Review EIPC WINTER CONFERENCE, TOULOUSE, FRANCE, 28TH & 29TH January 2010

DAY 1

This very well-attended conference opened with a welcome from **Rex Rozario**, the EIPC Chairman, who remarked upon how, even during the recent recession in Europe, EIPC had continued to offer services to the industry, notably with workshops in Germany and UK on flame retardants, and a seminar on ionic metallisation at the University of Leicester, all within the last 6 months. He remarked upon the opportunities open to the industry for technology transfers to the Far East which in turn can lead to revenue streams coming back into Europe, and he emphasised that the high-technology boards required for strategically-critical demand will remain from the medical, defence and aerospace industries within Europe, as will the profitable and demanding quick-turn market.

Walt Custer gave his customary ebullient presentation on the world economy and market statistics. Industrial production figures showed that whilst the worst is behind us the recovery still has a way to run, and the euro zone economy has recovered but he wondered how much of this was really down to government stimulus, which is to end shortly. $1712 billion is the value of the electronic equipment market, and Europe has around 13-16% of the assembly side of all of this. Growth is being seen for Q1 for 2010, with low inventories, which is good. Manufacture of PCs, electronic and optical products in Europe is lagging the rest of the world, and we are well down on the same time last year. In electronic equipment shipments, Taiwan and China have recovered well, with Europe having some way to go. Walt always has a barrage of data for the delegates to listen to, interspersed with the occasional spoof item, such as the iCasket, for those who wish to view videos after the grim reaper has called. Growth rates are good in all areas, which will translate into electronic assembly soon enough. In the world of circuit boards, this is a $50 billion business still, and amongst the top 20 PCB manufacturing companies, USA has but two, and Europe only one, with Japan and Taiwan still producing the major players. In Europe there is $3.658 million market for rigid and flex circuits, which is declining, but shipment growth shows some recovery. The following comments from Michael Gasch pretty much covered it all.

“We had a remarkable year; nothing was "as it was". From May onwards we observed an accelerating improvement - although the turnover in 2009 was 30% below 2008 and 40% below the (extreme) year 2000. Bookings were 33% below 2008 and just half of what was ordered in 2000. In 2009 we have seen the insolvency of Ruwel (which survived as a shadow of itself) and of Fuba (which at the moment is finishing its last

orders and then is to close "for good."). The remaining "Ruwel International" might reach just a third of last year's (2008) turnover.

On the other hand, it was similarly remarkable that almost all companies were able to cling on to life (at least so far). I do expect some nasty surprises during the coming months as the banks now are reluctant to pass on the needed umbrella. (just for our own good so that we won't spend it carelessly). Our customers suddenly are startled that they can't get everything immediately, that there is something called "lead time" and that their supplier seems more reluctant than in the past to accept price decreases (but, alas, there are again those people that won't quit an order at the lousiest price just to avoid letting the competition get it...)
On the employment side we have lost 20% of the jobs that were available last year. Very cautious new recruitment is beginning - perhaps it will last".

Although some positive growth rates will be seen this year one has to set this against the background of the really bad 2009; however, we will not be going back to where we were in mid-decade. Walt's comments basically were that electronic sales are both cyclical & seasonal, and globally we are currently in a cyclical upturn but a seasonal downturn.
Imbalances (higher growth) currently exist in some regions for components (PCBs & semiconductors) vs. electronic equipment, but this cannot last. Inflation is again a concern, as Metal and oil prices have risen. There has been a recent slowing in Germany, and the strong Euro is hurting exports.

2010 looks like a modest "growth year." SE Asia will benefit the most but all areas should expand. With Walt, we get to know where we've been, where we're going, and why. 'How' is a matter for the individual.

