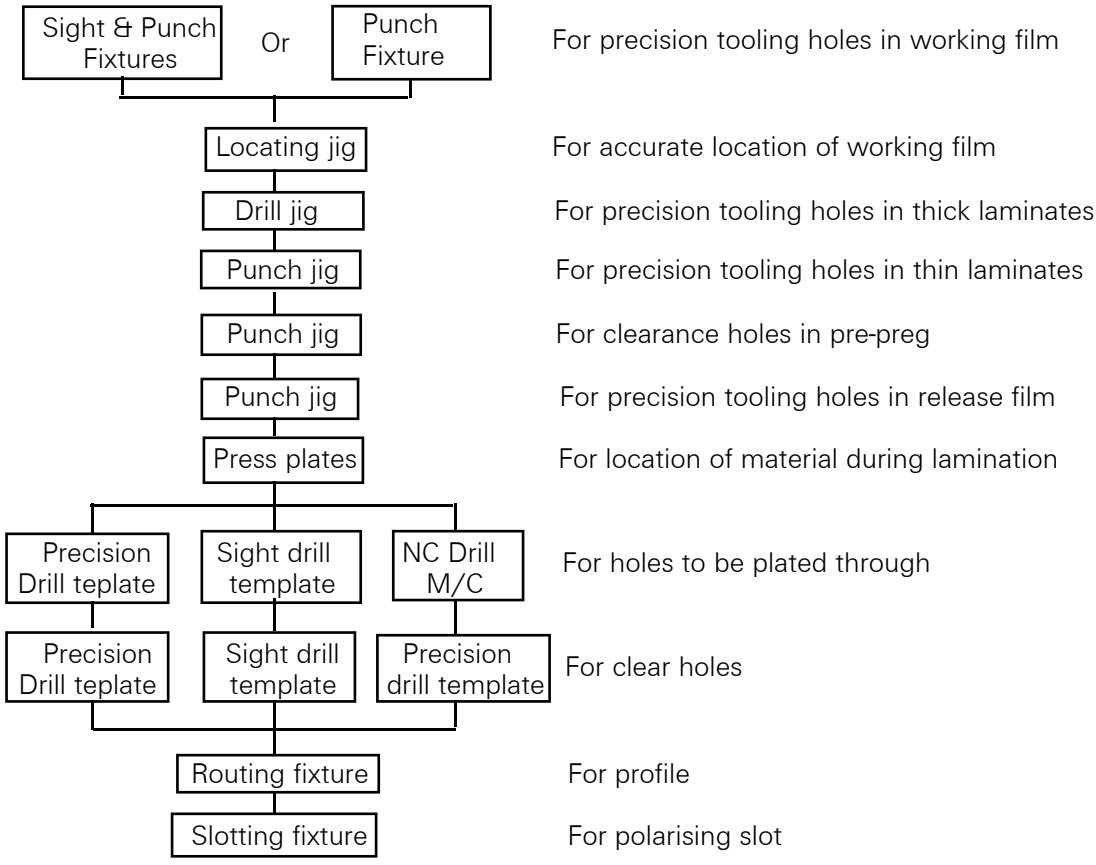

Table 2 Multilayer tooling requirements 1969

Track widths and gaps were of the order of .015" and imageing was achieved using wet photographic resists (primary dry film resists were in their infancy). The final plated finish was gold flash on nickel or tin-nickel or, more typically, unreflowed plated tin- lead alloy. Solder mask, if required, was screen printed using two-part epoxy. Reflowed finishes were not typical of the period although some customers requested a hydro-squeezed process which resulted in poor solderablity after storage and was soon discontinued.

3.) Tooling

Table 2 shows a typical tooling requirement for 1969 and there was very little or no sophistication such as we recognise today. Apart from the early N.C. drilling machines most other tooling was manufactured in accordance with the style and requirements of the individual board specified.

CAD was not yet established to the stage where drill data extraction and panelisation was available, master artworks were digitised manually to obtain drill data tapes which in turn had to be reprocessed on a computor in order to drive the N.C. drilling machine.

It is important to note that costs for a complete set of tools to produce say 17 different types of multilayer boards which would comprise a typical build in 1969 was in the re-

gion of £9-10K, in todays money that would equate to approx. £65K. These would be separated costs and not amortised into the cost of the boards.

Films were punched using sight and punch fixtures which were unique to the style of board, the laminates and unexposed films had their own punch fixtures, thick laminate was drilled using a drill fixture.

Drilling was initially achieved by using a precision bored template fixture which was located onto an inverted drilling machine although by 1970 N.C. drilling machines were being utilised for the plated throgh holes. This lowered tooling costs and increased the accuracy of the drilling.