Hans Friedrichkreit of PCB Network gave a most interesting and well-researched paper on 'green' technologies, and opportunities for the European PCB industry. Demographics and an aging population mean demands being made on medical services, and the decline in oil availability means pressure on green power, such as wind, solar and fuel cell. Newly installed power generation systems are led by wind turbines, followed by photovoltaics. Germany and Spain lead Europe in wind power generation. 6-7.5Mwatt turbines now operate offshore. In the realm of photovoltaics, Germany (31.4%) has the largest volume of installation, but comes second to Spain (41.3%) as a result of government stimulus, and production of pv cells Europe produces 27% of the demand, against 26% in China. Portugal has some interesting solar panel installations for power generation, with dedicated farms. There is a very high demand for high-copper large PCBs (2 boards per 18" x 24" panel) used in the invertors, this is a Euro 100 million market, and Schweizer, for example, is one of the major suppliers of such boards. Hans described the philosophy behind one German PV company, currently approaching a 1billion turnover, who has declared an intention to source all their components, including PCBs, within Europe. This is their business model.

The world market for photovoltaics is showing 27% pa. growth, and is now valued at $70 billion. Solar panels are only 14% efficient as yet. In the automotive world, the average

car nowadays has some 60-100 circuit boards within it, and it is predicted that by 2020, 58% of cars will still have a petrol/diesel power train, 20% hybrid, 6% electro and 2% by natural gas.

It is the use of fuel cells that will be exciting, with a range of 600kms, and a recharge time of 3-4 minutes. Hans showed pictures of a Mercedes B-Class fuel cell car that is under evaluation, and a GM Opel Ampera Hybrid. Needless to say the Chinese have a fuel cell car called 'Build Your Dream' but we did not see much detail of this. Finally it would seem that the EU present energy mix is coal 29%, natural gas 22%, with wind at only 8%, but 2050 sees the end of oil and by 2100 we will have most of our energy produced by solar power.

Giacomo Angeloni moderated the next session which commenced with a presentation from **Läetitia Tonnelier** from Airbus France who listed the specific requirements and traceability for circuit boards used in avionics. Domains here are flight controls, warnings, maintenance, and communication, as well as internal security. Board types include backplanes, daughter boards for them such as CPU I/O and power supply. Most are rigid multilayers, with some flex rigid multilayers for the A340. All boards are m/l 4-20 layers, with 14 being more common. Line gap ratio is 120um, with a standard dimension of 200mm x 300mm, all on FR4, with three surface finishes including HASL, chemical tin, and NiAu. They use both leaded and lead-free processes. They work to IPC A-600 + specific Airbus specifications. Ageing tests cover an environment that does not have much vibration and not much heat, thermal cycling 500 cycles -55/+125° with a dwell time of15 minutes, and humidity test 10 days at 85oC, 85% RH, etc. Quality requirements from suppliers include EN9100 and NADCAP accreditation. They run a first article inspection process, and process risk analysis plus a process of looking at continuous improvements that could be done. PCBs are seen as a strategic component, and they use European suppliers for both strategic reasons, and the need for a close working communication, and they have double sourcing by technology type.

Neil Chamberlain from Polar Instruments spoke on the work done on Speedflex 2010, which was the outcome of a demand from a customer to measure controlled impedance stack up simulation in flex-rigid PCBs. It eliminates the ambiguity of design requirements, reduces engineering time, and provides rapid assessment of cost and repeatability of the build. The tool that they have produced manages customer specifications with the integrated stack-up controlled impedance editor. Impedance calculations can be complex, time consuming and offers many opportunities for error. With Speedflex there is now a system that eliminate these opportunities, reduces time and costs. The information from these calculations can be exported in various formats including Gerber, DXF, amongst many others, and based on various materials for which the parameters are known. Speedflex runs a rules check, which highlights materials mismatch, copper imbalance, etc., and lists the material constraints to verify build quality. It creates a professional report and allows the customer to create repeatable "live" stacks complete with controlled impedance information, with maximum time-saving and in a format that is easy to read for those who know what this is all about.

Sybille Schmelzinger from HOLP informed us about the traceability of PCBs using Nutek 2D laser marking technology. There are known methods already include screen printing, laser imaging, inkjet printing, and data is need for tracing as well as security. Traditional (legend) marking print employs readable letters, numbers and graphics which use a lot of space on the PCB. The use of a 2D Data Matrix code means that a great amount of encoded information can be conjoined within a square or rectangular shape. Barcodes comprises 8-12 characters and uses 134 x 20 pixels, whereas 2D comprised 96 characters in a space of 14 x 14 pixels. It is not an additive process like screen print or inkjet, laser marking is a 'green' technology, with no ink drops, no chemicals, no curing process; it is highly accurate, needs only small area, and de-skills the marking process. It is known as the LMC, it uses a CO_2 laser using a servo-controller, and after each marking the code is verified. A neat, efficient and effective way in which board data can be created, applied and verified.

Vjeko Grishaber of Q-Technologies GmbH told us about a new Internet portal for the PCB industry. This is called pcbspecs®. This is a new central database for PCB specifications, for all boards, for everyone to share in a secure way. It makes the RFQ stage that much faster, and saves time, minimises misunderstandings, and carries full and detailed specifications, which secures reproducibility. Usually with PCB specifications, data files are large and unwieldy, contain illegible and unclear data that can be misunderstood. He showed us some alarming examples. All of this is eliminated with his system pcbspecs® can be used in all stages of the supply chain, through design, purchase, production and archiving. It saves time (17 minutes per job on average), saves costs, offers superb security, and better quality and can be used in conjunction with other data managers such as Polar Instruments, Mentor Graphics, and it has received the IT2009 award for innovation by Mittelstand.

Following the theme of traceability and security, **Alexander Schmoldt** from Murata Europe introduced a new system from his company. How to convert a PCB into a UHF RFID-tag, in a word. This is a new technology, which offers a great deal of security for products which can be counterfeited; it provides traceability, and overcomes known problems with barcode labels. The RFID can save costs, is more reliable, and is more flexible than a barcode, as information stored on a RFID tag can be altered, unlike a barcode, and additional user memory is available with an RFID tag. He described how their Magicstrap® could be used within a LTCC (low temperature co-fired ceramic) to form an RFID tag that could be embedded within a PCB, giving a range of 5m for reading as opposed to 0.7m using normal antenna. This can all be done under international standards, so that the use in a board of one tag is good for anywhere is the world. This tag can be completely invisible as it is hidden within the board, (he described how this was done) and adds value as well as security.

After a quite delicious Toulousienne buffet luncheon, the afternoon session covered three different technological sectors of PCB manufacture. Reliability testing was the subject of a paper from **Arndt Steinke** of CIS who was looking at the relevant microsystem tools. CIS is a research institute in the middle of Germany in Erfurt, and they work with microsystems and sensors. In the MEMS field they work on basic

components, piezo-resistive and impedimetric transducers, and in the MOEMS field with particle sensors, levelling sensors, and fluorescence sensors. In their business unit they are working on Si-based solar cell technology, with wafer analysis, module testing, and solar cell processing. He emphasised the demand for test modules, which are used in complex automotive electronics and the use of sensors therein, and specifically one used for measuring condensation. Here test modules are necessary for field tests and for tests in climate chambers, and in coating processes, and Herr Steinke gave us a comprehensive technical insight into how condensation sensors operate with their own 'smart systems' and where they are used, such as behind the dashboard, under the roof, behind the GPS (if fitted) and within the audio equipment. Tests can also be made in various different panels in the car, such that measurement of almost anything can be made almost anywhere.