Press plates for laminating were very much as they are today but final clear hole drilling and routing was achieved using precision made jigs.

4.) Capital Equipment

Twenty years ago capital equipment was relatively simple, mainly electro-mechanical with very little electronics and without numerical control (N.C.)

In almost every area of process there have been signifcant improvements to both equipment and chemicals that are in use today, and indeed without these improvements it would be impossible to manufacture multilayer boards to todays requirements.

However, these improvements do not come cheaply and money has to be found to re-invest in capital equipment so that board manufacturers can keep pace with the demand of high technology.

So what is new today compared with 20 years ago ? For a start, tooling is much reduced to handling electronic data by the use of a CAM station. These sophisticated front end systems enable vendors to receive data from customers direct via a modem or in the form of magnetic tape. This data is then verified by the vendor on a display screen, amenments can be made if necessary in conjunction with the designer (who now uses CAD), panelised for production by electronically adding robber bars, test coupons, legend, step and repeat images, etc.. The data can then be converted on film by plotting at 1 : 1 on a high speed laser plotter enabling first generation photo-tools to be used.

Inspection of the photographic image, can be carried out by an AOI system which can inspect to the design data incorporated electronically by CAD or to data manually inputed to the AOI machine.

Laminate blanks and pre-pregs are today punched using purpose built universal punch fixtures and photoresist is applied using dry film materials which involve special vacuum laminators. Printing of images is carried out using double sided high intensity UV expoure units and developed in enviromentally friendly aqueous developers.

Etching machines are now developed to consistently etch fine line tracks and to handle the ultra thin laminates that are generally used today. For cleaning, scrubbing machines are also designed to handle thin laminates and conveyorised stripping now forms part of the etching machine.

Although the basic requirements for press plates remain unchanged the ypical platen press of today is designed for a wider range of temperatures and pressures and will al-

1969	1989
Reduction camera	Front end tooling, CAM, Photoplotter
Double daylight platen press	Micro processor controlled platen press with/ without vacuum assistance
Brush cleaner	Brush cleaner for thin laminates
NC Drilling machine	CNC Drilling/Routing/machine
Etching machine	Micro processor controlled etching and stripping line
Liquid roller coater for front end imaging	Dry film laminator with vacuum and de-staticiser
Exposure unit	UV High speed exposure
Solvent developer	Aqueous developer
Plating lines and chemical desmear	Automated plating lines, Plasma or permanganate desmear
Inspection magnifiers	Automated Optical Inspection
Screen printer	Precision screen printer
	X - Ray machine
	HAL system, Hot oil or I/R reflow
Effluent tanks	Effluent treatment plant
	Water recirculating plant

Table 3 shows the relative rquirements for capital equipment

most certainly be micro-processor controlled. For some designs, vacuum assisted bonding is necessary and in some facilities the platen press has been replaced dy an autoclave which has many claimed advantages.

Once bonded, drilling of multilayer boards will be accomplished by the used of a sophisticated CNC drilling machine which will have facilities for data storage, programming, auto tool change and profiling.

After drilling, it is necessary to desmear the dilled holes by chemically attacking the smeared resin and removing it. Twenty years ago the universal method was to use sulphuricacid dip followed by vapour honing and although this process is still used today by some companies the majority of fabricators use plasma or permaganate to de-smear or achieve some degree of each back.

Apart from the use of automated (processor controlled) plating lineslittle has changed from the concept of electroless and electrolytic plating of twenty years ago. Of course there are innovations such as horizontal processing and pulse plating and it must be said that proprietary solutions used for plating have excellent throwing power and distribution, are easier to use and are backed up by excellent technical service.

The biggest change regarding surface finish is the almost universal requirement for a flow melt or hot air levelled tin-lead. The former requires either an infra-red or hot oil system whilst the latter involves the use of an integrated pre-clean, solder level and post clean conveyorised process which is usually installed as a stand alone system.

5.) Effluent Treatment

An area of major concern to all is the question of affluent treatment and the effects of the 1989 COSHH regulations. Every manufacturer using chemicals or substances hazardous to health has a moral and legal obligation to ensure that steps are taken to prevent damage to individuals or to the environment.

This does mean a significant increase in costs for the board manufacturer and together with the necessary and proper concern for control over water pollution, water treatment plant and re-circulation may be the only way forward for many board makers but the capital cost will be very high.

6.) Approvals

Since 1969 the rquirements for the manufacture and release of boards for the military has followed the need for more and more quality control and today a total quality system must be in place in order to receive orders.