Reliability is finding out how a product will survive in the field, said **Bill Birch,** of PWB Interconnect Solutions Inc. The impact of lead-free soldering was already known, and the temperatures seen during assembly are the highest that a board is likely to encounter. Stress causes delamination, and damage in via structures. Finding material damage is difficult, there are many conditions that cause delamination, and it is important to know that the materials involved can withstand the conditions of assembly. There is a need to have techniques for this and here IPC have a useful test method. He listed the "do's" and "don'ts" of tests to determine reliability and there were more than a few. In a comparison of solder float tests against the assembly process itself, he was able to show great anomalies. Bill ended with a high-fire round of caveats and cautions.

Dr. Udo Bechtloff spoke on PCBs for HF application, and here problems of signal integration are evident, where an impedance mismatch causes all manner of difficulties. 'High speed' demands SMD instead of through hole packages, BGAs instead of IC's with peripheral pins, amongst others. It's an ohmic situation, as the resistance at the end of the track restricts current flow. Minimal ohmic resistance cause wave distortion, whereas with minimal impedance nice neat line pairs are formed. He touched upon the skin effect which is where most current flows on the outside of the conductor. The skin depth does not tell us how far the current penetrates into a conductor. This was a most helpful technical paper of great value to the board manufacturers present.

DAY 2

Michael Fink is the rather versatile and highly-experienced CEO of Dyconex, a Swiss company whose position in the market is the production of circuit boards of very high complexity. Their customers are in the medical and defence related industries, their turnover is SFr 46 million (2008), and they have 170 employees. The factors of flexibility, quality, performance, and cost, apply equally to the defence and medical areas, and whilst complexity out = cost down, that reduces flexibility. The secret is in the professionalism, the state-of-the-art equipment, and human skills combined with methodology. It's to do with having highly educated people with the right mindset; it's a culture. They are still using plasma etching for very good reasons. Amongst their rigid, flex and flex-rigid production, specialities include stacked vias, fine-line capability (<50 µm lines and spaces), and embedded active and/or passive components. They operate a fully integrated IT structure, with a manufacturing execution system allied to statistical process control, that avoids bottlenecks. With a background in semiconductors, Michael has led Dyconex down a route where they partner with six other companies to form the Micro Systems Technology Group, a unique syndicate out of which comes a complete implant of a system whether for the medical or defence sectors. Michael concluded by saying that Quality will ultimately pay for itself, but it does NOT come for free. High Performance interconnect is NOT a commodity !!

Markus Wille of Schoeller Electronics presented a paper dedicated to the construction of basic stack-up construction techniques. Rigid-flexible circuits are a very well established interconnection technique and are used in a wide range of applications for nearly any market, e. g. consumer products, (viz Apple iPhone) automotive electronics, industrial electronics, medical electronics, telecom infrastructure, avionics, aerospace and defence. Markus showed us how flex rigid circuitry is used in automotive braking systems, one for each wheel. It has application in microelectronics, here he illustrated a swallowable pill with a camera, power supply, and a 6-layer flex-rigid board to connect it all in it, which was impressive to say the least. Rigid-flex can be used to replace cable harnessing, is used in high-speed data transmission, and optical transceivers. Schoeller were involved in a joint research project "hotEL" (Innovative Production Processes for High Temperature Electronics) which have shown that organic substrates for high temperature electronics for the range of 150 °C to 180 °C are available on the market. Multilayer circuit boards made of those materials will withstand that high temperature range with high reliability. This knowledge and substrate technology can also be applied for rigid-flexible circuits, which qualifies them for the next generation of high-tech electronics. Rigid-flexible circuit boards eliminate many connector- or solder joints that are potential sources for failures and therefore provide high reliable interconnection. Rigid-flexible circuits are suitable for high speed data signal transmission. The structures are defined by planar layout design and the electrical properties can be reproduced very easily. New materials like LCP and PEEK can be an alternative to the Polyimide for high temperature applications. However, they are very new on the market and are currently produced in small quantities, so the price is uncompetitive.
During the panel discussion, Markus made the important point that one of his customers had made a survey, and it showed that to achieve the same quality from the Far East, the price compared to Europe was the same.

Giacomo Angeloni of Somacis pcb Industries gave us an impressive insight into the capabilities of the Somacis Group, and the range of products and markets served internationally. However, the goal of his paper was give an overview of future capabilities of PCB European makers versus the rest of the world, particularly the Asiatic countries, Everyone is constantly trying to find ways to increase the line of profit. Even sometimes being. So maybe it means war. So who is the enemy? The enemy is in China, and have enormous, superbly equipped factories, sometimes with 200 drilling machines in one hall, professionally managed and staffed, producing 12 & 14L heavy copper boards of great complexity. And who are we? We are 27 countries in Europe, speaking 23 languages. Talk about the Tower of Babel. And if that was not bad enough we're saddled with the regulation-obsessed EU parliament as well. Is being big good for a European PCB company? Apparently not, as all the big players in Europe have either closed, or moved, or reduced their capacity. Giacomo presented some excellent examples of the type of SBU boards being produced in Europe, which are well ahead of the capabilities of the Chinese, he also looked at the products coming on to the market in the next five, ten and twenty years and the capabilities need to support them. He concluded that for Europe to survive, in spite of itself, PCB companies should concentrate on High mix, low volume; quick turn / quick service; military; aerospace; industrial, medical; innovation and high-tech boards; environmentally friendly materials and processes, and flex/rigid-flex.

Paul Comer, Technical Director at Graphic PLC, used the phrase made famous by Henry Ford, "You can have any colour you like as long as it is green" In fact circuit boards can come in a range of colours! Paul looked in some technical detail at the move towards stacked vias, flex-rigid boards, and advanced materials , and how they were assembled, and concluded by saying that many interconnect options were available, they can be used in combination, most can achieve high reliability, some may effect product requirement criteria. Systems are available to maintain and demonstrate high-reliability in manufacturing, and monitoring and test equipment is available to maintain and demonstrate reliability and compliance of complex structures.

Pierre Emmanuel Goutorbe of the CIRE Group, spoke on why HDI boards are needed. Essentially to accommodate Chip Scale Packages, Fine Pitch Ball Grid Arrays,Ball Grid Arrays, Quad Flat Packs, Small Outline Packages and Dual-in-Line Packages. There is increased demand for medical, avionics, military and space applications, and technology emanating from the consumer market. HDI is standard practice for mobile 'phones, GPS, PDA, and digital cameras. Design now calls for having several components on the same PCB: these components have higher I/O and smaller pitch. HDI has technology benefits, which include blind microvias, core multilayer, and available space for tracks interconnection in the core. Base materials are High Tg FR4 180°C, Polyimide 260°C Copper foils 5~18µm, microvia dielectric material, standard prepregs 106 and 1080. Pierre illustrated layup processes and explained how the CIRE Group use laser drilling for the FR4 with electroless copper for microvia metallisation. Technology trend include embedded passives, tighter impedance control, increased level of microvias & drilling sequences, thinner /special materials and CTE matching between PCB material & devices.

Joachim Goertz from 3M Deutschland presented a paper on performance and reliability benefits of ultra-thin embedded capacitor materials, and he provided a wealth of evidence for the conference to absorb. He showed how discrete capacitor elimination on a telecom board could be achieved even at temperatures up to 260oC. The embedded capacitance material from 3M is widely used and 300 million cell phones have this material within their circuit boards. The electrical benefits of Ultra-Thin Embedded Distributed Capacitance (Power-Ground) are that it lowers impedance of power distribution system, dampens board resonances, reduces noise on power planes, reduces radiated emissions, and the High Dk significantly improves performance compared to the same thickness with low Dk.