This means that the cost of implementing quality control has risen dramatically in recent years particularly with the added needto qualify to

7. Relative Costs

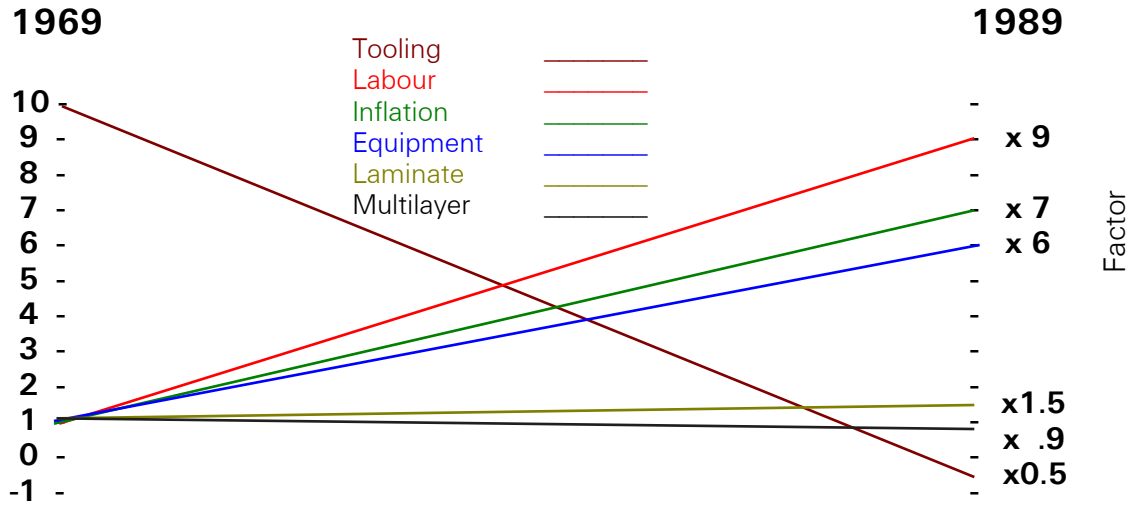

Table 4 Relative Costs - Movement of costs shown as a factor comparison

	1969	1989	Factor
Ford Escort Saloon	£793	£7150	x 9
Gallon petrol	£..31	£ 1.89	x 6
20 Filter Cigarettes	£ .21	£ 1.55	x 6
Pint best bitter	£ .12	£ 1.25	x 10
Semi-detached house (SE)	£5,000	£120,000	x 22
Average earnings/wk	£26.10	£239.70	x 9
Retail price index	18.4	126	x 7
Gold	£14.67	£229.5	x 15
Tin	£1451	£5486	x 3.75
Copper	£620	£1734	x 2.8
Laminate	1	1.5	x 1.5
NC Drilling Machine	£24,000	£120,000	x 5
Double daylight press	£ 5,000	£ 40,000	x 8
M/L Boards per sq/ft	£ 54	£ 48	x 0.9

Table 5 Commodity prices over 20 years

national (BS.9000) and international specs. (CECC, MIL).

The cost of obtaining approvals and then maintaining them is increasing yearly and again a great deal of capital eqipment is necessary in order to actually test and measure the product.

8.) Complexity

In order to demonstrate the increase in complexity of multilayer boards due to technological change a simple formula can be used and Table 6 shows the increase in complexity of a typical multilayer board. This shows that a factor of 18X can be given to todays board compared with the technology level of 1969.

Year	No. Of Holes	No. Of Layers	Track Width	Aspect Ratio	Hole Diameter
1969	1000	6	.35mm	2 : 1	0.90mm
1989	1500	8	.20mm	4 : 1	0.35mm

$$\text{Difficulty Rating} = \frac{\text{No. Of Holes}}{1000} \times \frac{\text{No. Of Layers}}{6} \times \frac{.35}{\text{Track Width}} \times \frac{\text{Aspect Ratio}}{2} \times \frac{0.9}{\text{Hole Diameter}} = 1$$

1969 parameters substituted into formla give a value of 1
If 1989 parameters are substituted into formla it gives a value of **18**

Table 6 Difficulty Rating Chart

Acknowledgements to :-
Dr.A Angstenberger
Leitron GmbH
for the "Difficulty Rating Chart"

9.) Summary

Remember that this paper is concerned not with the high volume multilayer producers, nor with the prototyping and quick turnaround houses but with small batch, high product mix typical of the military and avionics industry.

In comparing the cost of producing military boards over a twenty year period it is evident that whilst costs have generally increased in line with inflation at approximately severn times, and the complexity has increased many times, the actual selling price remains at about the same per square foot, in real terms a seven fold reduction.

Whilst competition for business remains as it is today there is a danger that if board manufacturers continue to sell at cost or below, then the industry will not be able to survive. With escalating costs including the hikes in interest rates, proprty tax and water rates, high- tech companies are unable to finance the investment necessary to meet the demands of the more exacting designs required by the military and avionics.

It will be said that the PC industry sets it own prices but the system of subsidies payable to companies that set up in state or EEC aided communities leads to price cutting in order to gain orders. This in turn puts pressure on the independently owned, self financing companies that form the backbone of the printed circuit industry.

Customers continuously strive to lower the price of boards whilst at the same time insist on a high degree of vendor service to be maintained such as free consultancy, ship to stock and fixed prices over long term contracts.

Whilst a vendor is delighted to be consulted over the foregoing it must be remembered that the cost of service has to be paid out of profit.

NO PROFIT - NO VENDOR - NO SERVICE !

The demands of technical progress requires PC manufacturers to develop new materials and processes in order to satisfy todays designers. In the past, much of the development work was carried out by R & D elements of a captive PC shop and used in that company's product. Thus the industry kept abreast of and indeed promoted the technical innovation that has seen a tremendous growth in PC technolgy. To keep up with the even faster developments in silicon technology the growth in PC requirements needs to be even faster.

Unfortunately, the last year or two has seen the demise of many of the captive PC Shops putting the onus of developments onto the independents. This they are happy to do but without adequate funding it becomes a financial liability and can only be achieved by having a pricing structure that will allow for research and development by the independents.

The electronics industry is an integrated one and relies on many disciplines and specialists in order to survive nationally. Please help.

David Kingsley - 1990

David Kingsley

Production Engineering leader of successful Printed Circuit Technology

From the late 60's to the mid 90's David Kingsley, who has died age 74 after a long illness, played a prominent part in the race to develope sophisticated Printed Circuit Technology.

David came into prominence as Group Leader of the Printed Circuit Group, Digital System Division of Ferranti Ltd. , Bracknell where he specialized , over a period of 20 years, in Multilayer development and manufacture with special interest in soldering, solderability and rework. In the latter area he made a significant contribution to the introduction of a British Standard for rework.

In a later period at Ferranti Computers he became closely involved with the development of Substrates and Assemblies for SMT with particular emphasis on copper-clad Invar Cores and Polyimide Glass Dielectric.

After leaving Ferranti he joined Graphic Electronics at Crediton, Devon, as their Technical Director where he was responsible for all technical activities at the company including the maintenance of approvals.

David was a Chartered Production Engineer and a member of many professional Societies to whom he made a considerable input.

He was an Author of many Technical Articles and in 2000 he was elected an Honorary Fellow of this Institute in recognition of his contribution to the Printed Circuit Industry.

Subsequently in his retirement David donated his entire collection of 35mm slide presentations, which covered his work over a period of nearly 40 years, to our Institute. This Treasure Trove will be catalogued and digitized and eventually uploaded onto our Web Site to form the *David Kingsley Library* for use by our members.

John Walker Hon. Sec ICT

David Kingsley, production engineer, born 1st March 1933, died 29th January 2008

The Membership Secretary's notes February 2008

With just over 200 registered members, we can claim to have the cream of the UK PCB Industry! It is a little known fact that the Institute have an informal help desk running through the Web site

www.InstCT.org

and with the vast amount of expertise within our membership, we can call on members, who are acknowledged authorities in their field to comment on issues raised by members.

We would like to congratulate Chris Hunt of NPL at Teddington, who has been awarded an IPC Distinguished Service Leadership Award. Thanks to Chris, we have held our Annual Symposium at NPL in 2006 and 2007. We would also like to thank another of our long term members, Kelvin Leigh of Eurotech Group for supporting our Arundel Seminar and AGM in February. The write-up was recorded by Martin Goosey and is in this edition of the Journal. Members, Darren Southee of Brunel University and Francesca Stern of BPA both gave presentations at this lively event.

One of our American Members, Walt Custer has given the Institute permission to distribute his monthly Circuitree Market Outlook Column and it will now be sent On-Line to the membership on a monthly Basis - thanks, Walt!

The Obituary on the sad death of one of our Honorary Fellows, Dave Kingsley is recorded above, but I would like also to thank another of our members, Dennis Price, who has kindly offered to catalogue the extensive collection of 35 mm slide presentations, which Dave donated to the Institute. The cataloguing is likely to take some time, but we plan to have the Presentations digitised to form the *Dave Kingsley Library* on our Web site for use by members

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