Alun Morgan of Isola UK then came to tell us a story. It was all about FR4, and what it is. Didn't we know? We settled down to be re-enlightened. He went back, fondly, to the 1960's (was he born then?) and explained how the technology of incorporating resins into paper led to the production of FR4 in 1962. It was called 'hard glass fabric', and was produced 1.0mm, 1.5mm, and 2mm thickness, with 1oz and 2 oz copper. Punching led to drilling, and wave soldering came along, and with it high temperatures. The need for flame retardancy was evident, and hence FR-4 as a name for this type of laminate. Alun told an interesting tale of the progress from a simple carrier to a sophisticated interconnect platform over the last 40 years. In the beginning, FR-4 was just one grade. Today, more than 10 different grades are approved as FR-4. Thus, if we specify "FR-4" today, it is not enough to characterise a grade in particular. One needs to use suffices Tg, Td, T260 and az to describe a FR-4 grade properly.

Thomas Lantzer of DuPont looked at the evolution of the flexible circuit, how it came about and why it is needed. Smaller, it allows for 3D customisation and packaging, dynamic flex (numerous cycles), flex-to-install (bend and crease); it is thin, has low weight, high density and a reduced thermal path. Polyimide is a dielectric with high speed performance and good chemical resistance. Flex circuits in use in 'cell phones, in the medical field, were illustrated, as was a 24-layer 'bookbinder' board shown as an example of what can be achieved nowadays, and their use in portable phones, for storage, mid-large LCD and COF as well as flex mutlilayer and RF boards. There were many examples of where flex can be used, including aerospace. As for the future, the move is towards thin to thick copper foils, both ED and RA. They can use different metals, and dielectrics.

The technology trend for laminates was looked at by **Sylvestre Cottard** of Winside/Nanya and here he covered in great graphic detail the various aspects of laminate composition, including cloth effect, filler effect (which can improve loss), weave effect, and how NP175F 26l board reliability tests were carried out. That Nan Ya laminates would pass all thermal tests was confirmed. Some papers defy a written review, this was one of them; it deserves the attention of the interested reader by downloading the full text from the internet.

Dr Ronald Kirby of Arlon had thermo-oxidative stability as a subject, and informed us all about functional materials in the real world where they are being used. Materials for leadfree soldering- guidelines designed for assembly life to minimise failures associated with higher reflow temperatures. Their stability study looked at 5 different laminates, and they have found that some materials react with air, causing oxidation. Arlon have a much more stable material, being released this month, and this gives greatly improved signal integrity, which is important. The test was 72 hours at 130oC.

Marc Laureys and **John Hendricks** of Rogers Corporation came with news about new laminates for use in high temperature and harsh chemistry environments, called Syron and XT/duroid™. Rogers specialise in high frequency materials, they have the largest range of high frequency laminates, and their new materials have many benefits as well as being 'green'. The melt point is extremely high, and use in the field includes oil and drilling; the automotive sector for sensors and others PCBs; printing applications, inkjets; RFID tags for harsh environments; airborne radar, lightweight antenna arrays and thin film battery packs. These new laminates are comfortable at 250°C, are resistant to oxidation peel strength at 288°C, and have tested against a wide variety of chemistries, crude oil, various acids, salt water and beer. No mention of wine.

Atotech had sent along **Jaime Peraza** who had being doing some work on corrosion resistance of pcb surface finishes. Corrosion makes electronics unreliable, and so there are increased legislative requirements and increased ecological requirements. Every year corrosion damage produces costs to a value of 4% of the German GDP (€ 100 billion), and about half of all damage in an automobile comes from the electronic systems, mostly due to corrosion. At Atotech they have carried out exhaustive tests, including a SO2 gas test, the Kesternich Test, a salt spray test, and a surface insulation test (SIR). The tests themselves were described, and the test result were analysed. He concluded that Immersion tin, ENIG High Phosphor, and ENEPIG show the best corrosion resistance for the final product.

This was an excellent conference, organised with the usual EIPC proficiency, and with the usual comprehensive range of papers presented most ably by all concerned. Toulouse is a most hospitable city, and thus a very good choice of venue. Congratulations to all concerned.

J.H.Ling
5th February 2010